TROSTRE FORMER LANDFILL, LLANELLI

SURRENDER REPORT

AUGUST 2015

Prepared for:

Carmarthenshire County Council

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1.0 INTRODUCTION

ExCAL Limited have been commissioned to carry out a surrender report on behalf of Carmarthenshire County Council (CCC) for a site in Trostre, Llanelli: Land off Trostre Works Link Road, NGR: 252799 199700.

This report is designed to summarise the information gathered in relation to the site over its operational and non-operational life to conclude whether the development has had a lasting impact upon the state of the environment, and whether or not the existing Inert Landfill License No. LLN/WD/007 is applicable for surrender.

This report has been completed following the guidance of the Environmental Agency document 'Landfill (EPR 5.02) and other permanent deposits of waste (how to surrender your environmental permit)', a copy of which can be found in Appendix A – Environmental Agency 'how to surrender your permit'.

All geotechnical logs (borehole and trial pit) have been compiled and are presented in Appendix B – Geotechnical logs.

2.0 SITE LOCATION

The site is located approximately 300m east of Parc Trostre, near Cefncaeau, Llanelli, Carmarthenshire. The approximate centre of the site is location at NGR: 252799 199700. The site location is shown in Drawing 44-05-02.D02.

2.1 Site Description

The site is surrounded by commercial and industrial land and is bisected by access roads and a roundabout. It is bounded to the south and west by mature trees and shrubs and to the north by shrubs and tall grasses. The access roads predominantly cover the western portion of the site. The area of the site to the west of the roads is elevated above the remainder of the site and comprises tall grasses and shrubs. The area east of the roads is surfaced with crushed aggregate and bunded with soil.

The nearest surface water is contained within a part culverted drainage trench, which runs parallel to the northern boundary of the site, passing beneath the roads and elevated ground to meet the River Dafen to the west.

Trostre Tin Plate Works exists approximately 100m to the south of the site and the A484 road passes northwest to southeast adjacent to the north-eastern boundary of the site.

2.2 Site History

Analysis of the available historical maps provides a basis for the assessment of potential historic contamination through associated land-use. A summary of the history of the site is provided in Table 1 overleaf.

Table 1 – Significant features, changes and developments on-site and in surrounding areas

Dates	Scale	Significant features, changes and developments	
		On site	**Surrounding areas**
1878 – 1901	1:1,250 & 1:10,560	Undeveloped farmland with two water courses; one running southwest across the site to the River Dafen and another running through the centre of the site to a small pond on the southern site boundary.	Residential dwellings surround the site to the northeast, east, south and southwest – *Forest Villa* is adjacent to the eastern boundary of the site and *Maes ar Ddafen Fach* is 50m south. River Dafen bounds the site to the west. Access track west of the site. Surface water (pond) 100m south.
1901 – 1907	1:1,250 & 1:10,560	No change.	Coal shaft 5m south and an air shaft 60m southeast.
1907 – 1916	1:1,250 & 1:10,560	No change.	Coal shaft mapped as *Old Shaft (Coal)* indicating that it is now disused. 3no. additional buildings adjacent to south.
1916 – 1953	1:1,250 & 1:10,560	No change.	Cefncaeau residential development 200m northeast. Works and electricity sub-station 110m south. Buildings adjacent to southeast.
1953 – 1969	1:1,250 & 1:2,500	No change.	Buildings to southeast replaced by tennis courts, bowling green and pavilion. Works 110m south developed with additional buildings.
1969 – 1994	1:1,250 & 1:10,000	No change.	Construction of A484 and access roads to north. Further development at Works 110m south. Garage and buildings 150m northwest.
1994 – 2000	N/A	Site used as an inert waste landfill (Licence No. LLN/WD/007)	Major development north and west including retail park, sports stadium (*Parc Y Scarlets*) and other commercial properties.
2000 – 2011	1:1,250 & 1:10,000	Development of access roads and roundabout. Area east of access roads used as a car park. Concrete lined drainage ditch and watercourse running through centre of site redirected to join watercourse running southwest across site into River Dafen.	

The site remained undeveloped until 1994 when the land was used as an inert waste landfill. The landfill ceased to accept waste in 2000 and was subsequently used for infrastructure to surrounding developments. Notable developments in the surrounding areas include the presence of a coal shaft 5m south (1901 – 1907) and the Works 110m south (1916 – present) of the site boundary.

3.0 ENVIRONMENTAL SETTING

GroundSure reports (GeoInsight and EnviroInsight) provides the basis for the information presented in this section.

3.1 Geology

Made Ground was encountered in all exploratory holes to a maximum proven depth of 8.90m below ground level (bgl). Typically, Made Ground comprised brick, concrete, ceramics, timber, metal, glass, coal, slag and coal tar.

The superficial geology of the western half of the site is Alluvium (Quaternary age) comprising clay, silt, sand and gravel. The superficial geology of the eastern half of the site is Devensian Till (Quaternary age) comprising a mixture (diamicton) of glacially derived materials. Silty clay was encountered at depths between 1.40m bgl and a maximum proven depth of 15.00m bgl.

The underlying bedrock is the Swansea Member (Carboniferous age), which is described in the British Geological Survey (BGS) Lexicon of Named Rock Units as comprising green-grey lithic arenites ("Pennant Sandstones") with thin mudstone/siltstone and seatearth interbeds and mainly thin coals. Bedrock was encountered and proven to a maximum depth of 50.00m bgl. Sandstone, mudstone and coal were encountered at various depths.

3.2 Hydrogeology

The Environment Agency (EA) website shows that the site is not located in a groundwater Source Protection Zone (SPZ).

The superficial deposits (Alluvium and Devensian Till) are shown by the EA website to be a Secondary (undifferentiated) aquifer. The bedrock (Swansea Member) is shown to be a Secondary 'A' aquifer.

A Secondary 'A' aquifer is defined as containing permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

A Secondary (undifferentiated) aquifer is assigned in cases where it has not been possible to attribute either category 'A' or 'B' to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.

Catchment areas for source protection zones are located approximately 8km southwest of the site. There is no known groundwater abstraction located within 1km of the site.

3.3 Hydrology

The nearest surface water is an unnamed tributary of the Afon Dafen (River Dafen) crossing the site from northeast to southwest and joining the Afon Dafen immediately adjacent to the western boundary of the site. The source of the tributary is located approximately 100m north of the site and is culverted beneath recently constructed access roads and a roundabout.

The site is within 250m of a Zone 2 and Zone 3 floodplain. There is a groundwater flooding susceptibility within 50m of the site and the BGS confidence rating for this susceptibility area is moderately low.

3.4 Designated environmentally sensitive sites

There are no environmentally sensitive sites within 500m of the site.

3.5 Condition of land at permit use

No baseline data exists for the site at the time of permit issue.

4.0 PERMITTED ACTIVITIES

Permitted activities are stipulated within the *Waste Disposal Site Licence (Licence No. LLN/WD/007)* issued on 2 March 1994 for the site described as *Land off Trostre Works Link Road, Trostre, Llanelli (Grid Reference SS5279999767)*. The licence relates only to the requirements of the Control of Pollution Act 1974 for the deposit of waste and the use of plant or equipment subject to the conditions set our within the licence.

The landfill ceased to accept waste on 26 February 2000.

4.1 Types of waste

The types of controlled wastes accepted at the facility include only the following inert wastes: -

- Topsoil
- Subsoil
- Brickwork
- Stone
- Concrete
- Clay
- Sand
- Silica (excluding finely powdered waste)
- Glass.

4.2 Quantity of waste

The total quantity of waste accepted daily should not have exceeded 50 tonnes.

4.3 Operations

Operations were to be in accordance with the Working Plan as agreed by the Disposal Authority.

All wastes were to be visually inspected to ensure they conformed to the types of controlled wastes accepted under the conditions of the licence. Any wastes not conforming should have been rejected as unsuitable for disposal.

No operations were to be conducted during the hours of darkness.

No material should have been burnt within the boundaries of the facility.

The depth of any layer of waste should not exceed 1.5m after initial compaction.

Waste would have been deposited in order to encourage surface water runoff from the working face.

No contaminated surface water was to be discharged / permitted to enter controlled waters.

No processing, sorting or re-excavation of waste was to take place without prior written agreement from the Disposal Authority.

Completed areas were to be graded and maintained as detailed in the Working Plan.

5.0 CHANGES TO THE ACTIVITY

No known changes to the activity have occurred.

6.0 MEASURES TAKEN TO PROTECT LAND

No operational records exist for the site.

7.0 POLLUTION INCIDENTS

GroundSure Reports indicate that there are no recorded pollution incidents within 250m of the site.

Historical map data does not indicate any former potentially contaminative land-use on site. Potential off-site sources of contamination include the coal shaft and Works to the south of the site.

8.0 DECOMISSIONING

No formal decommissioning has occurred on the site.

9.0 REFERENCE DATA

Groundwater, surface water and gas monitoring has been carried out on a monthly basis between September 2010 and July 2015 by ExCAL Ltd.

Chemical analysis of soil and water samples was compared to available guidelines; CLEA Soil Guideline Values (SGV's), LQM/CIEH Generic Assessment Criteria (GAC) and Environmental Quality Standards (EQS's).

Table 2 below summarises the list of compiled values and sources of the guidelines used for comparison.

Table 2 – EQS and GAC's for Water Samples

Determinand	EQS / GAC	Determinand	EQS / GAC
pH	6.0 – 9[*1]	Fluoranthene	0.02 ug/l[*1]
Biological Oxygen Demand	<3 mgO2/l[*2]	Benzo[a]anthracene	0.02 ug/l[*1]
Chemical Oxygen Demand	30 mg/l[*2]	Chrysene	
Electrical Conductivity	1000uS/cm*[3]	Benzo[b]fluoranthene	0.03 ug/l[*4]
Chloride	250 mg/l[*1]	Benzo[k]fluoranthene	0.03 ug/l[*4]
Ammoniacal Nitrogen	1 mg NH_4/l[*2]	Benzo[a]pyrene	0.03 ug/l[*4]
Cyanide (total)	5 ug/l[*1]	Dibenzo[a,h]anthracene	0.03 ug/l[*4]
Iron (total)	2,000 µg/l[*1]	Indeno[1,2,3-cd]pyrene	0.02 ug/l[*4]
Iron (dissolved)	1,000 µg/l[*1]	Benzo[g,h,i]perylene	0.02 ug/l[*4]
Sulphate	250 mg/l[*1]	Phenol	30ug/l*[3]
Antimony	5 µg/l[*5]	Nickel	20 µg/l[*1]
Arsenic (dissolved)	50 µg/l[*1]	Selenium	10 µg/l[*1]
Arsenic	50 µg/l[*]	Antimony (dissolved)	5 µg/l[*2]
Barium	100 µg/l[*3]	Antimony	5 µg/l[*2]
Beryllium	None	Vanadium (dissolved)	20-60 µg/l[*1*7]
Boron	2,000 µg/l[*1]	Vanadium	20-60 µg/l[*1*7]
Cadmium	5 µg/l[*1]	Zinc (dissolved)	30-50 µg/l[*6*7]
Chromium (dissolved)	5-50 µg/l[*1*7]	Zinc	30-50 µg/l[*6*7]
Chromium (total)	5-50 µg/l[*1*7]	TPH (Aqueous Phase)	50 µg/l[*1]
Copper (dissolved)	5-112µg/l[*6*7]	PAH (total EPA 16)	1ug/l*[3]
Copper	5-112µg/l[*6*7]	Naphthalene	1 ug/l[*3]
Lead (dissolved)	5-20 µg/l[*1*7]	Acenaphthylene	1 ug/l[*3]
Lead	5-20 µg/l[*1*7]	Acenaphthene	1ug/l[*3]
Mercury	1 µg/l[*1]	Fluorene	1 ug/l[*3]
Nickel (dissolved)	20 µg/l[*1]	Phenanthrene	1 ug/l[*3]
Anthracene	0.1 ug/l[*4]		

*1 Council Directive on pollution caused by certain dangerous substances discharged into the aquatic environment of the community (Dangerous Substances Directive) – List I and II substances
*2 Council Directive on the quality of freshwater needing protection or improvement in order to support fish life (Freshwater Fish Directive)
*3 Council Directive on the quality of surface water intended for the abstraction of drinking water in the member states (Surface Water Directive)
*4 Directive Establishing a framework for community action in the field of water policy (Water Framework Directive)
*5 Water Supply (Water Quality) Regulations 2000
*6 Surface Water (River Ecosystem) (Classification) Regulation 1994
* Standard is dependent on the hardness value of the surface water

10.0 GAS MONITORING

The Environment Agency (EA) document *'The surrender of permits for the permanent deposit of waste'* (2010) states that maximum concentration of methane in waste must be less than 1.5% by volume and the maximum concentration of carbon dioxide in waste must be less than 5% by volume throughout the entire waste body to achieve completion criteria. These concentrations must not be exceeded for at least two years in order for the landfill to comply with the completion criteria.

Gas monitoring was carried out on a monthly basis between September 2010 and July 2015, for methane (CH_4), carbon dioxide (CO_2) and oxygen (O_2).

10.1 2010 – 2013 results

The results of gas monitoring between 2010 – 2011 and 2012 – 2013 are outlined in Table 3 and Table 4 below.

Table 3 – Monthly Gas Monitoring Results 2010 – 2011

Borehole Location	Date	O_2 (%)	CH_4 (%)	CO_2 (%)
1	September 2010	0.2	13	7
2		16.2	0	1.4
3		12.3	0	4.2
4		1.4	0	2.5
1	October 2010	1.7	10	5.2
2		18	0	1.7
3		2	47	9
4		1.2	0	5.1
1	November 2010	1.3	5	6
2		19.8	0	0.7
3		17.1	1	1.2
4		1.8	1.5	3.2
1	December 2010	1.4	1.3	5.2
2		19.7	0	0.1
3		10.8	1.4	2.3
4		4	0	4.2
1	January 2011	0.2	6	4
2		19.3	0	0.6
3		9.2	4.9	2.7
4		0.6	0	2.7
1	February 2011	0.7	5.3	3
2		18.4	0.1	1.1
3		13	2.2	1.7
4		3.2	0	2.7
1	March 2011	0.2	4.5	4.4
2		19.1	2.2	1.5
3		16	0	1.7
4		1.6	0	3.1
1	April 2011	0.7	1	5
2		18.5	0	0.9
3		15.9	0.1	1.1
4		2	0.9	2.2
1	May 2011	0.4	5	7
2		16.6	0	2.9

Borehole Location	Date	O_2 (%)	CH_4 (%)	CO_2 (%)
3	June 2011	14.4	0.8	2.7
4		0.8	0.5	3.1
1		0.4	5	7
2		16.6	0.6	2.9
3		14.4	0.8	2.7
4		0.8	0.5	3.1
1	July 2011	5.5	9	5
2		20.4	0	0.1
3		3.5	4.6	7
4		1.2	2.5	3.3
1	August 2011	0.4	4	3
2		20.2	2	1.1
3		15	0.5	2
4		2.2	0	2.4

Results exceeding the concentration levels are highlighted in yellow.

Table 4 – Monthly Gas Monitoring Results 2012 – 2013

Borehole Location	Date	O_2 (%)	CH_4 (%)	CO_2 (%)	Barometric Pressure	Dip
1	April 2012	7.30	7.00	4.50	1008	Dry
2		19.9	0.00	0.60		Dry
3		19.2	0.10	1.00		Dry
4		0.10	3.00	3.90		Dry
1	May 2012	5.60	8.00	5.00	1021	Dry
2		20.8	0.00	0.60		Dry
3		15.4	4.20	3.00		Dry
4		1.80	1.70	3.10		Dry
1	June 2012	2.70	9.00	6.00	1019	Dry
2		20.3	0.00	0.70		Dry
3		2.30	34.00	6.00		Dry
4		3.40	1.00	3.90		Dry
1	July 2012	2.60	10.00	7.00	1020	Dry
2		19.3	0.00	1.00		Dry
3		8.00	27.00	6.00		2.1
4		3.40	1.00	3.90		Dry
1	August 2012	13.0	4.10	5.00	1013	2.35
2		20.4	0.00	0.80		Dry
3		5.00	24.00	5.00		1.3
4		2.20	2.20	3.50		Dry
1	September 2012	20.9	0.00	0.00	1020	Dry
2		20.9	0.50	2.80		Dry
3		15.2	2.50	0.00		Dry
4		4.80	1.20	2.40		Dry
1	October 2012	3.70	7.00	5.10	1003	Dry
2		19.9	0.00	0.60		Dry
3		6.60	34.00	5.00		1.6
4		4.80	1.20	2.40		Dry
1	November 2012	13.4	4.50	1.70		Dry

Borehole Location	Date	O_2 (%)	CH_4 (%)	CO_2 (%)	Barometric Pressure	Dip
2		20.3	0.00	0.30	1018	Dry
3		19.2	0.20	0.80		1.6
4		2.70	1.00	3.40		Dry
1	December 2012	6.50	7.00	2.90	1022	Dry
2		19.0	1.70	0.40		Dry
3		6.10	2.45	4.20		1.8
4		2.40	0.00	4.00		Dry
1	January 2013	4.10	8.00	3.90	1018	Dry
2		20.7	0.00	0.40		Dry
3		11.6	9.00	2.10		1.6
4		3.60	0.20	3.40		Dry
1	February 2013	5.60	4.80	3.40	1020	Dry
2		20.4	0.00	0.40		Dry
3		20.3	0.10	0.30		**1.6**
4		4.40	0.30	2.60		Dry
1	March 2013	2.40	9.00	2.90	1015	Dry
2		20.3	0.00	0.40		Dry
3		20.1	2.00	0.30		1.7
4		1.10	0.20	2.80		Dry
1	April 2013	7.90	1.30	2.90	1017	Dry
2		18.4	1.20	0.9		Dry
3		11.3	5.20	2.50		2.2
4		4.90	0.20	2.10		Dry
1	May 2013	1.80	3.90	5.00	1024	Dry
2		16.0	1.30	1.40		Dry
3		19.7	0.00	0.80		1.59
4		0.90	0.20	4.20		Dry
1	June 2013	1.80	3.90	5.10	1024	Dry
2		16.0	1.30	1.40		Dry
3		19.7	0.00	0.80		1.59
4		0.90	0.20	4.20		Dry
1	July 2013	2.40	7.00	4.80	1002	Dry
2		13.1	0.20	3.60		Dry
3		19.7	0.00	0.80		1.5
4		2.80	0.00	5.20		Dry
1	August 2013	3.20	6.00	5.00	-	Dry
2		16.6	0.00	1.20		Dry
3		Water logged				Full
4		2.60	0.80	2.70		Dry
1	September 2013	0.50	12.00	7.00	1028	Dry
2		17.1	0.10	2.50		Dry
3		17.2	0.00	2.80		2.5
4		20.2	0.00	1.20		Dry

Results exceeding the concentration levels are highlighted in yellow.

Elevated levels of carbon dioxide and methane were recorded in BH1 – BH4 throughout the monitoring period, with considerable elevated methane concentrations around BH1 and BH3.

10.2 2013 Site investigation

ExCAL undertook a site investigation in July 2013 to determine the potential source of the methane gas. A report of which is available under separate cover, found in Appendix C – ExCAL Site Investigation 2013.

A summary of the investigation is provided below:-

Methane gas is generated as a product of anaerobic digestion of organic matter.

The site investigation involved the excavation of trenches around the area with the most elevated methane concentrations (BH3).

The excavated material was closely inspected to determine whether or not any organic matter was present in the soil, and if so the type and extent.

In an attempt to identify the extent of the organic matter around BH3, excavations were progressively extended away from the borehole until none was encountered in the trial pit.

High concentration wood fragments and other organic waste were encountered during the excavations.

Identified organic matter was blackened which is typical of the effects of anaerobic biodegradation, a by-product of which is methane gas.

The waste examined from this area had a strong odour, typical of organic materials biodegrading under anaerobic conditions.

10.3 Remediation of landfill for organic matter

As a result of the aforementioned site investigation, which showed a large amount of organic matter showing biodegradation believed to be causing increased levels of methane, ExCAL was commissioned in September 2013 by Carmarthenshire County Council to remove all organic matter from the site and re-instate it to a suitable standard to aid in the process of landfill license surrender.

An excavator was utilised to excavate around the boreholes located on site.

The removed material from the trenches was segregated into inert and organic materials, with the organic materials being placed into a skip and transported to a suitably licensed facility.

Figure 1 below shows excavated organic material which had been blackened due to anaerobic biodegradation.

Figure 1 – Blackened organic material

As material was segregated, the remaining inert material was compacted back into the initially excavated area.

This cycle was repeated until no further organic matter was encountered in the areas of interest.

10.4 2013 – 2015 results

Monthly monitoring continued to take place following the removal of organic material. Table 5 below provides a summary of 12 readings between October 2013 and July 2015.

Table 5 – Monthly Gas Monitoring Results 2013 – 2015

Borehole Location	Date	O2 (%)	CH4 (%)	CO2 (%)	Barometric Pressure
1	October 2013	0.00	0.00	6.00	1006
2		0.00	0.00	0.10	
3		Water logged			
4		0.00	2.50	5.00	
1	November 2013	20.9	0.00	0.00	1025
2		20.4	0.00	0.40	
3		20.9	0.00	0.00	
4		13.1	0.00	2.10	
1	February 2014	0.40	1.80	5.20	1000
2		20.9	0.00	0.00	
3		16.6	0.10	0.30	
4		0.40	1.80	3.50	
1	March 2014	19.8	0.30	0.60	1027
2		20.5	0.10	0.70	
3		19.2	0.00	0.30	
4		11.0	0.20	2.40	
1	May 2014	16.5	0.00	2.00	1018
2		19.2	0.00	1.10	
3		-			
4		18.0	0.00	1.30	
1	August 2014	19.8	0.00	0.80	1018
2		19.6	0.10	1.20	
3		19.4	0.10	1.20	
4		20.4	0.00	0.70	
1	November 2014	20.9	0.00	0.10	999
2		20.6	0.00	0.30	
3		21.0	0.00	0.00	
4		19.1	0.00	1.40	
1	December 2014	20.8	0.00	0.10	1004
2		20.6	0.00	0.20	
3		20.9	0.00	0.00	
4		18.0	0.00	1.10	
1	January 2015	20.9	0.00	0.10	998
2		20.6	0.00	0.20	
3		20.9	0.00	0.00	
4		19.2	0.00	1.10	
1	February 2015	20.8	0.00	0.10	1002
2		20.7	0.00	0.20	
3		20.9	0.00	0.00	
4		19.2	0.00	1.00	

Borehole Location	Date	O2 (%)	CH4 (%)	CO2 (%)	Barometric Pressure
1	March 2015	20.7	0.00	0.10	996
2		20.7	0.00	0.10	
3		20.8	0.00	0.00	
4		19.3	0.00	1.10	
1	June 2015	19.0	0.00	1.20	-
2		18.0	0.00	1.50	
3		20.1	0.00	0.20	
4		17.6	0.00	1.70	

Results exceeding the concentration levels are highlighted in yellow.

With the exception of October 2013 and February 2014, all measurements fell below the concentration levels as outlined by the Environmental Agency (1.5% for methane and 5% carbon dioxide), with all readings below the threshold in the last 16 months.

It can be assumed that this is a result of the removal of organic material in September 2013.

The results shown in Table 5 have been averaged to represent values for each month throughout the entire site, and are displayed in Table 6 below.

Table 6 – Monthly Gas Monitoring Results for the Entire Site

Date	O_2 (%)	CH_4 (%)	CO_2 (%)
October 2013	0.00	0.83	3.70
November 2013	18.8	0.00	0.63
February 2014	12.6	0.93	2.25
March 2014	17.6	0.15	1.00
May 2014	17.9	0.00	1.47
August 2014	19.8	0.05	0.97
November 2014	20.4	0.00	0.45
December 2014	20.1	0.00	0.35
January 2014	20.4	0.00	0.35
February 2015	20.4	0.00	0.33
March 2015	20.4	0.00	0.33
June 2015	18.7	0.00	1.15

When taking into account the concentrations of gas being generated by the site as a whole, the results for methane and carbon dioxide do not exceed the guidelines outlined by the EA, with the highest readings of CH_4 and CO_2 0.93% and 3.70% respectively.

Figures 2 – 5 on the following pages underline the decrease in methane concentrations at each location throughout the monitoring period.

Figure 2 – CH_4 concentrations at BH1

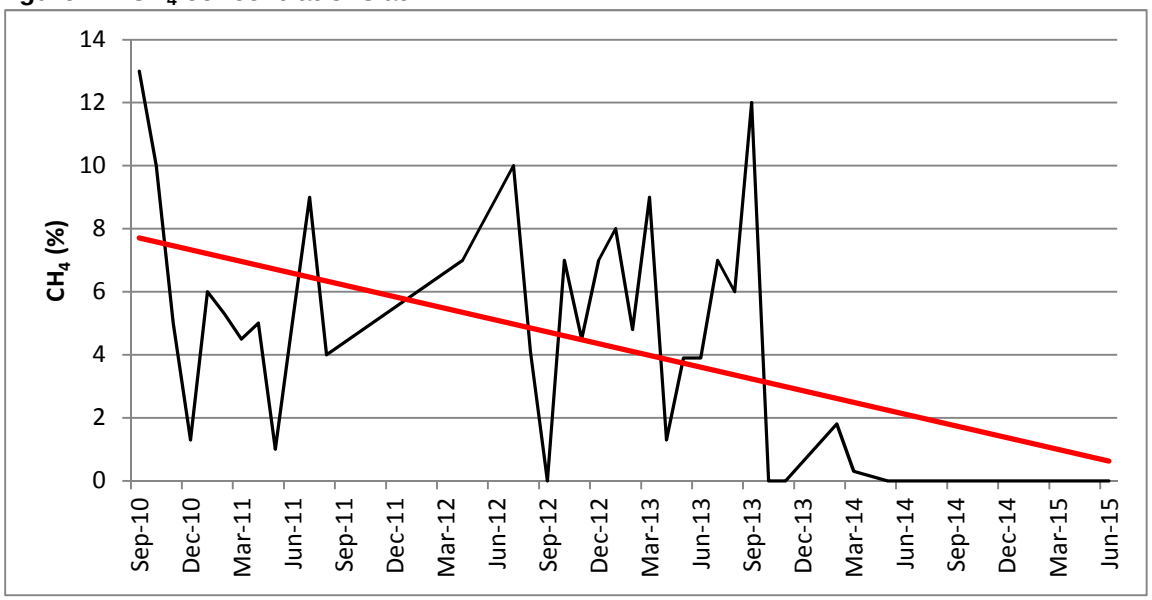


Figure 3 – CH_4 concentrations at BH2

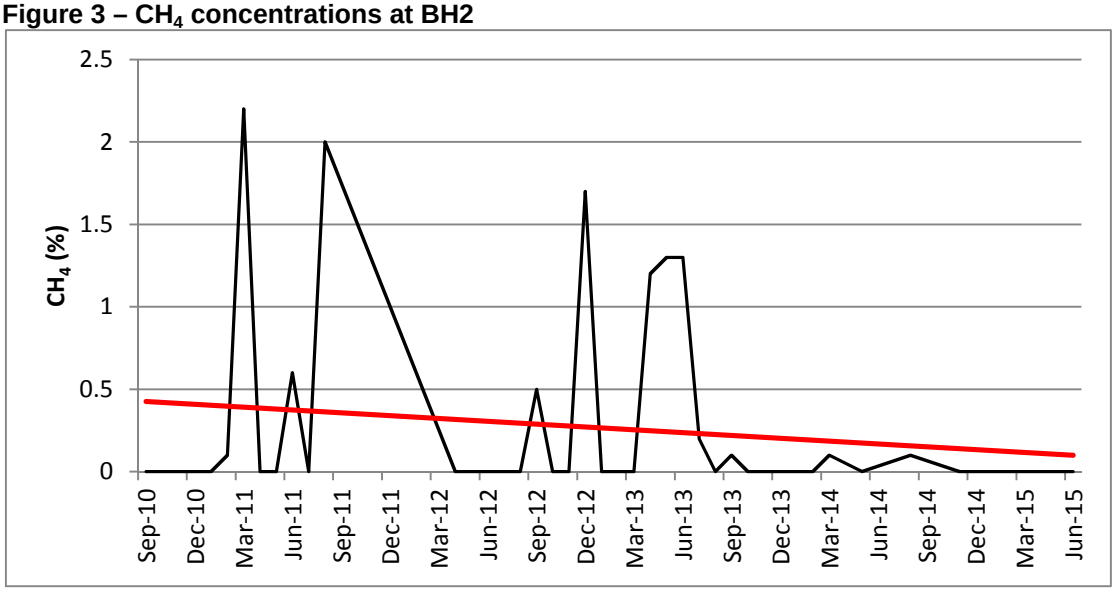


Figure 4 - CH_4 concentrations at BH3

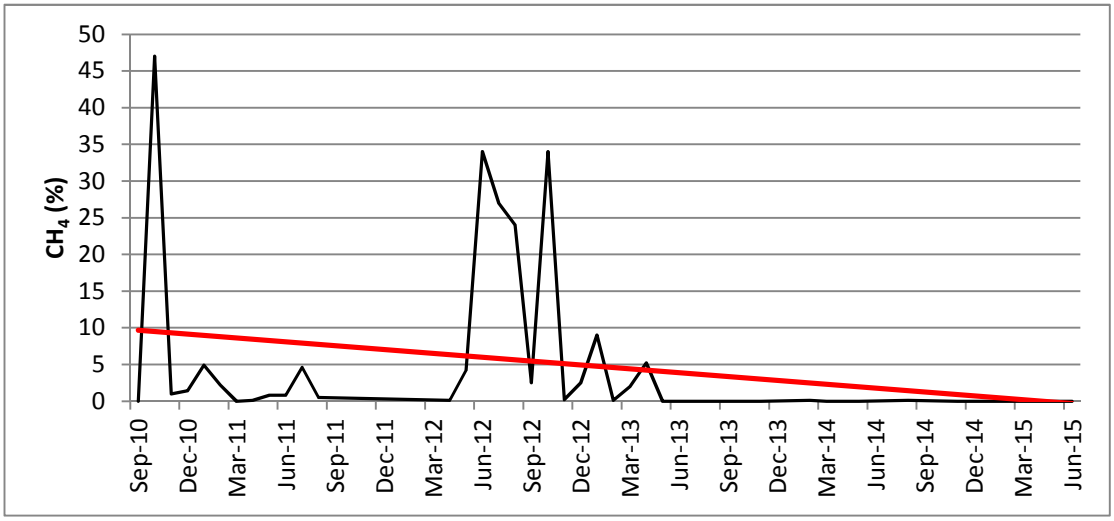
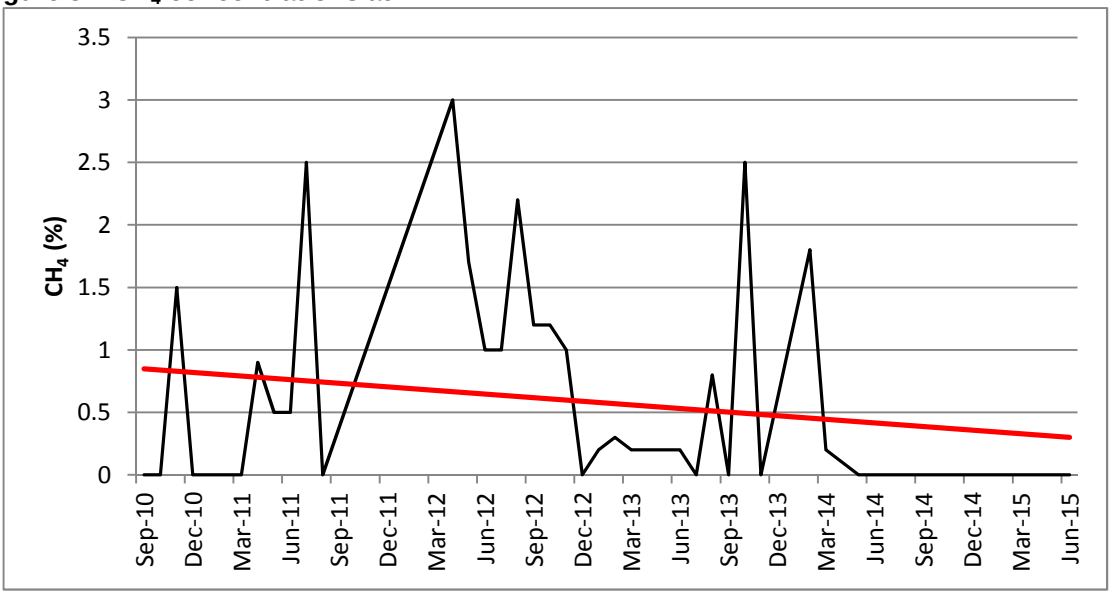


Figure 5 – CH_4 concentrations at BH4



There is a clear indication that the concentrations of CH_4 have decreased considerably since 2010, with levels now well below the permitted concentration levels in all four boreholes required for the surrender of the landfill license.

During the 2010 – 2013 monitoring, CO_2 levels occasionally exceeded the concentration threshold, however more recent monitoring between 2013 and 2015 show that levels consistently fall below the 5% limit, as highlighted throughout Figures 6-9 below.

Figure 6 – CO_2 concentrations at BH1

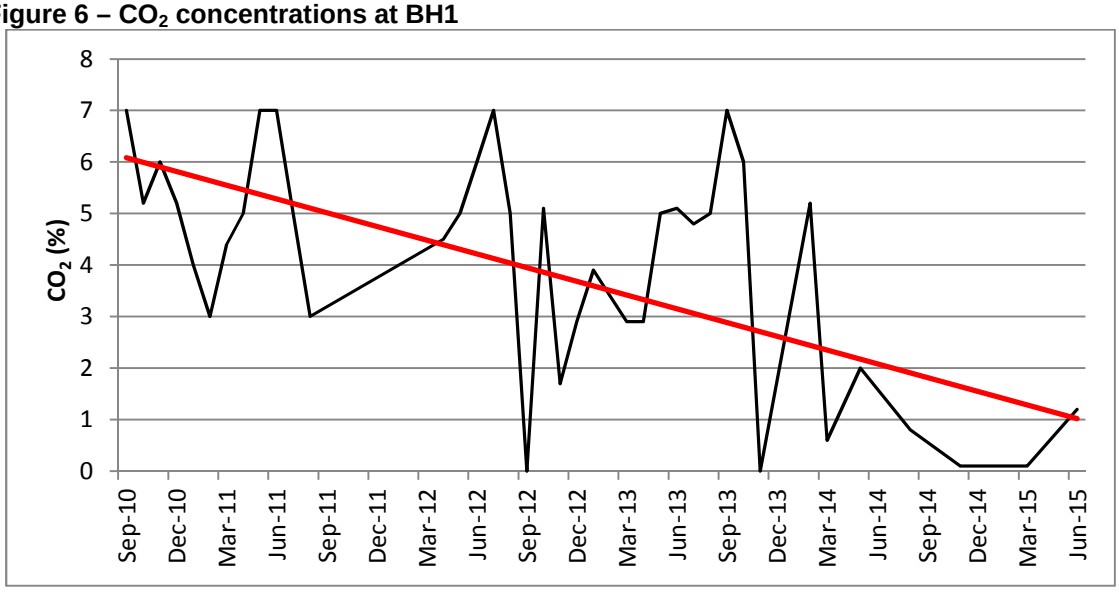


Figure 7 – CO_2 concentrations at BH2

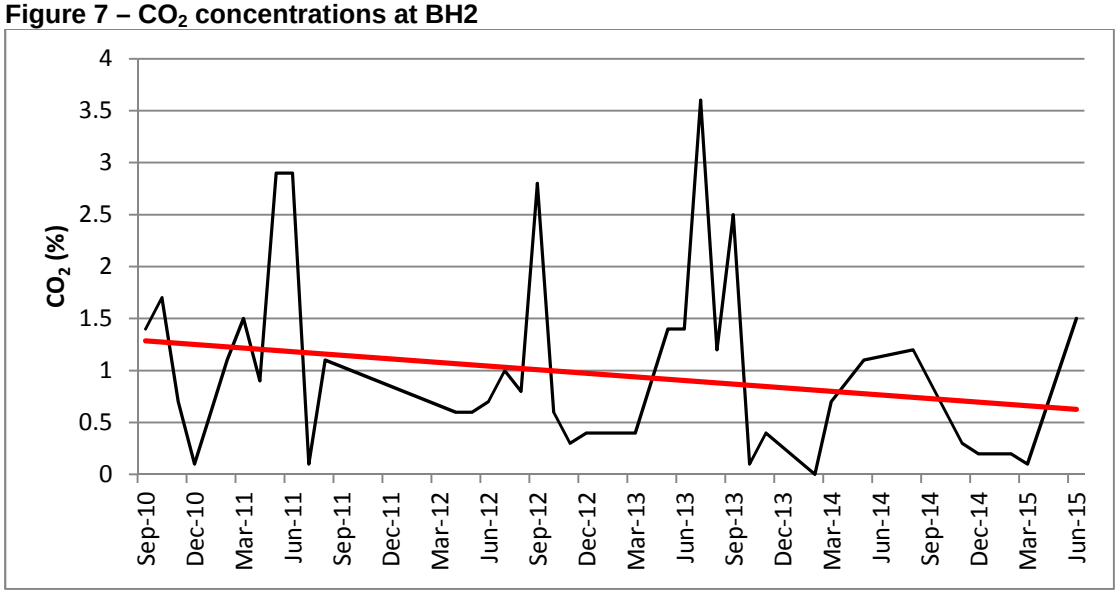


Figure 8 – CO_2 concentrations at BH3

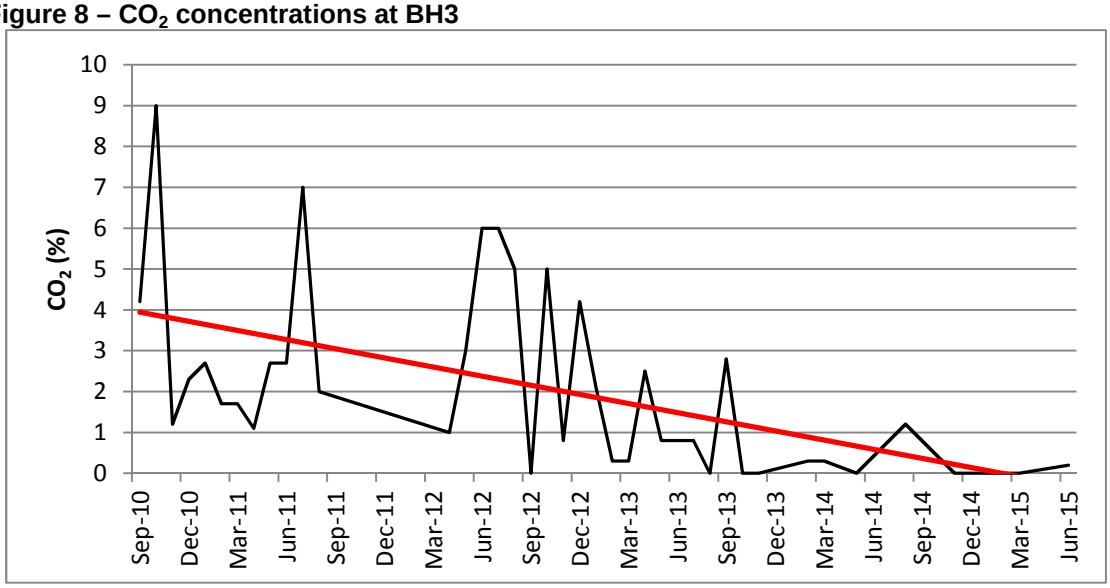
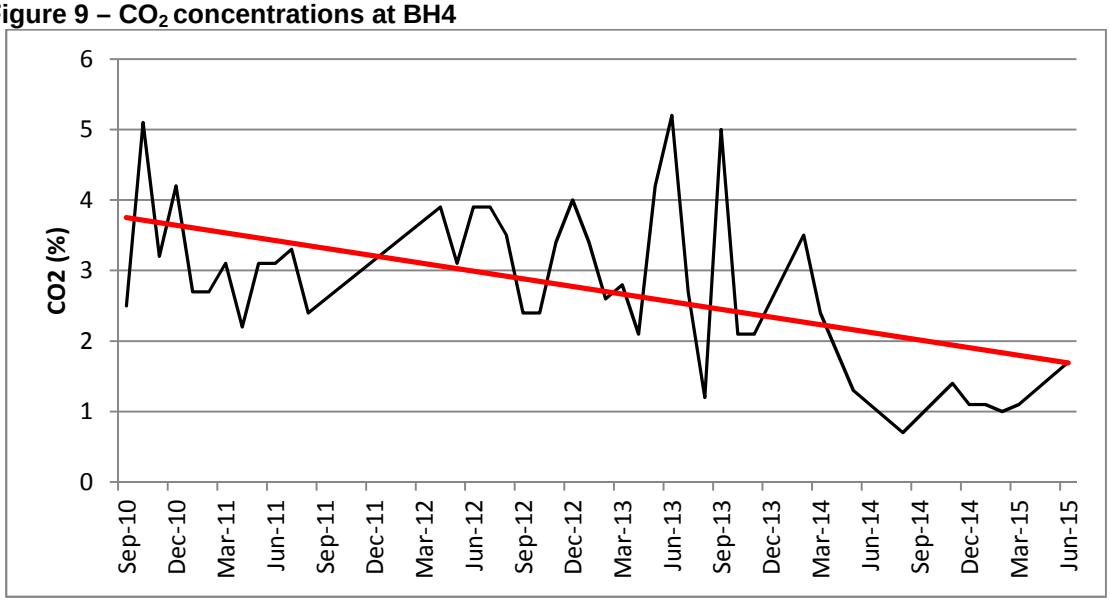


Figure 9 – CO_2 concentrations at BH4



11.0 WATER MONITORING

Monthly monitoring of groundwater and surface water was undertaken between June 2014 and June 2015.

Groundwater samples were taken from BH3, and represent downstream values from SW3.

The surface water monitoring points were selected to provide background concentrations as well as to allow identification of the potential landfill contribution to surface waters.

- SW1 – background concentrations from the River Dafen / Afon Dafen (upstream);
- SW2 – surface waters that are likely to have originated onsite (downstream);
- SW3 – background concentrations for the unnamed tributary of the River Dafen / Afon Dafen.

The monitoring locations can be found on Drawing 44-05-02.DO2 in Appendix D – Drawings.

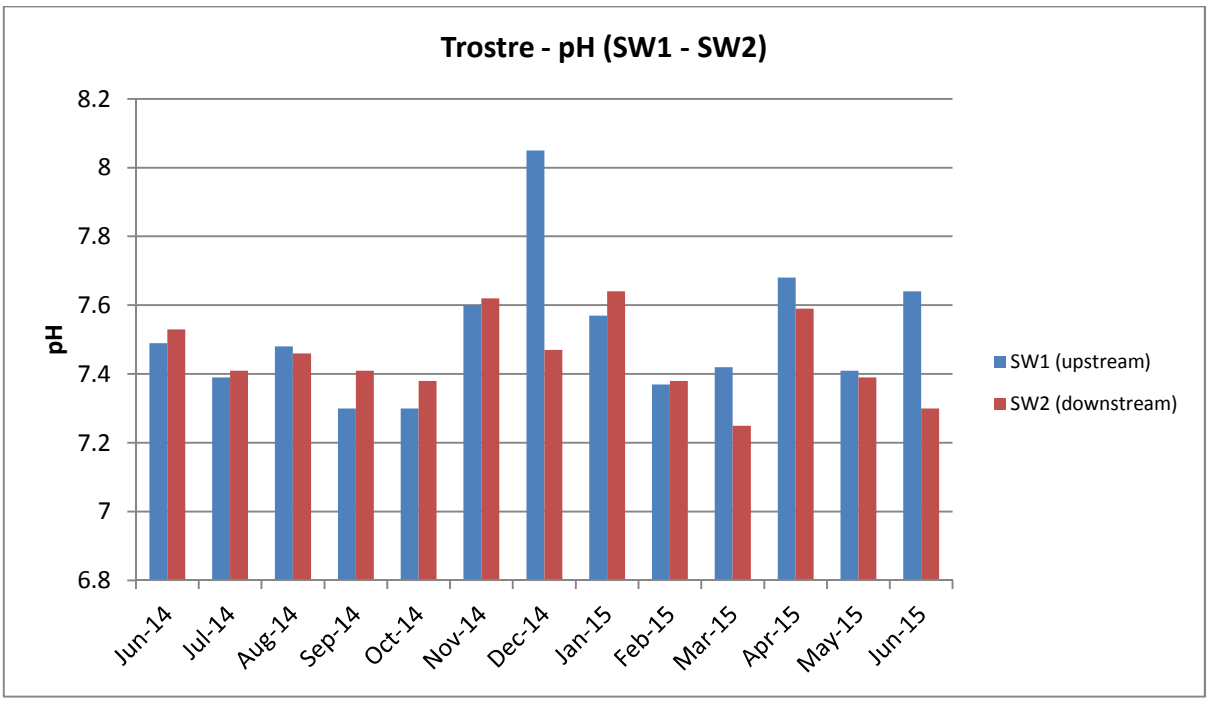
Water samples were analysed for the suite of determinands listed in Table 7 below: -

Table 7 – Suite of Determinands

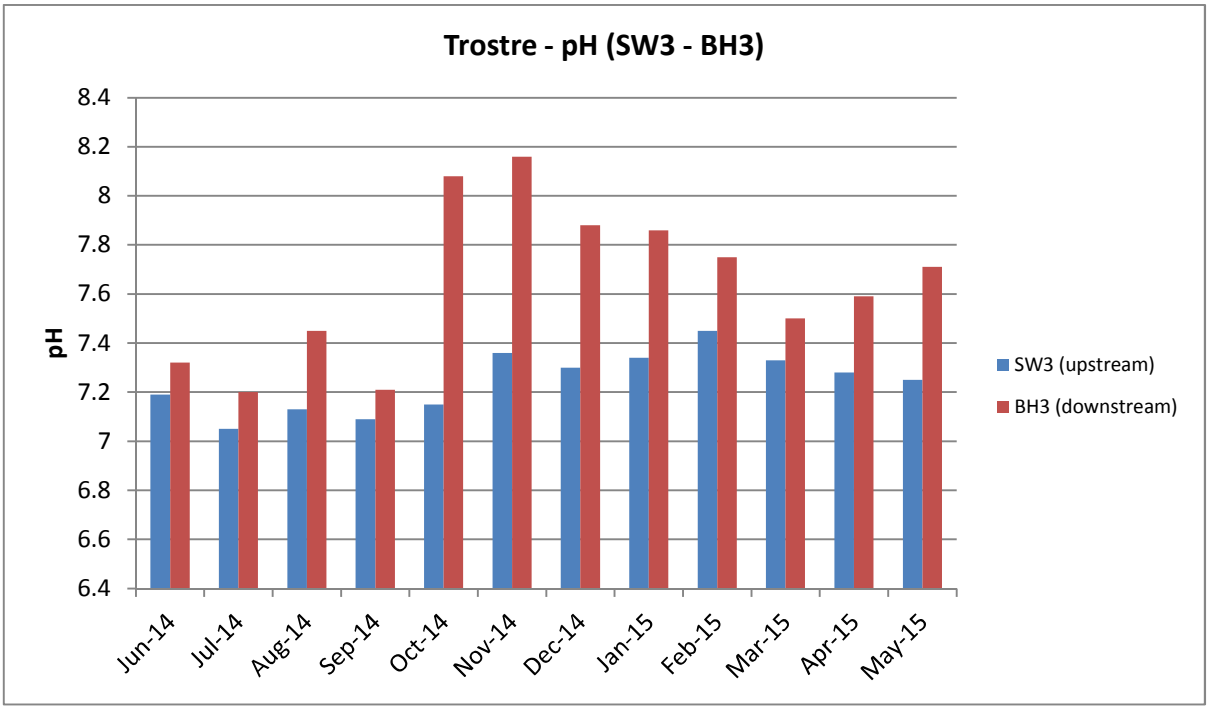
• pH	• TPH (Aqueous Phase)
• Conductivity	• Nickel (total and dissolved)
• Ammonia	• Copper (total and dissolved)
• Chloride	• Lead (total and dissolved)
• Chemical Oxygen Demand	• Zinc (total and dissolved)
• Biochemical Oxygen Demand	• Iron (total and dissolved)
• Alkalinity	• Chromium (total and dissolved)
• Phenol	• Arsenic (total and dissolved)
• Boron (total)	• Vanadium (total and dissolved)
• Barium (total)	• Antimony (total and dissolved)
• Beryllium (total)	• Mercury (total)
• Selenium (total)	• Cadmium (total)
• Sulphate (total)	

11.1 June 2014 – June 2015 results

The graphs on the following pages show the upstream and downstream results for each determinand.

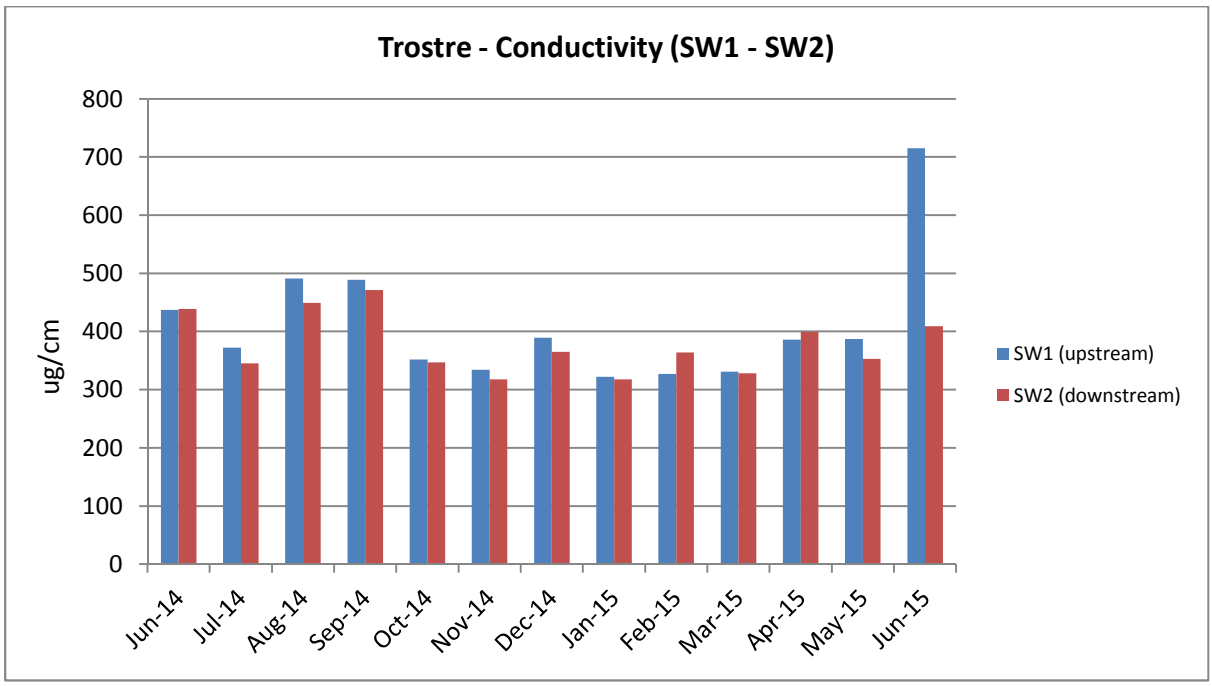


EQS 6.0 – 9.0 – Dangerous substances directive

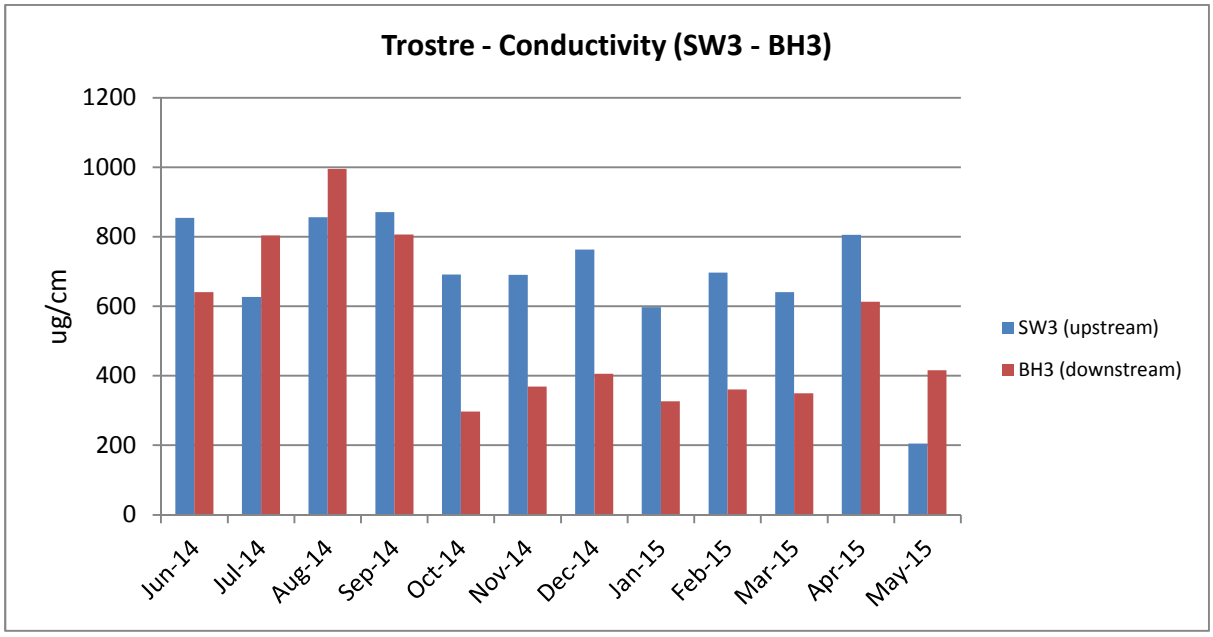


EQS 6.0 – 9.0 – Dangerous substances directive

The results indicate that the pH of surface water was below the recommended limits throughout the monitoring period, both upstream and downstream.

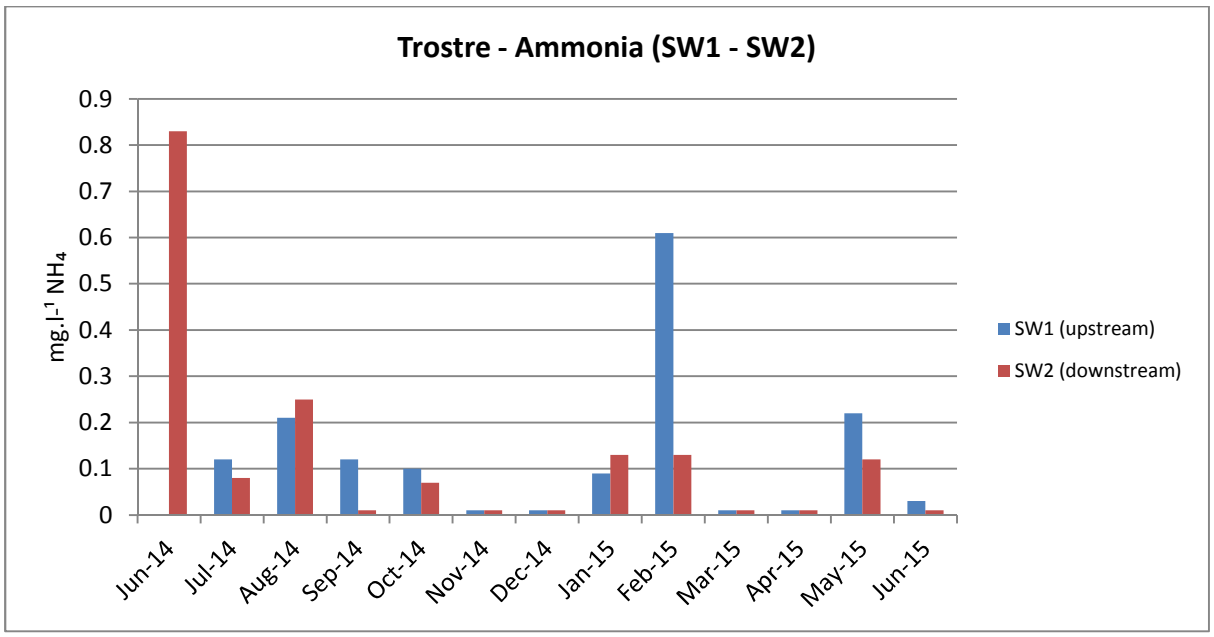


EQS 1000 uS/cm – Surface Water Directive

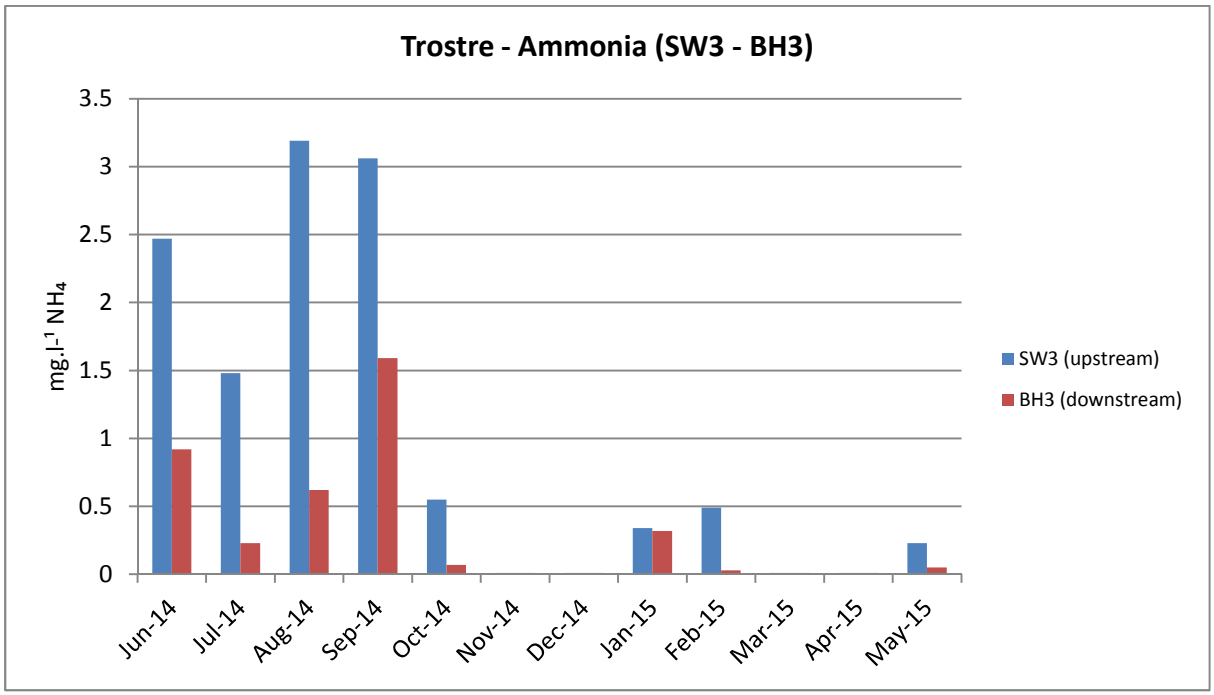


EQS 1000 uS/cm – Surface Water Directive

The results never exceeded the recommended limit.

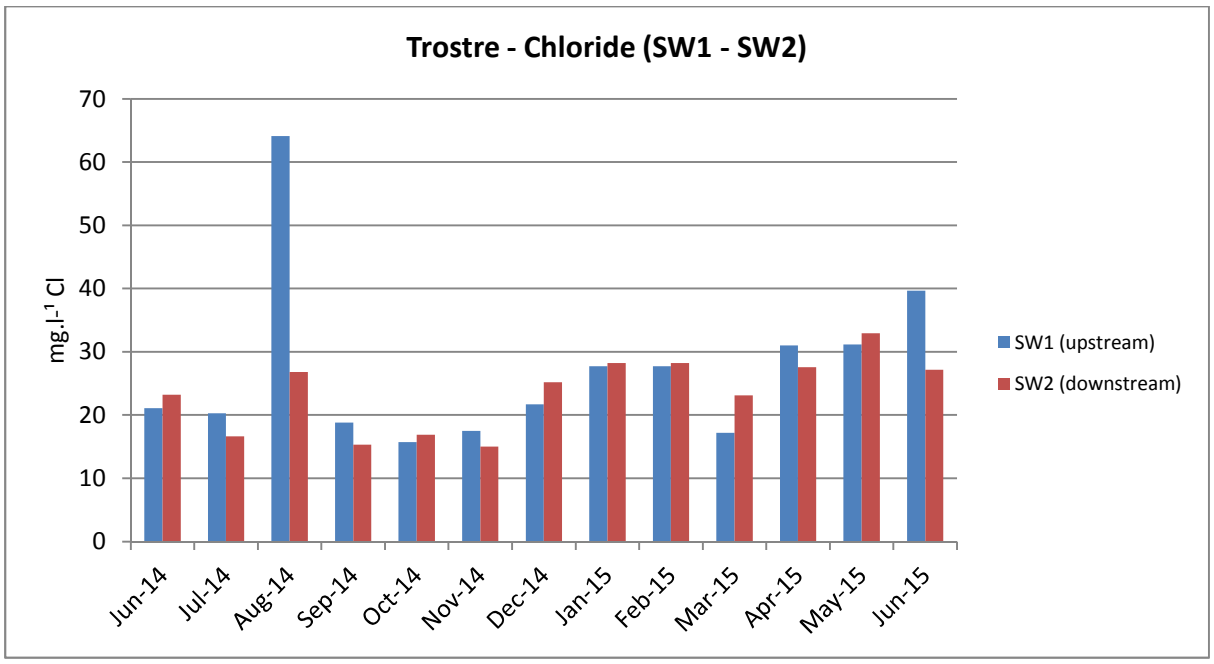


EQS 1 mg NH_4/l – Freshwater Fish Directive

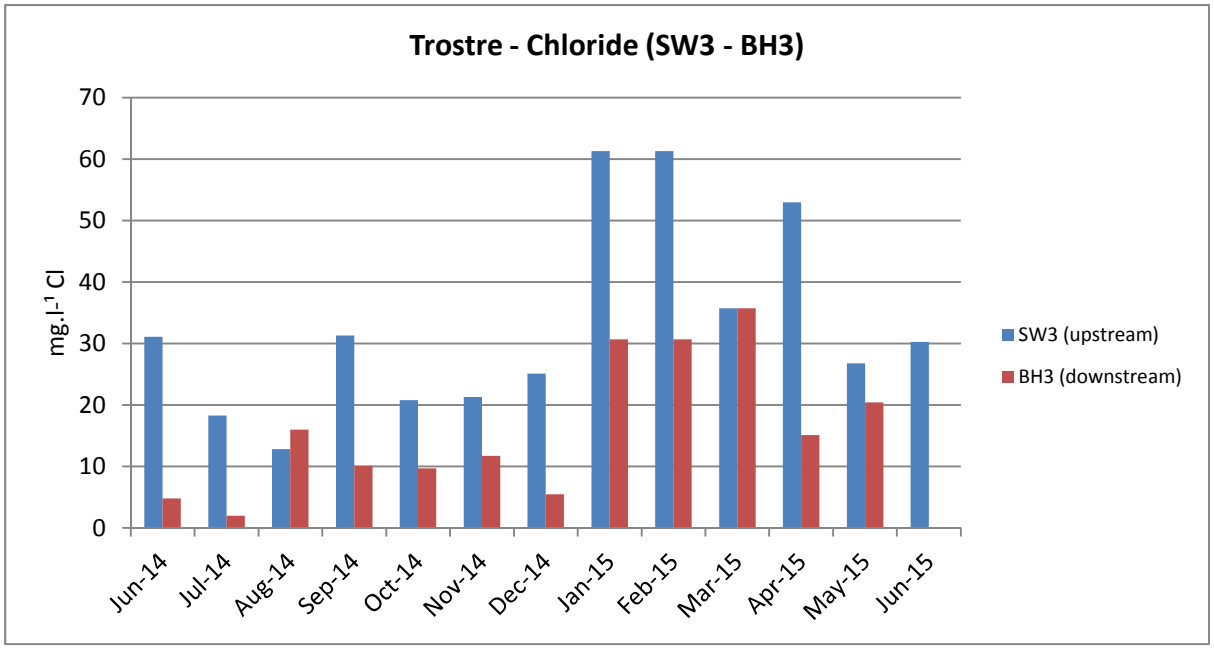


EQS 1 mg NH_4/l – Freshwater Fish Directive

All results fell below the limit at SW1 – SW2. In cases where the readings exceed the EQS at SW3 – BH3, the downstream results are less than the upstream, showing that the site is not having an impact and that the surface water entering the site was above the EQS. It can also be noted that ammoniacal nitrogen (as NH_4) levels have decreased over time.

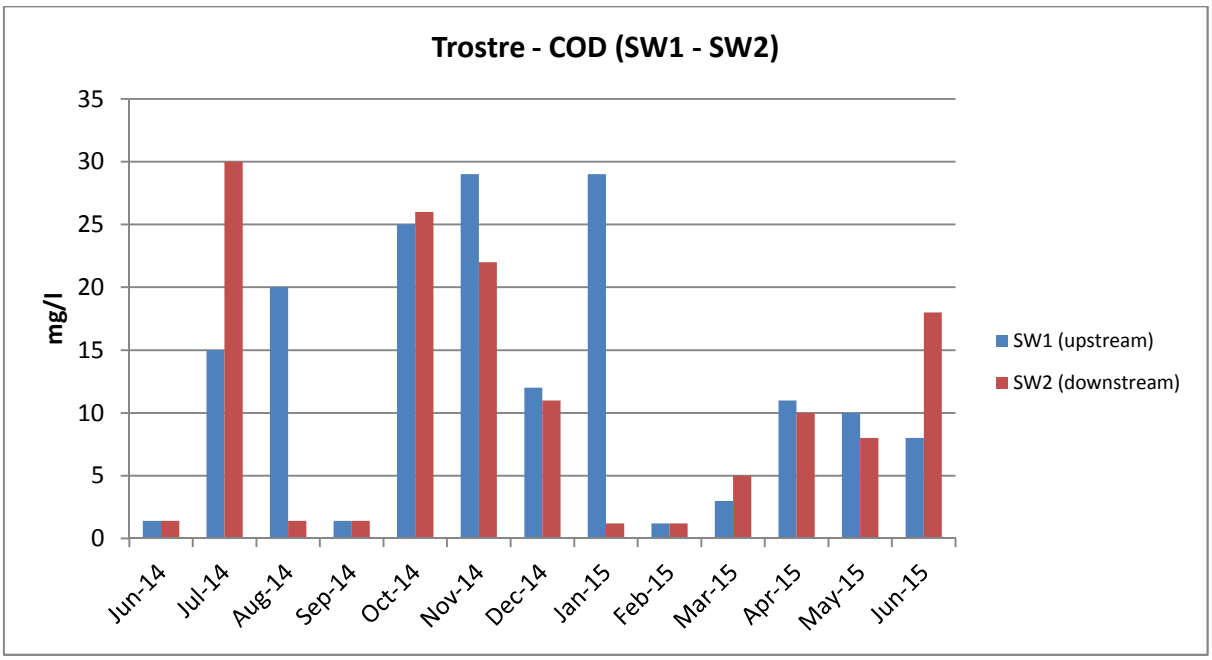


EQS – 250 mg/l – Dangerous Substances Directive

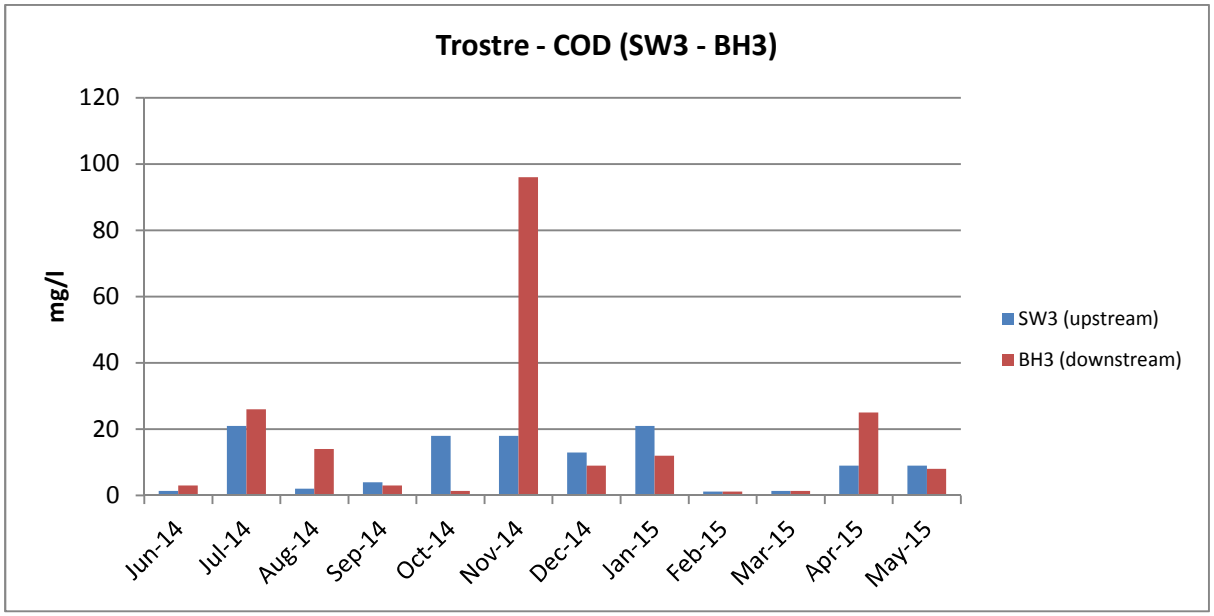


EQS – 250 mg/l – Dangerous Substances Directive

All samples analysed for chloride were within the recommended limits.

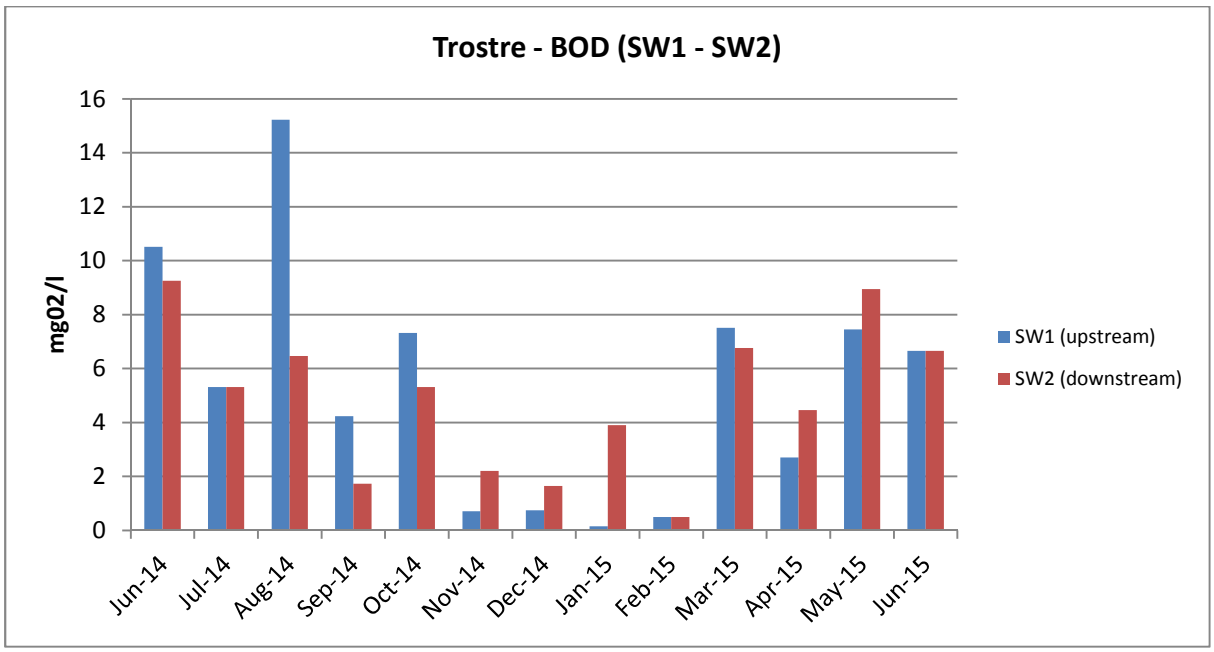


EQS – 30 mg/l – Freshwater Fish Directive

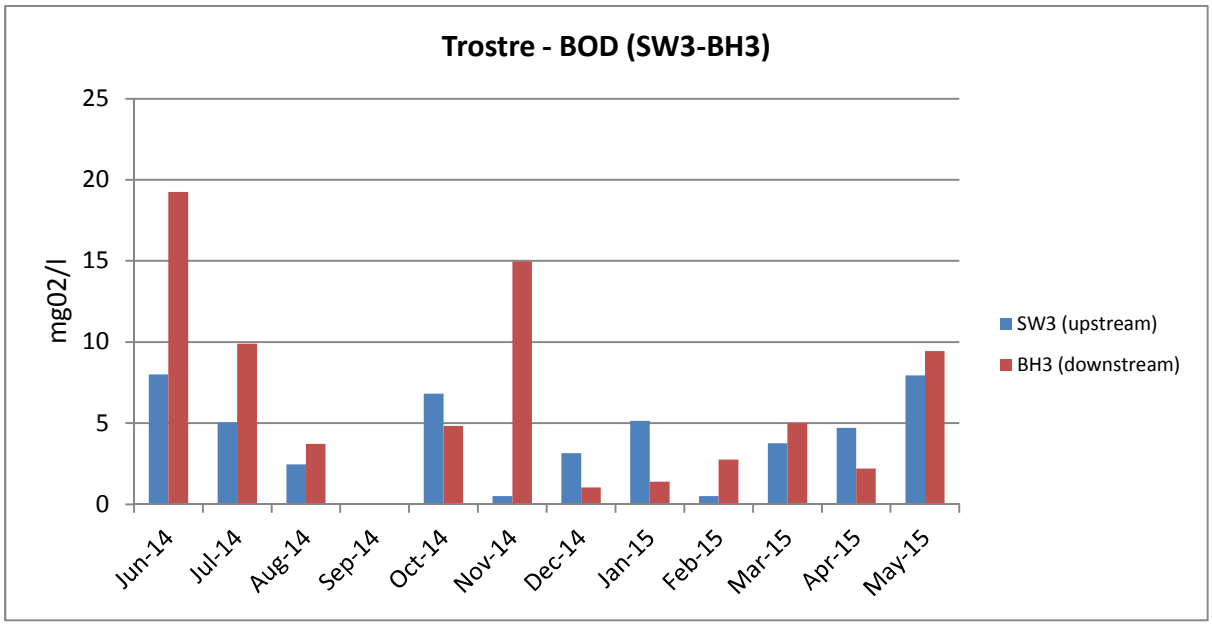


EQS – 30 mg/l – Freshwater Fish Directive

All samples analysed at SW1 and SW2 fell below the recommended limits. The only result over the Freshwater Fish Directive EQS of 30 mg/l was recorded in November 2014 at BH3.

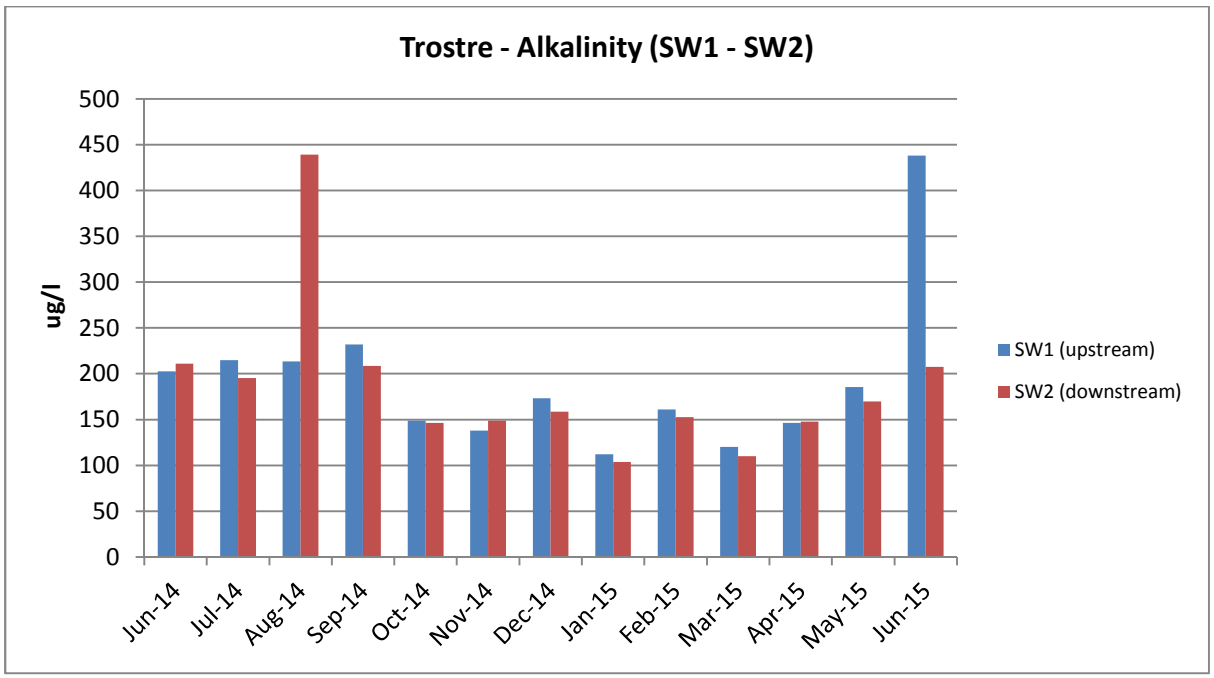


EQS – 30 mg02/l – Freshwater Fish Directive

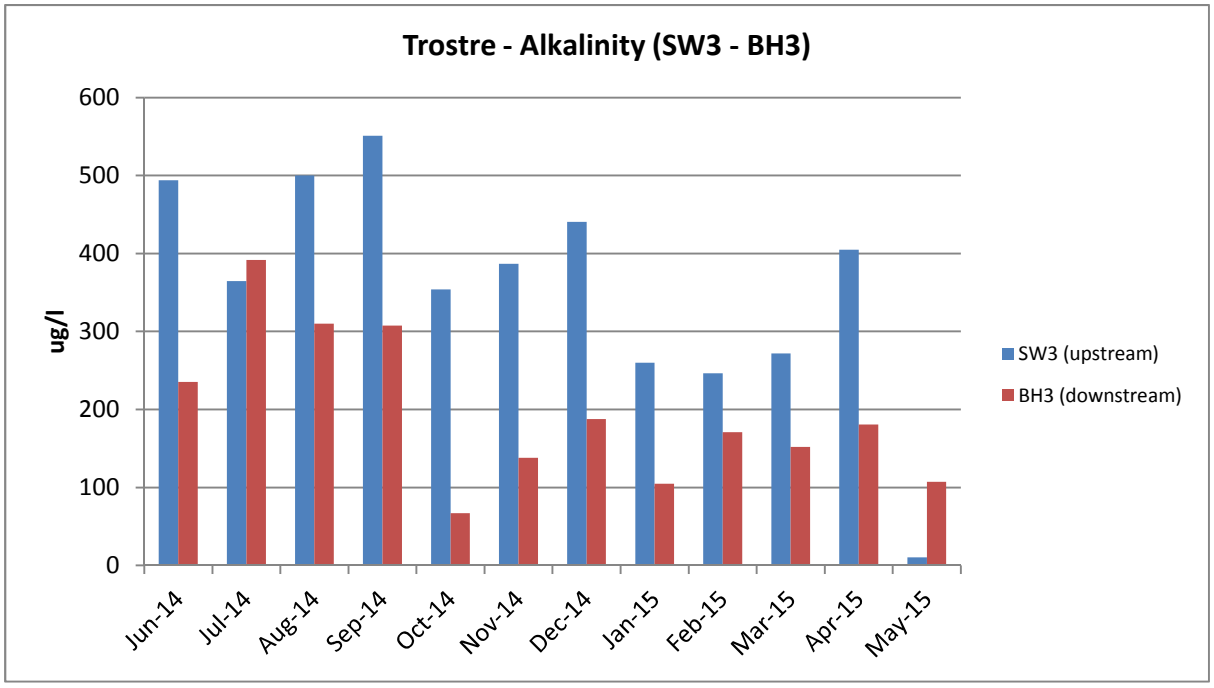


EQS – 3 mg02/l – Freshwater Fish Directive

Results often exceeded the EQS of 3 mg02/l throughout the monitoring period, in some cases there is evidence that this was due to high BOD levels from incoming surface waters.

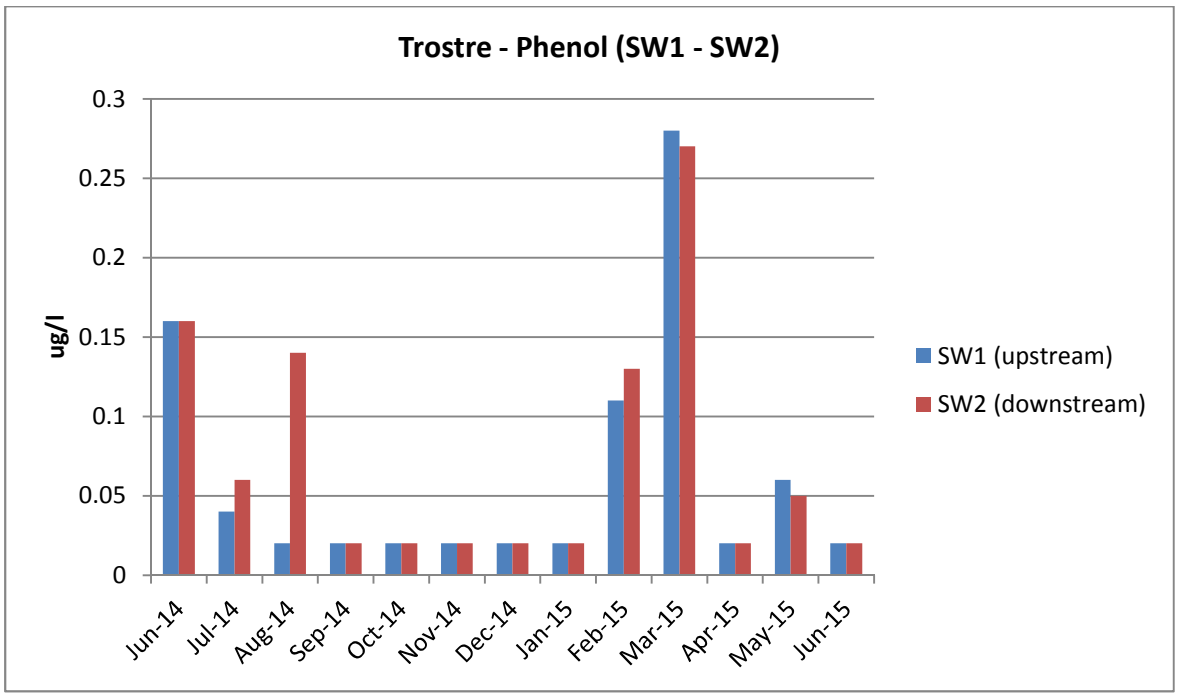


No EQS

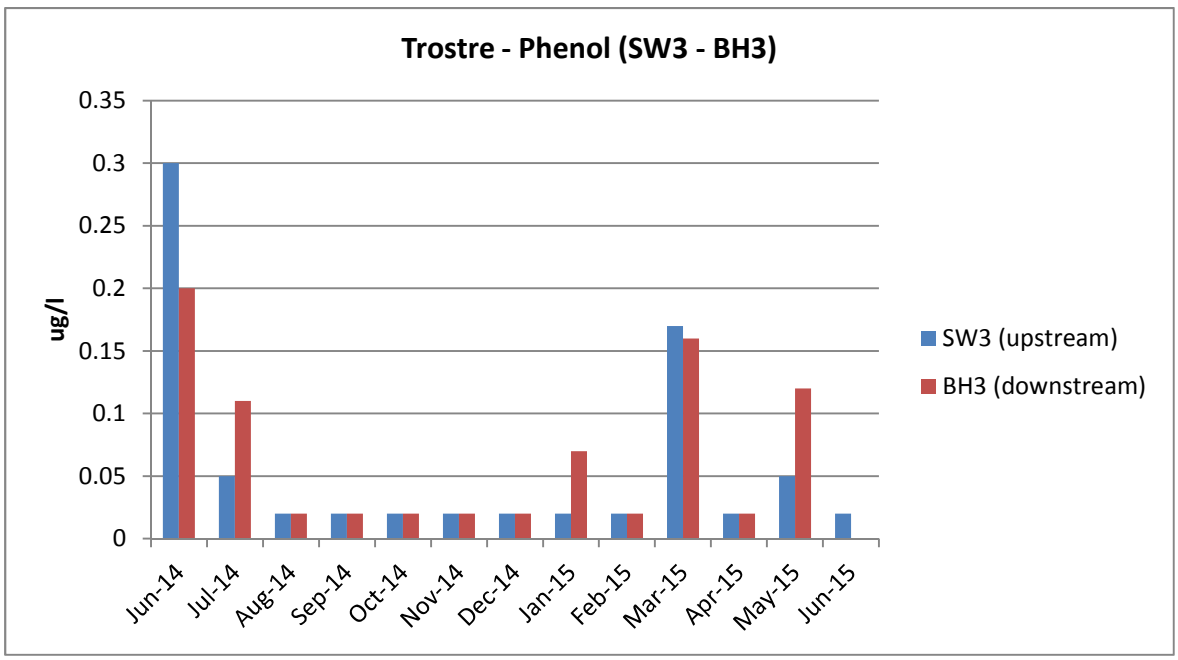


No EQS

There is no recommended limit for Alkalinity but it should be noted that the concentration was generally higher at SW1 and SW3, indicating that the alkalinity is being brought into the site by the incoming surface water and not produced by the site.

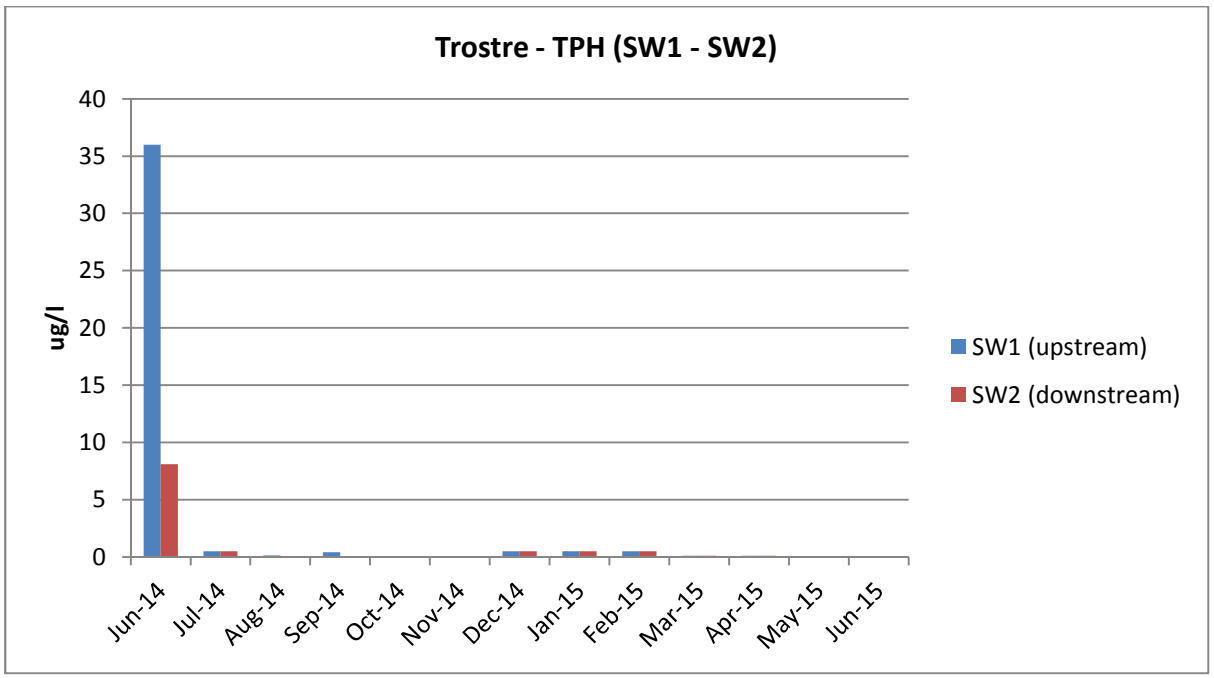


EQS – 0.03 mg/l – Surface Water Directive

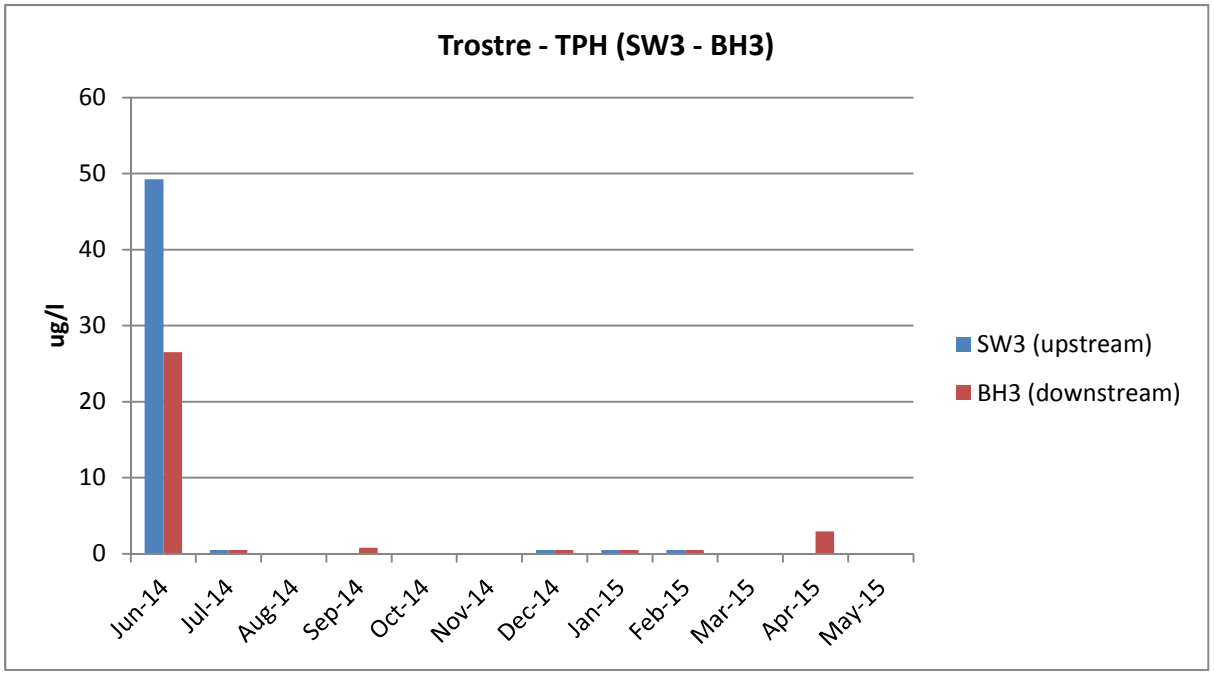


EQS – 0.03 mg/l – Surface Water Directive

All results were at or below the recommended limits (0.03mg/l) throughout the monitoring period.

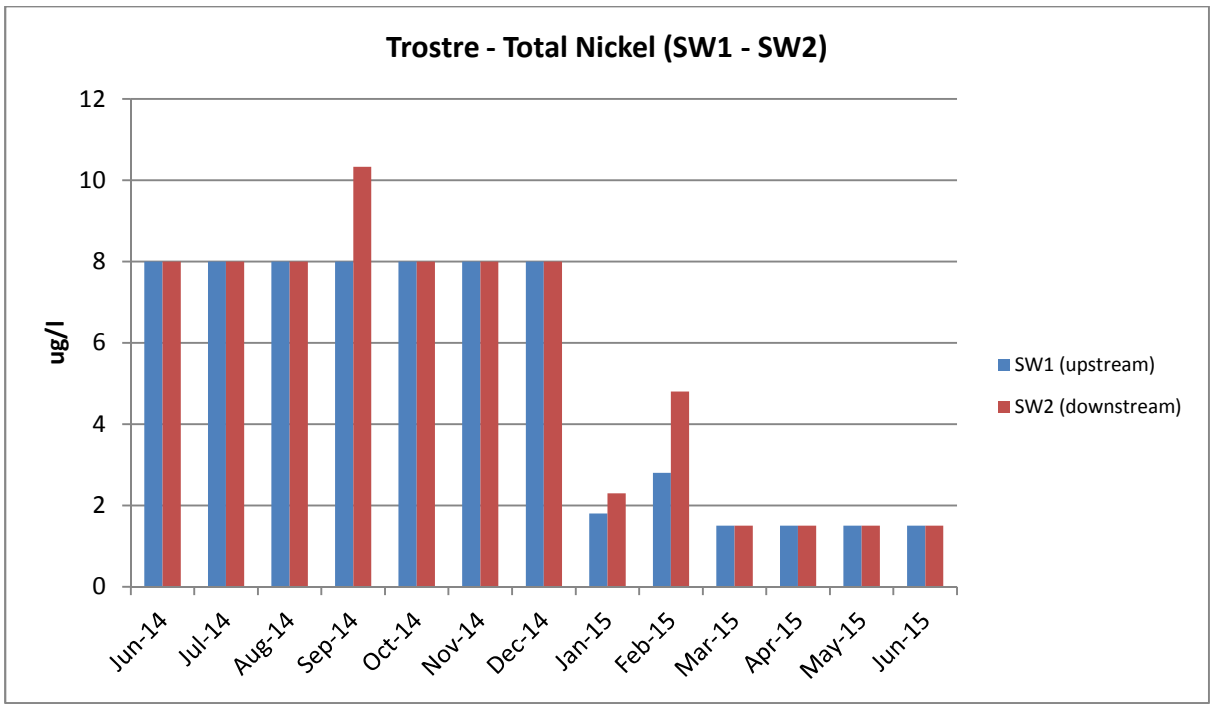


EQS – 50 ug/l – Dangerous Substances Directive

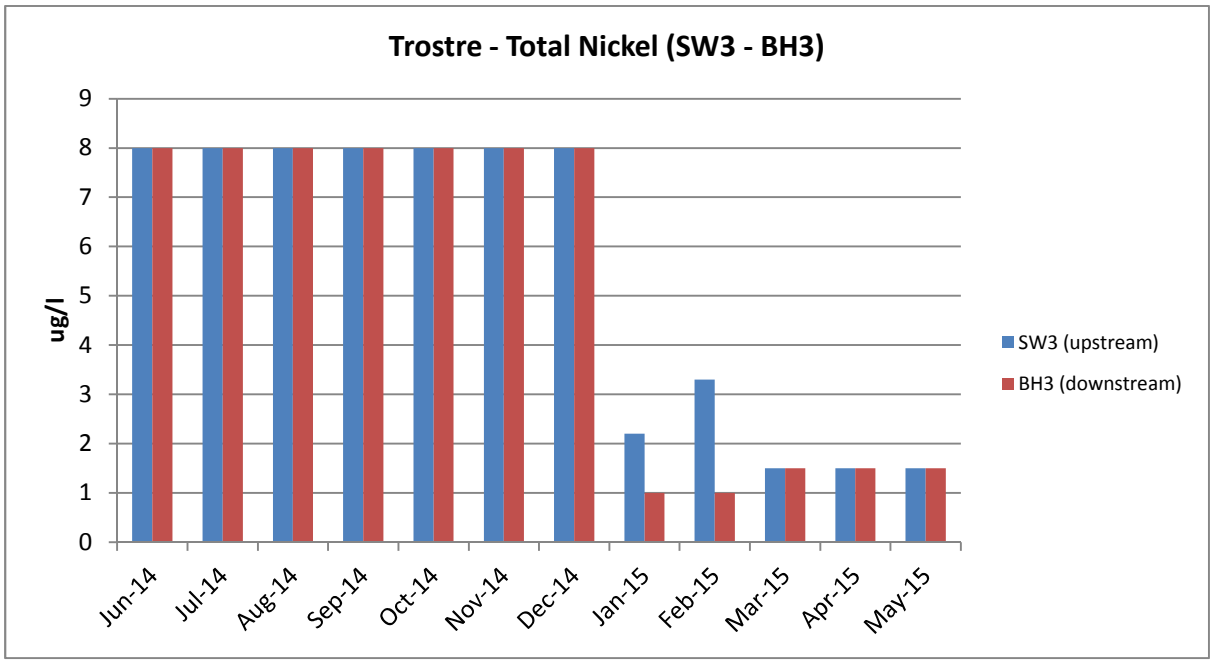


EQS – 50 ug/l – Dangerous Substances Directive

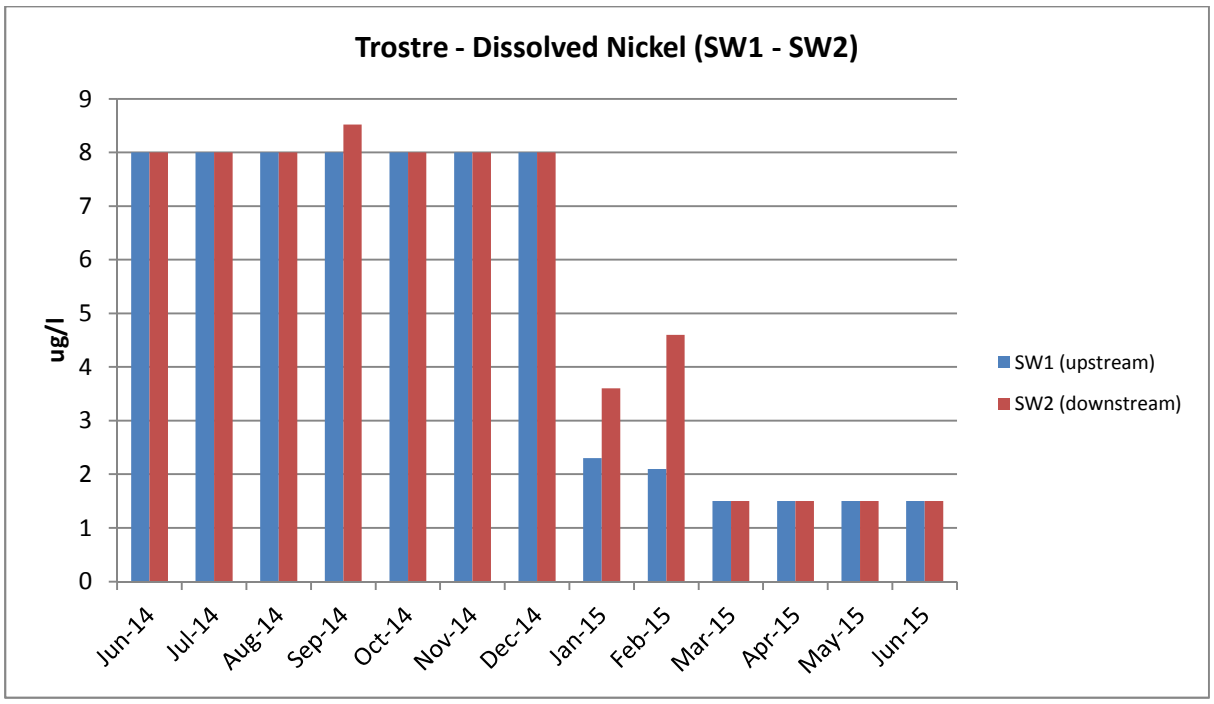
All results fell below the recommended limits.



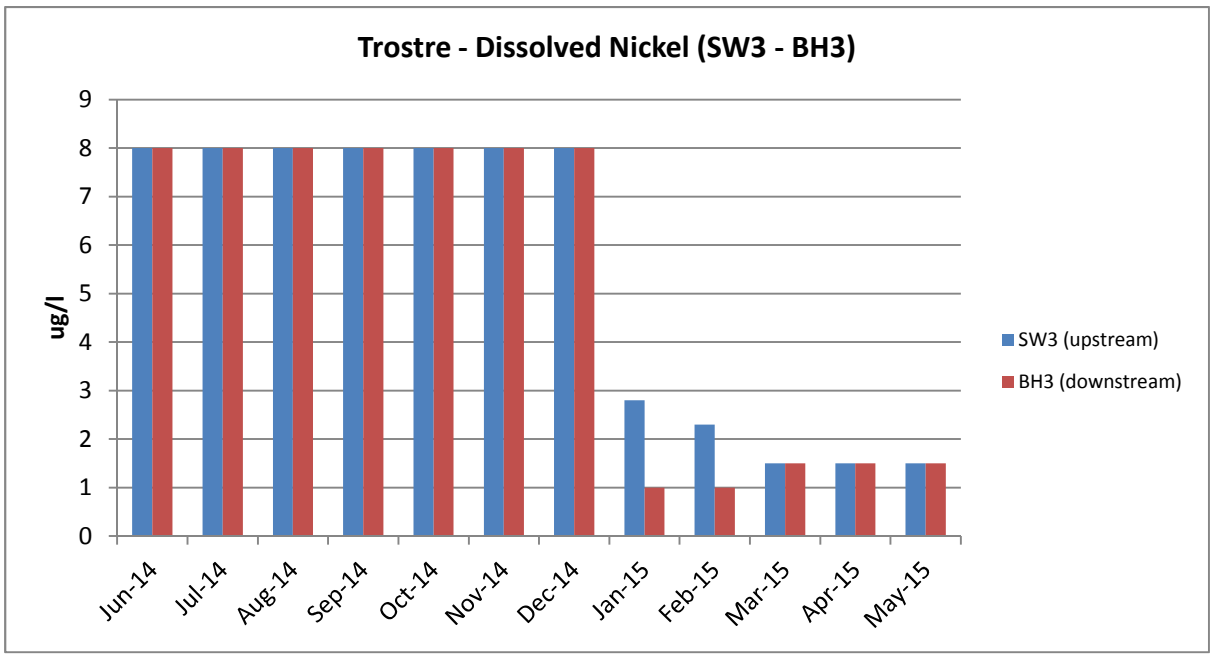
EQS – 20 ug/l – Dangerous Substances Directive



EQS – 20 ug/l – Dangerous Substances Directive



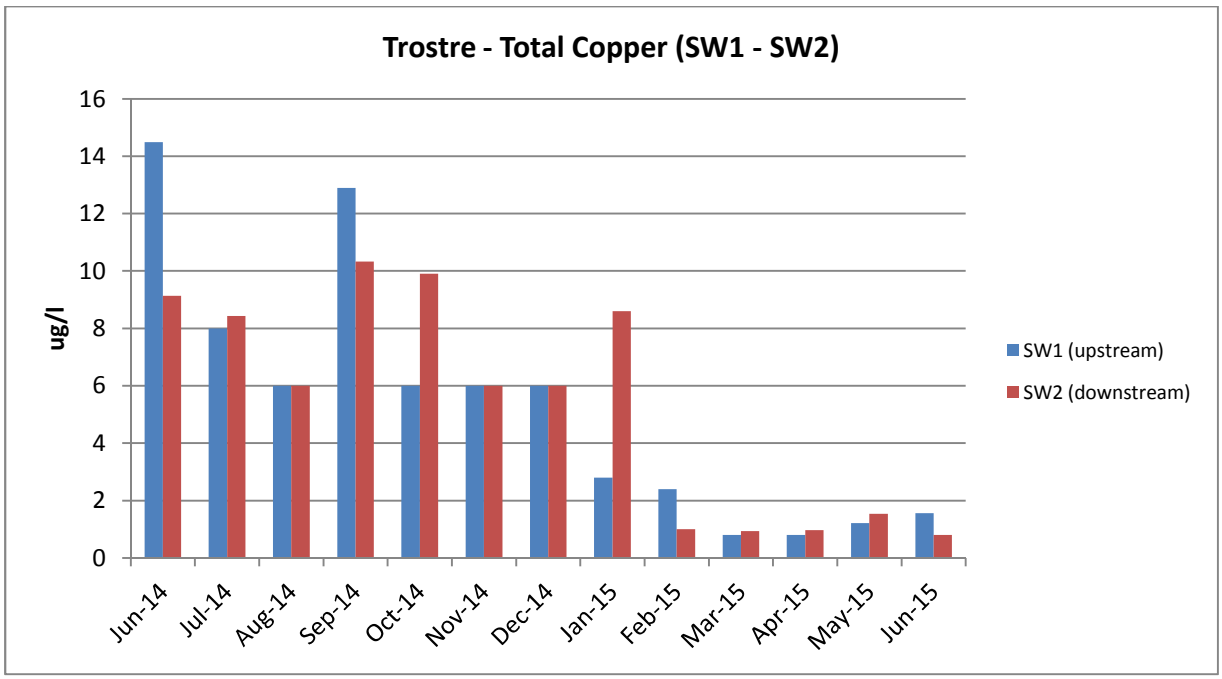
EQS – 20 ug/l – Dangerous Substances Directive.



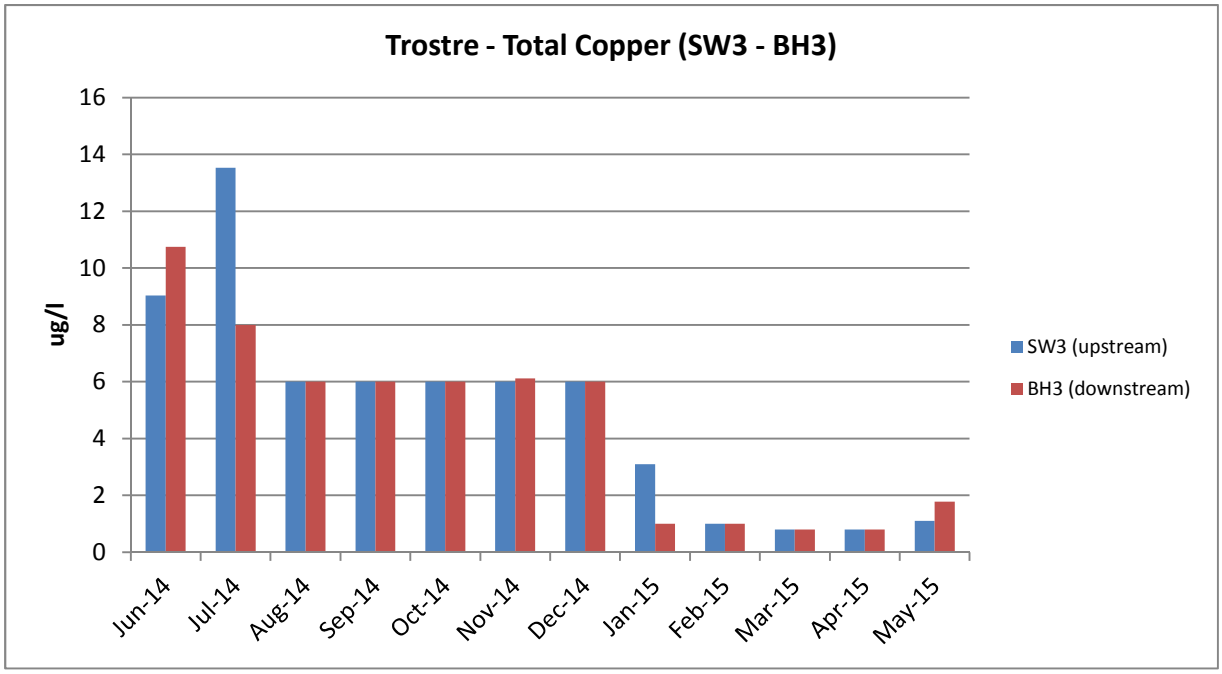
EQS – 20 ug/l – Dangerous Substances Directive.

All results fell below the recommended limits for total and dissolved nickel.

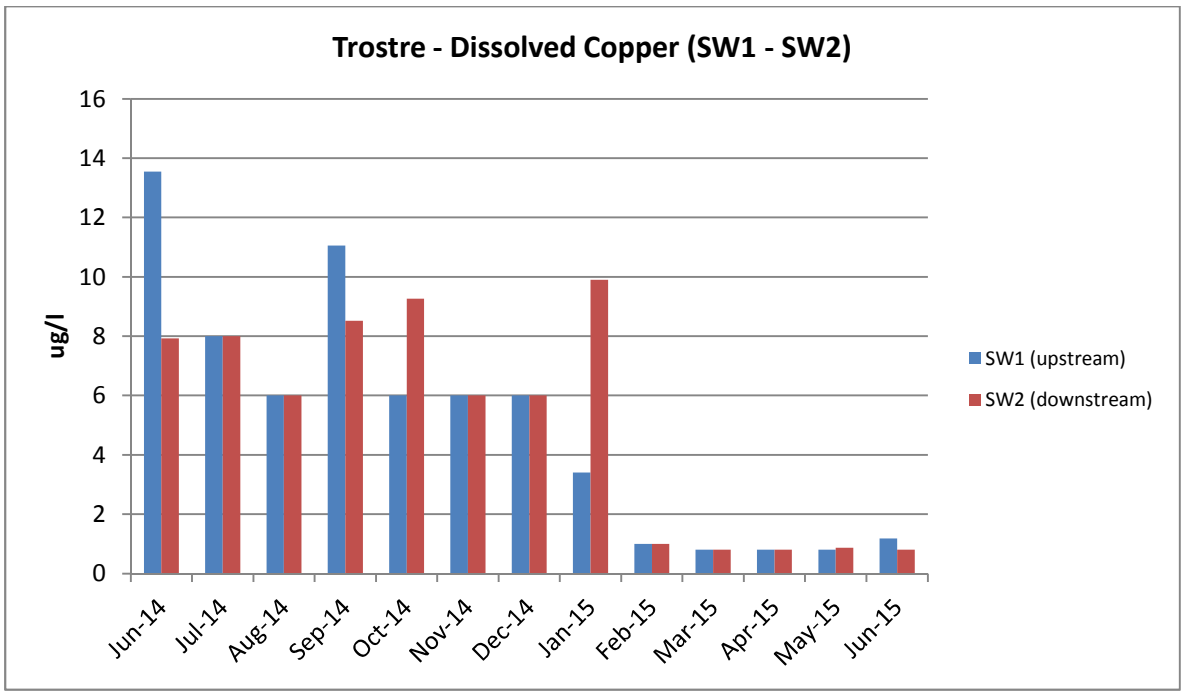
There was a change in detection limit in the laboratory in January 2015, previously; <8 ug/l, the new detection limit is <1.5 ug/l.



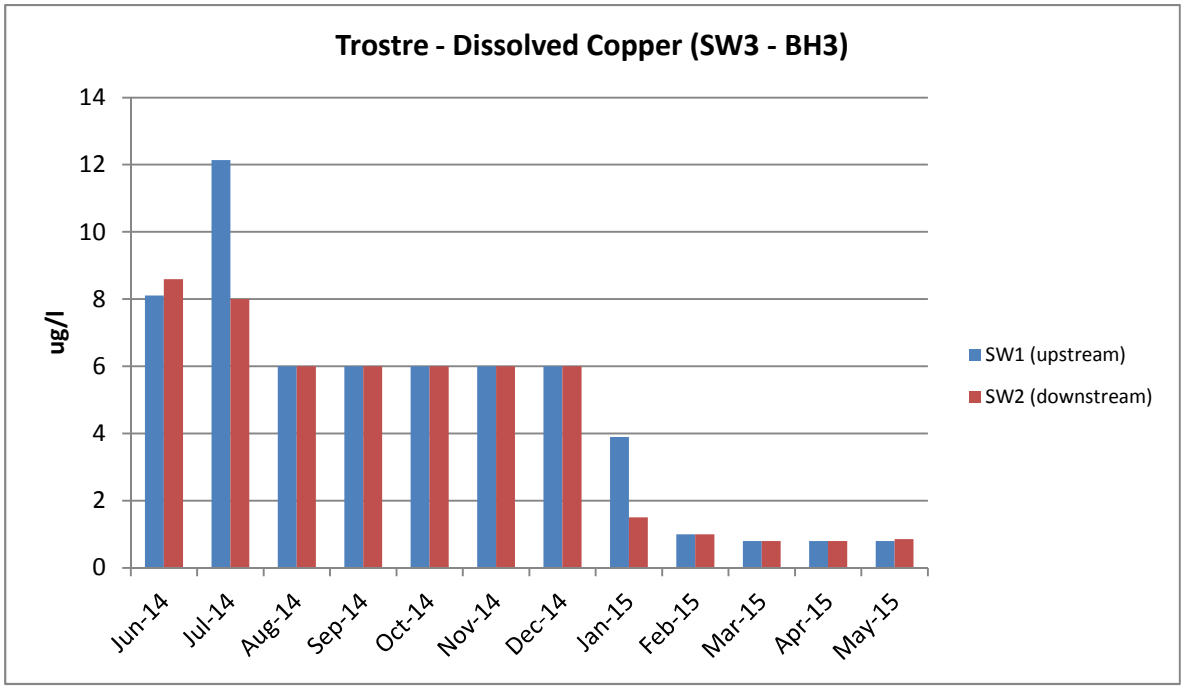
EQS – 5ug/l – Surface Water Regulation.



EQS – 5ug/l – Surface Water Regulation.



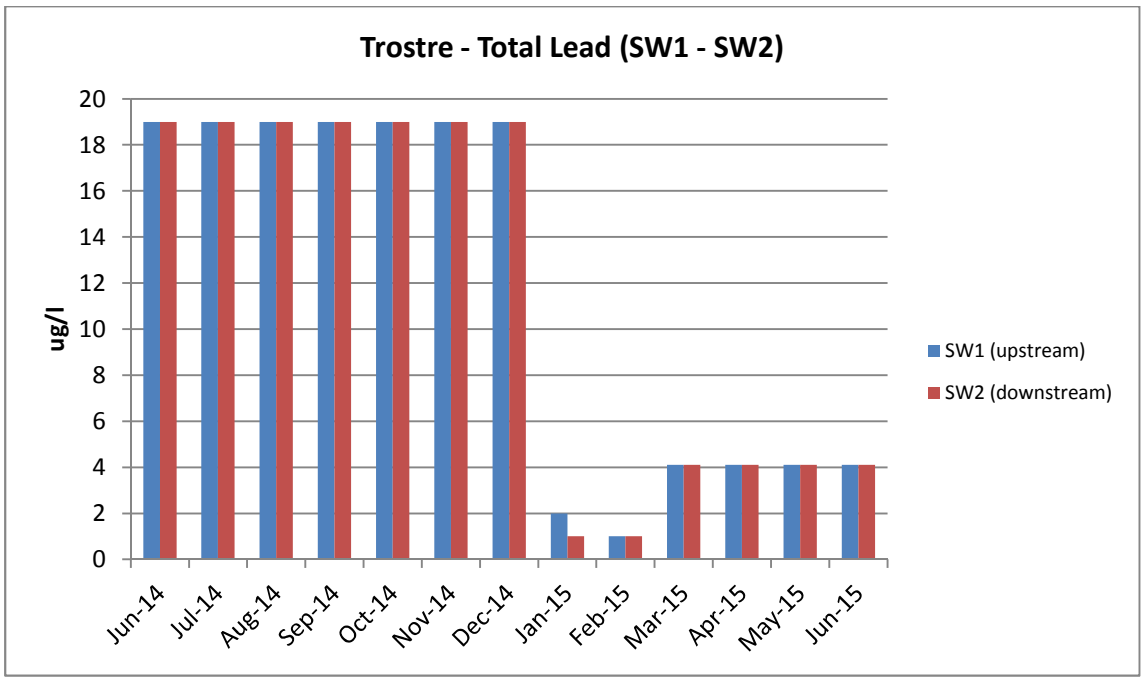
EQS – 112ug/l – Surface Water Regulation.



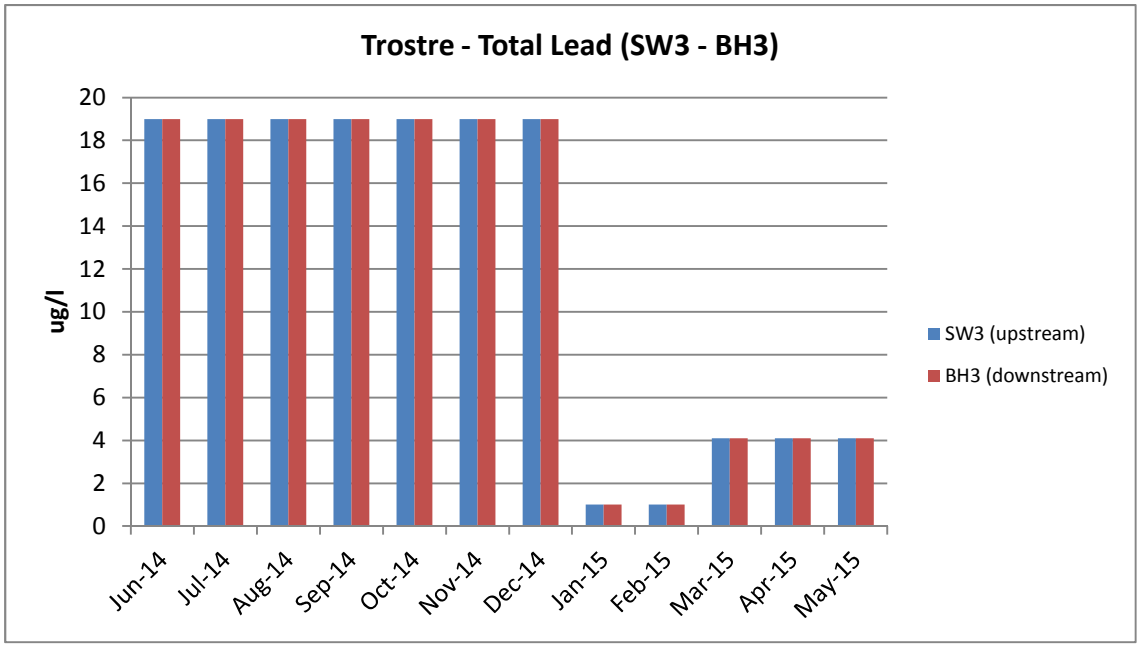
EQS – 112ug/l – Surface Water Regulation.

There was a change in detection limit in the laboratory in January 2015, it was previously <6 ug/l, the new detection limit is <1 ug/l.

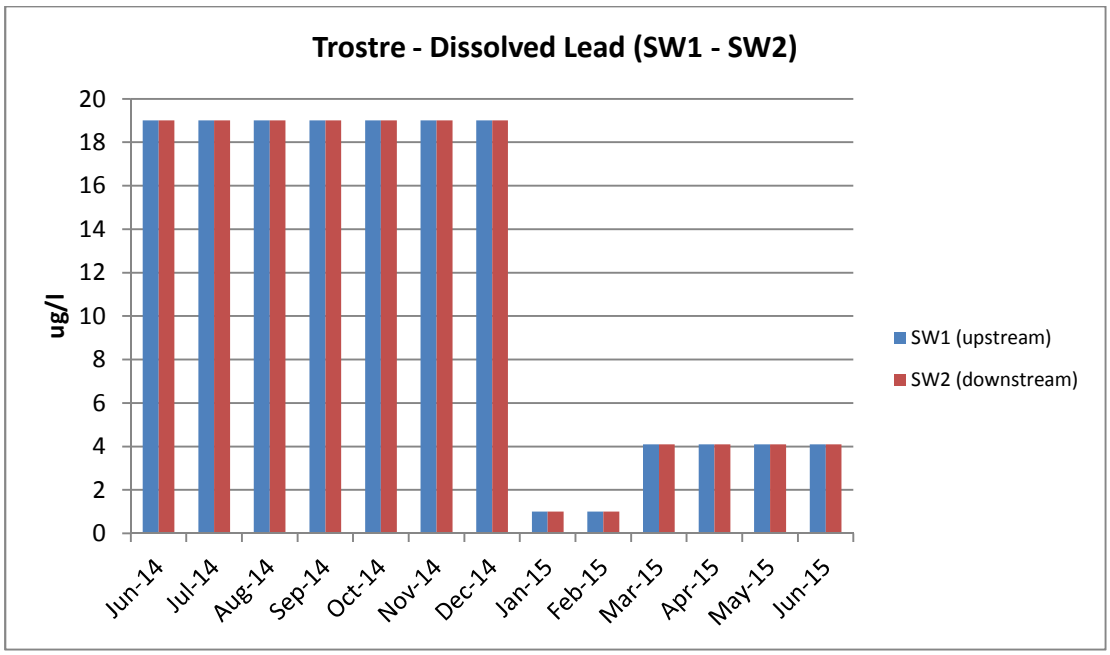
All results fell below the recommended limit.



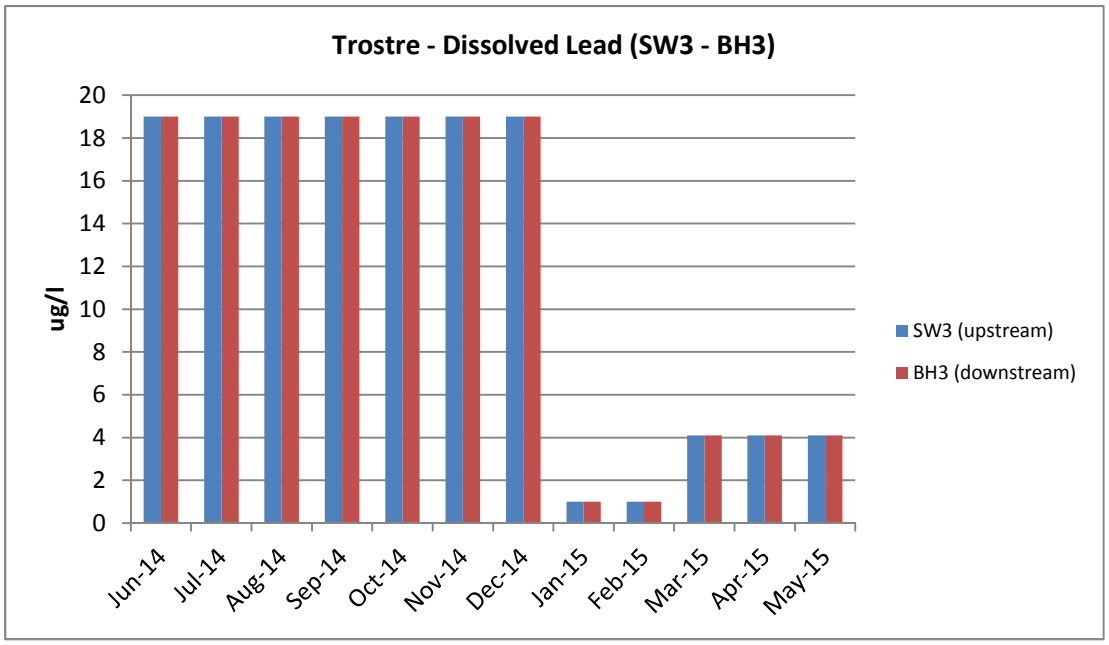
EQS – 20 ug/l – Dangerous Substances Directive



EQS – 20 ug/l – Dangerous Substances Directive



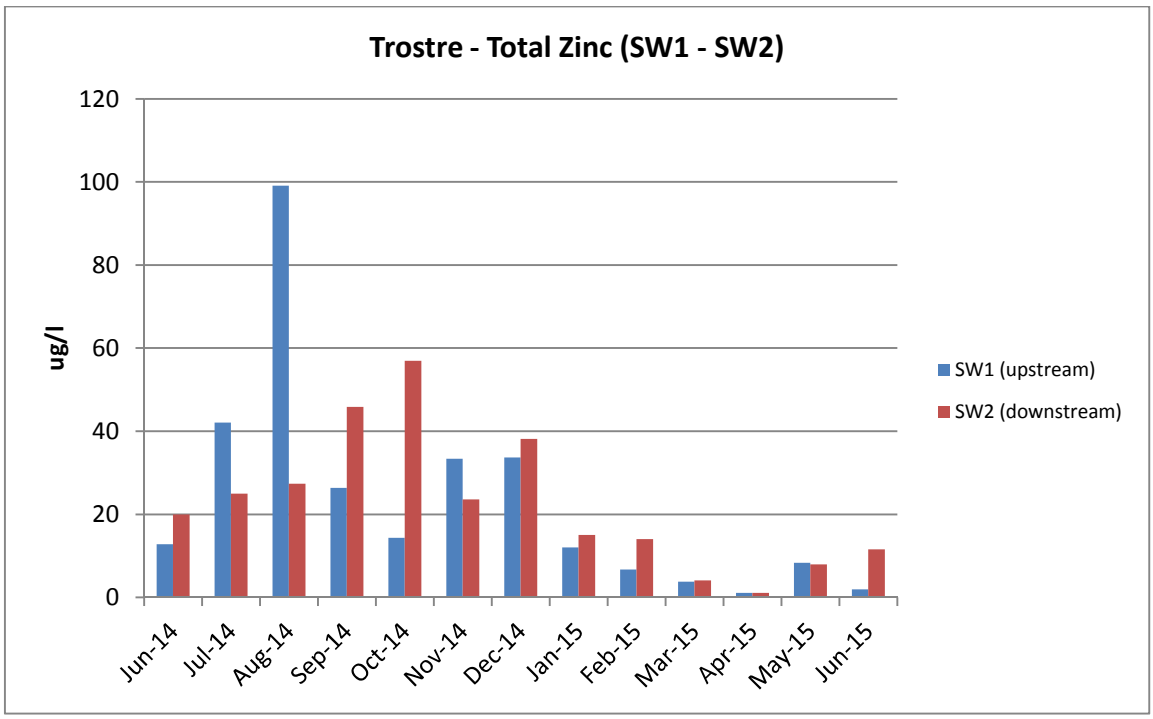
EQS – 20 ug/l – Dangerous Substances Directive



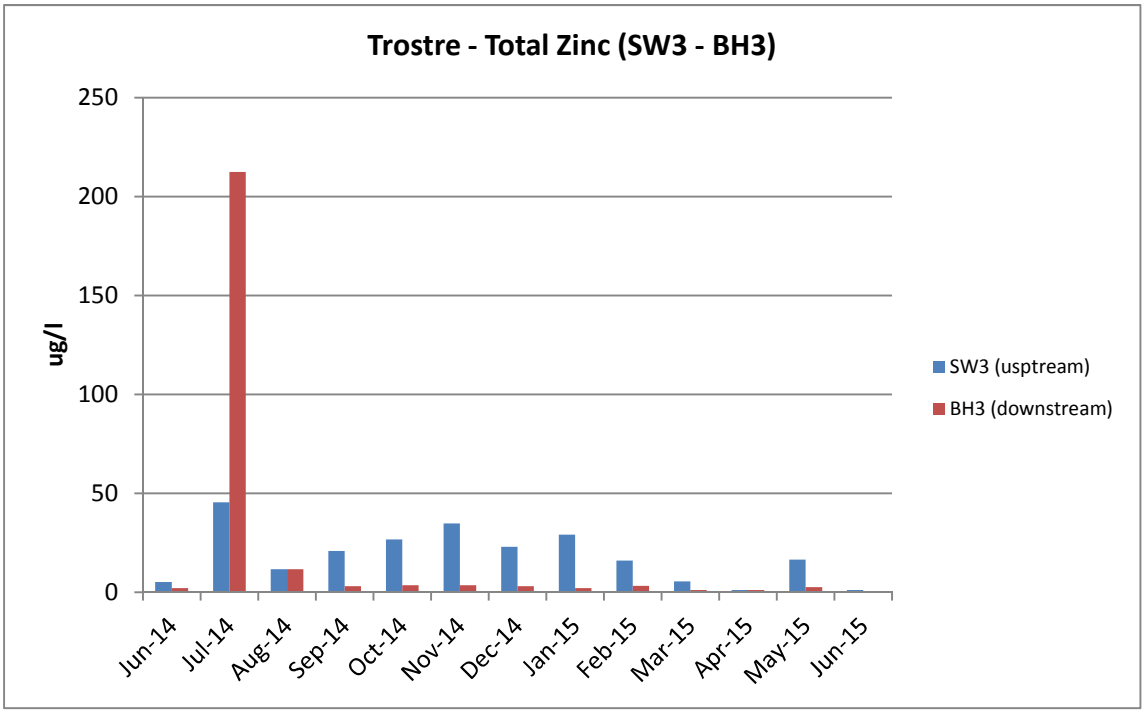
EQS – 20 ug/l – Dangerous Substances Directive

There was a change in detection limits in the laboratory in January 2015; all results between June 2014 and January 2015 were <19 ug/l.

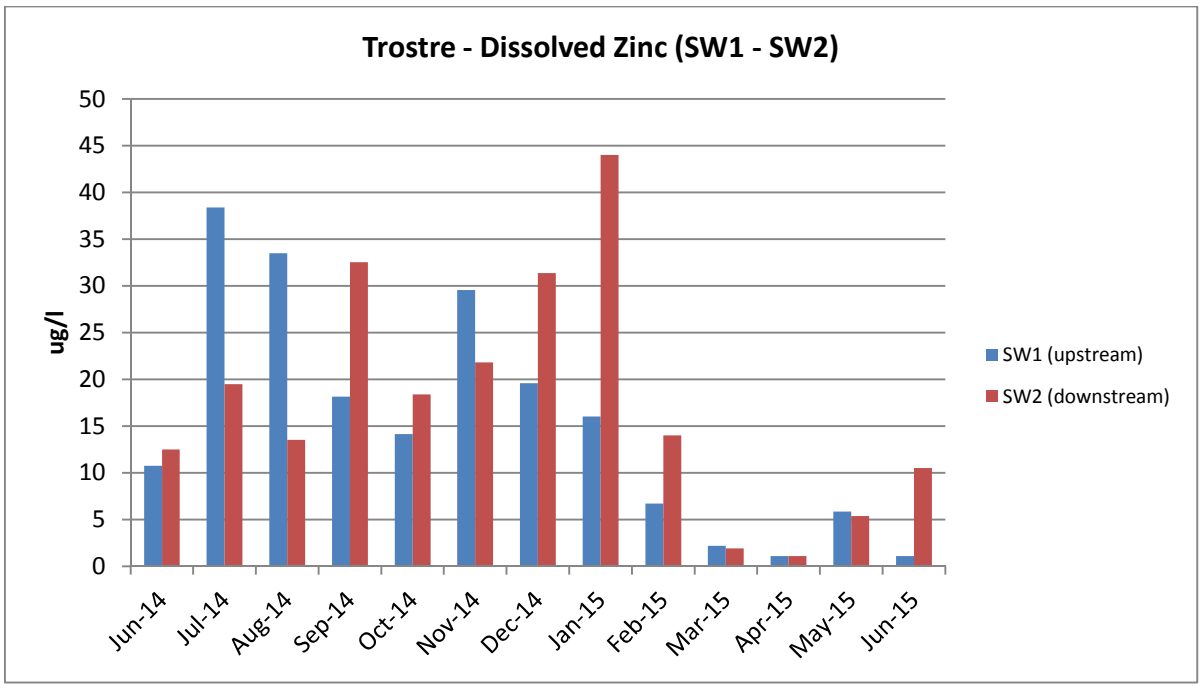
All results fell below the recommended limits.



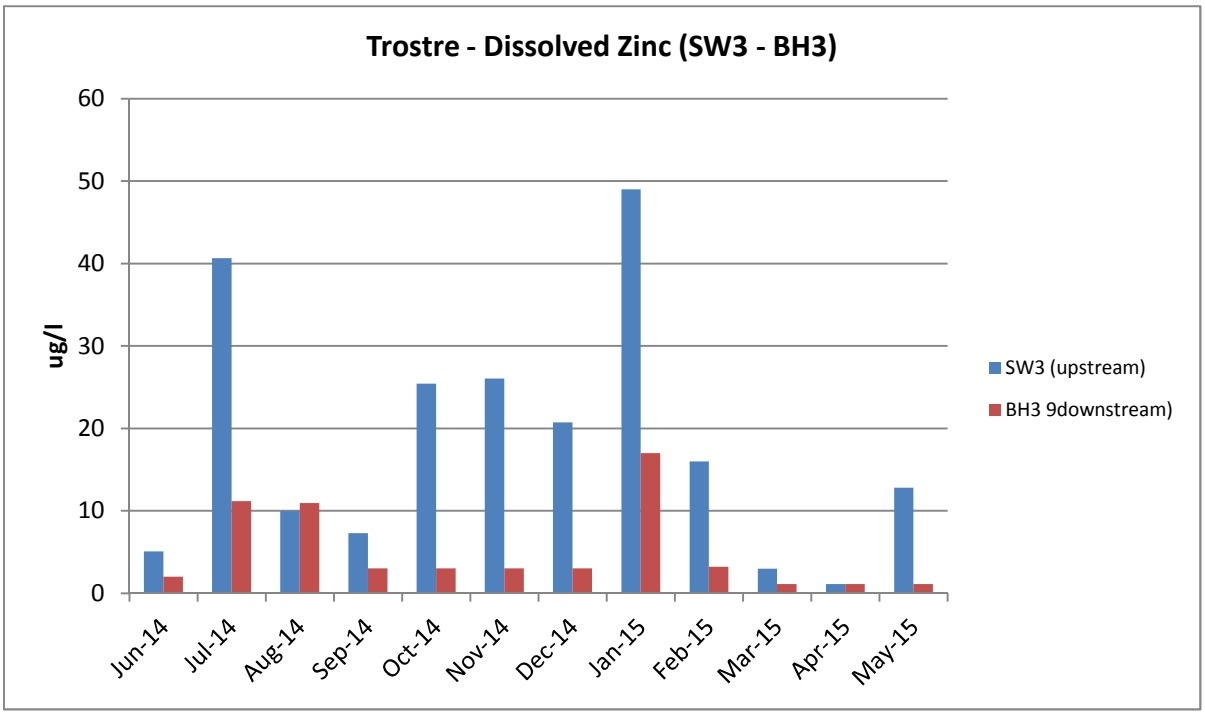
EQS – 50 ug/l – Surface Water Regulations.



EQS – 50 ug/l – Surface Water Regulations.

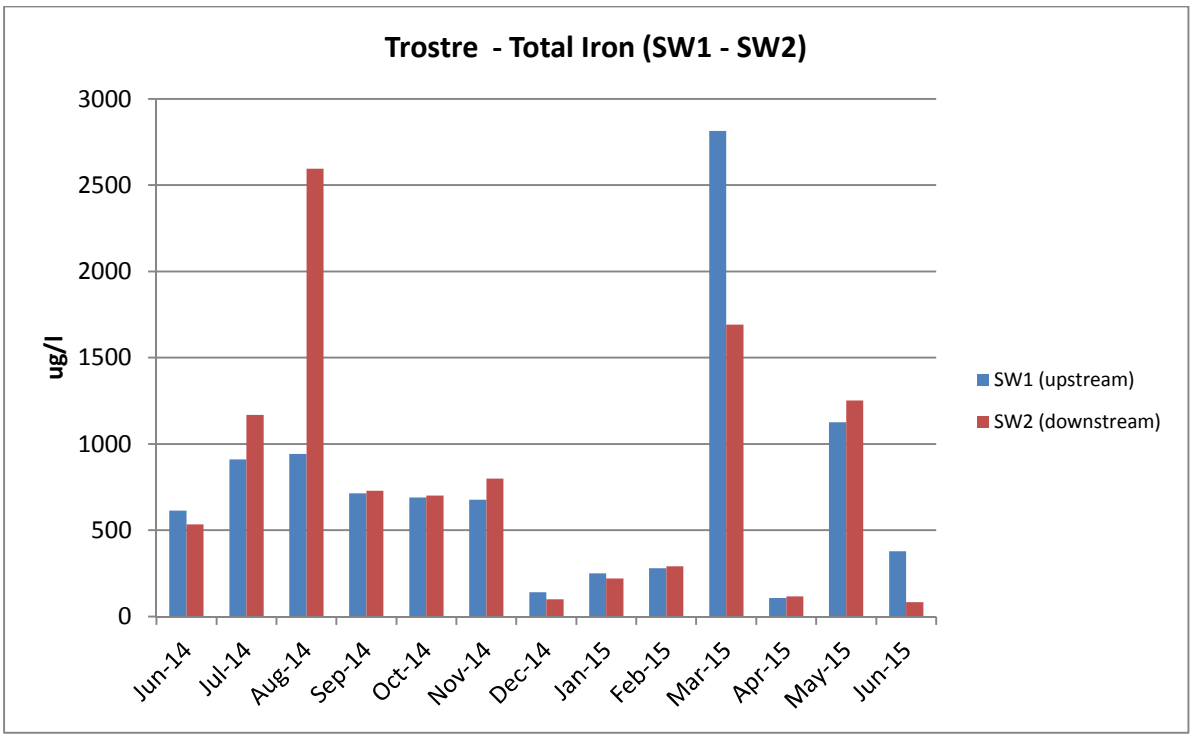


EQS – 50 ug/l – Surface Water Regulations.

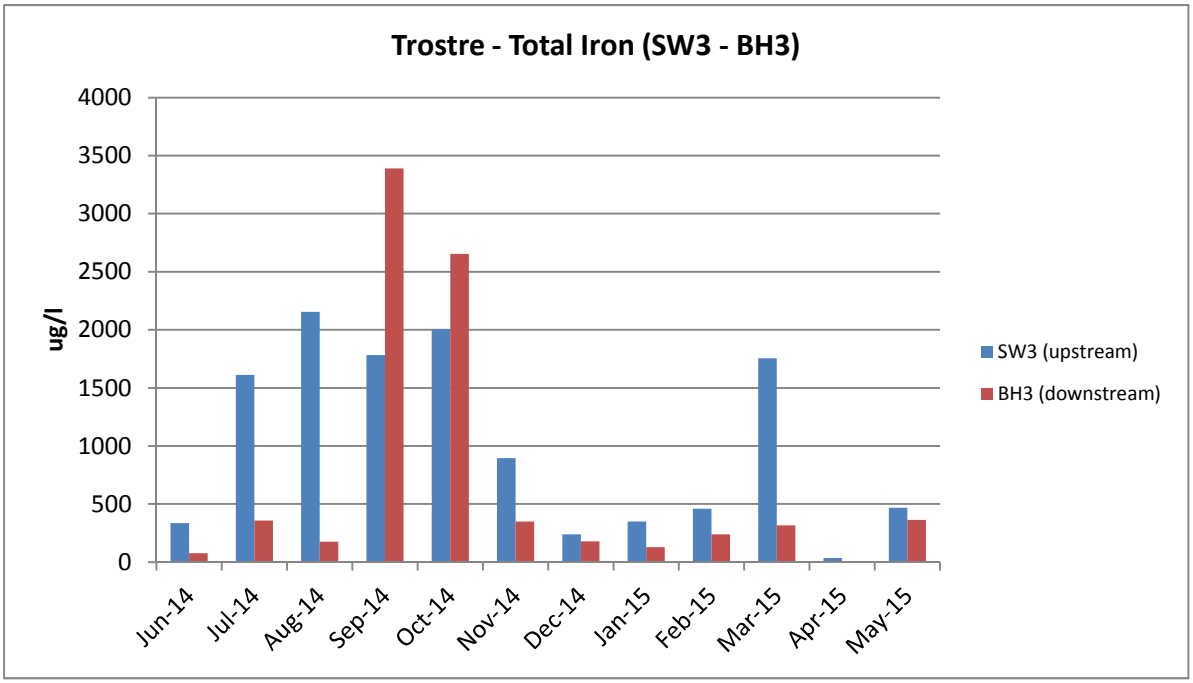


EQS – 50 ug/l – Surface Water Regulations.

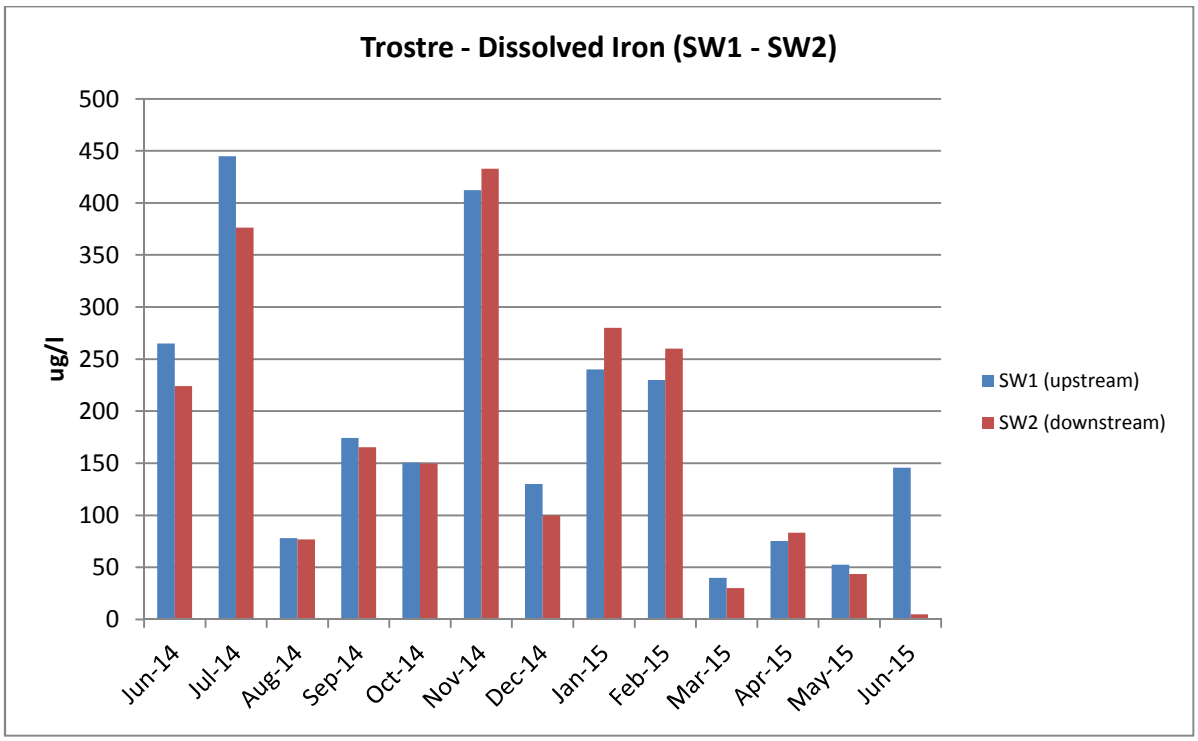
The results for Total Zinc at SW1 in August 2014 and BH3 in July 2014 are above the recommended limit. All other results for Total and Dissolved Zinc fall below the EQS and have generally decreased over time.



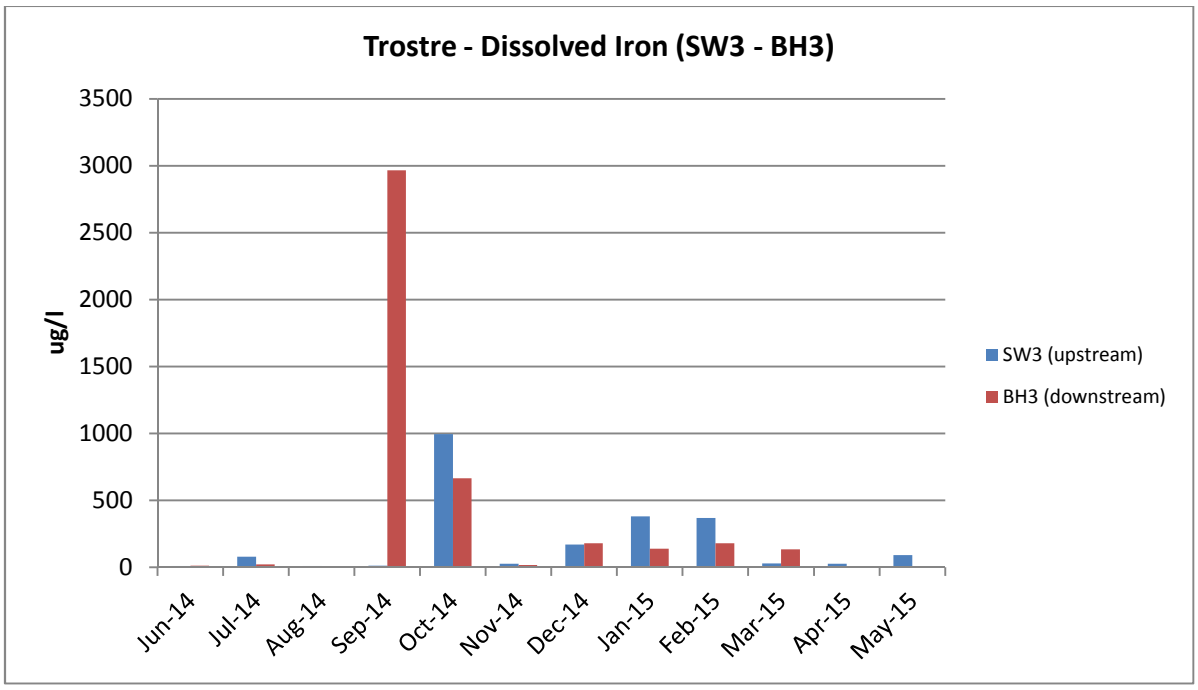
EQS – 2000 ug/l – Dangerous Substances Directive.



EQS – 2000 ug/l – Dangerous Substances Directive.



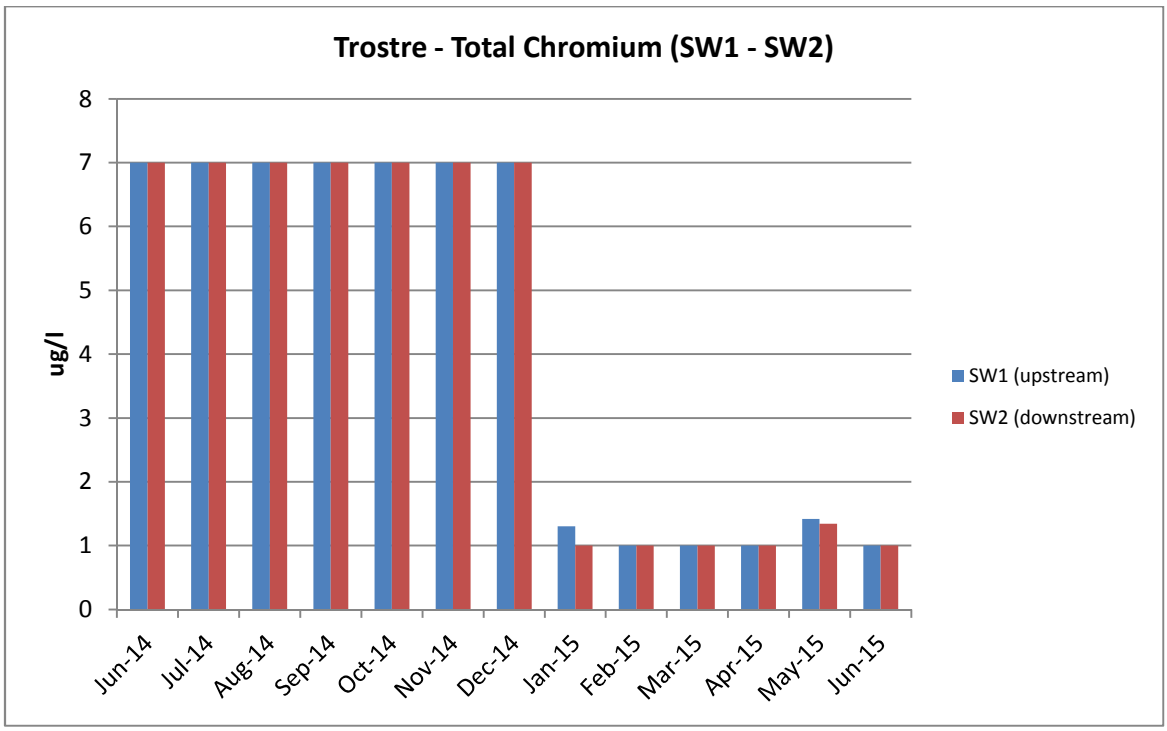
EQS – 1000 ug/l – Dangerous Substances Directive.



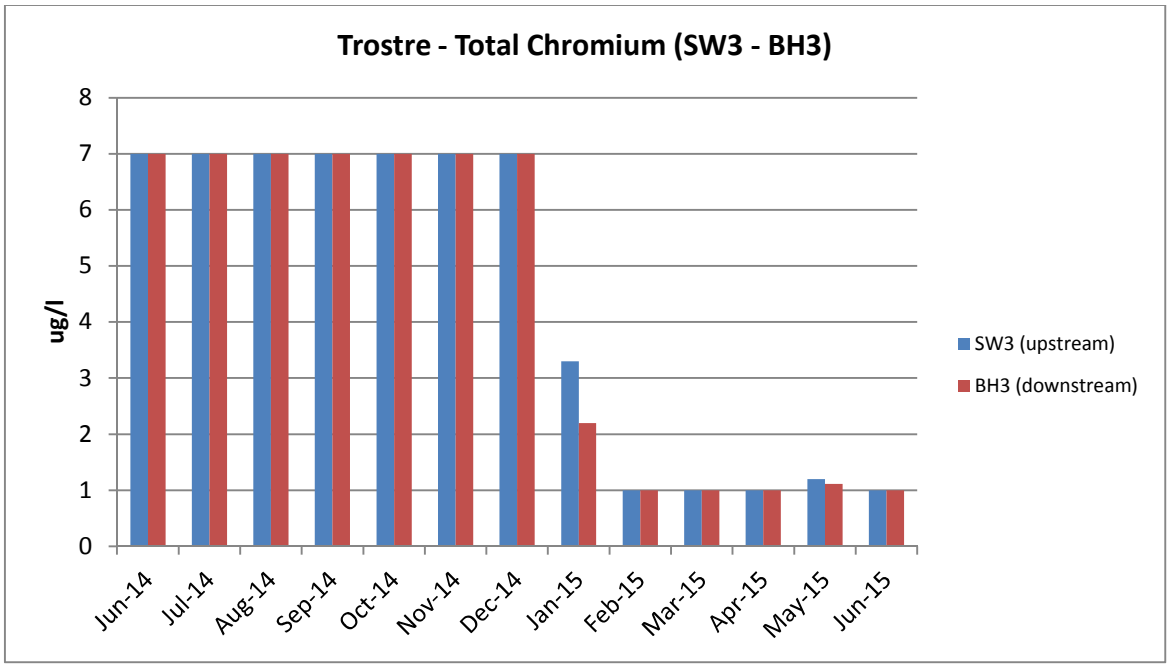
EQS – 1000 ug/l – Dangerous Substances Directive.

Total Iron was found to be above the recommended limits on a few occasions; August 2014 at SW2, August 2014 at SW3, September 2014 at BH3 and in October 2014 at BH3 and March 2015 at SW1. With the exception of SW1 in March 2015, which is surface water entering the site, more recent monitoring has shown levels well below the EQS.

Dissolved Iron was consistently below the recommended limit at SW1 and SW2, however in September 2014 at BH3, a result of 2967 ug/l was found. More recent monitoring has shown levels to be well below the EQS.



EQS – 20 ug/l – Dangerous Substances Directive.



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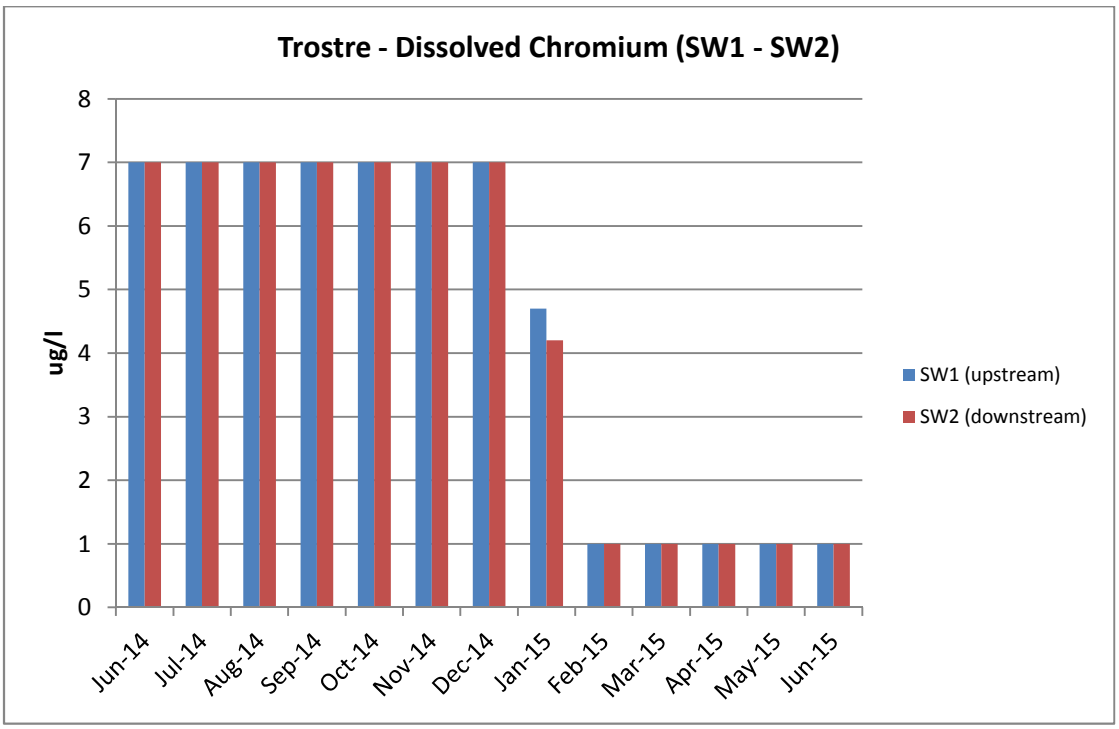
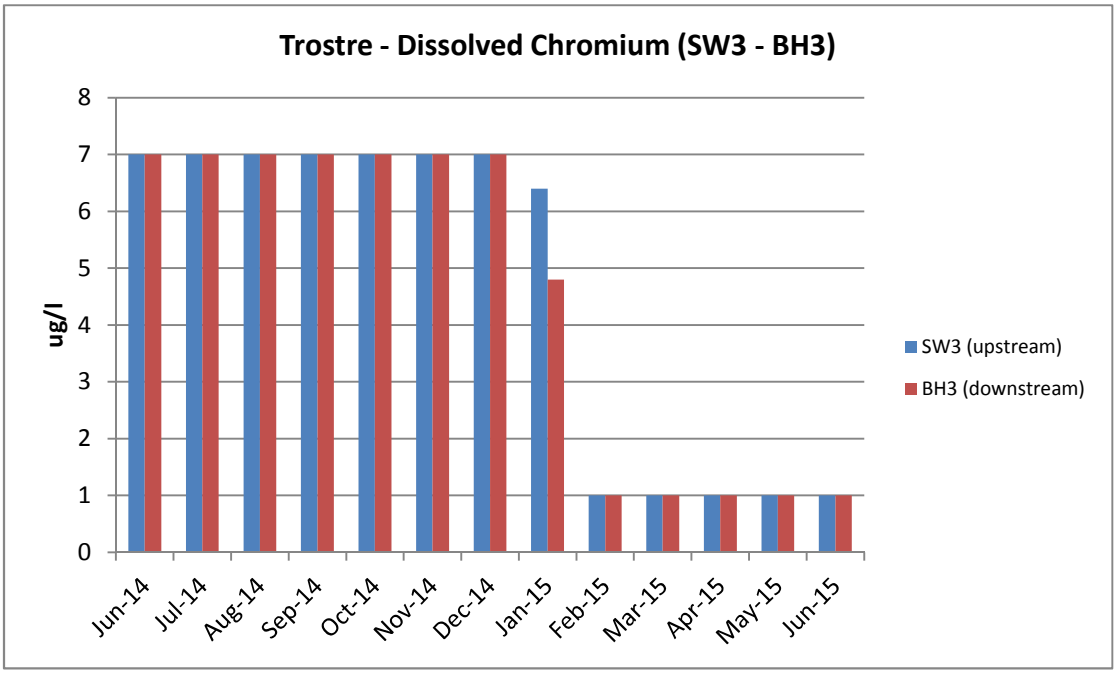


EQS – 20 ug/l – Dangerous Substances Directive.



EQS – 20 ug/l – Dangerous Substances Directive.

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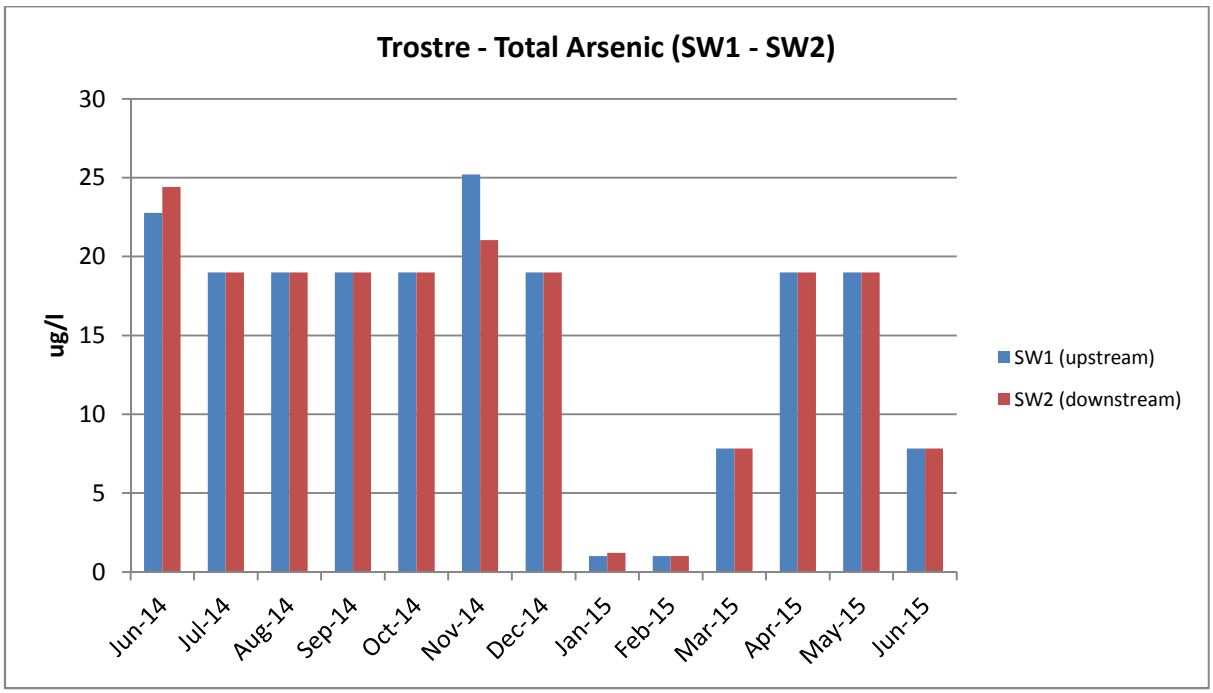
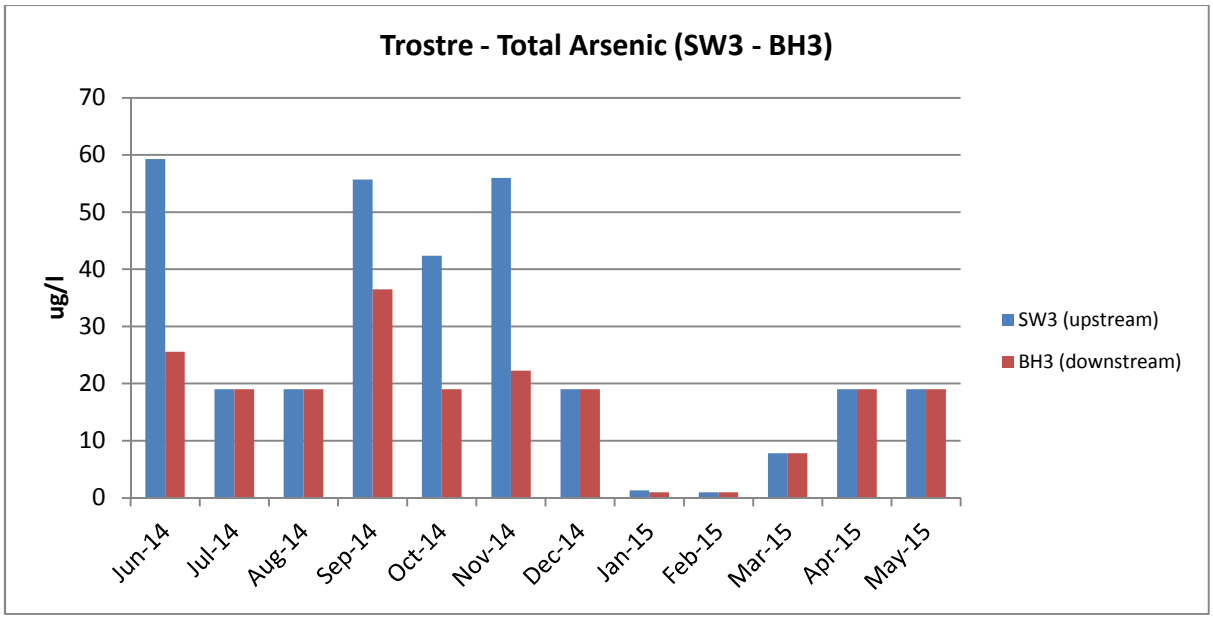
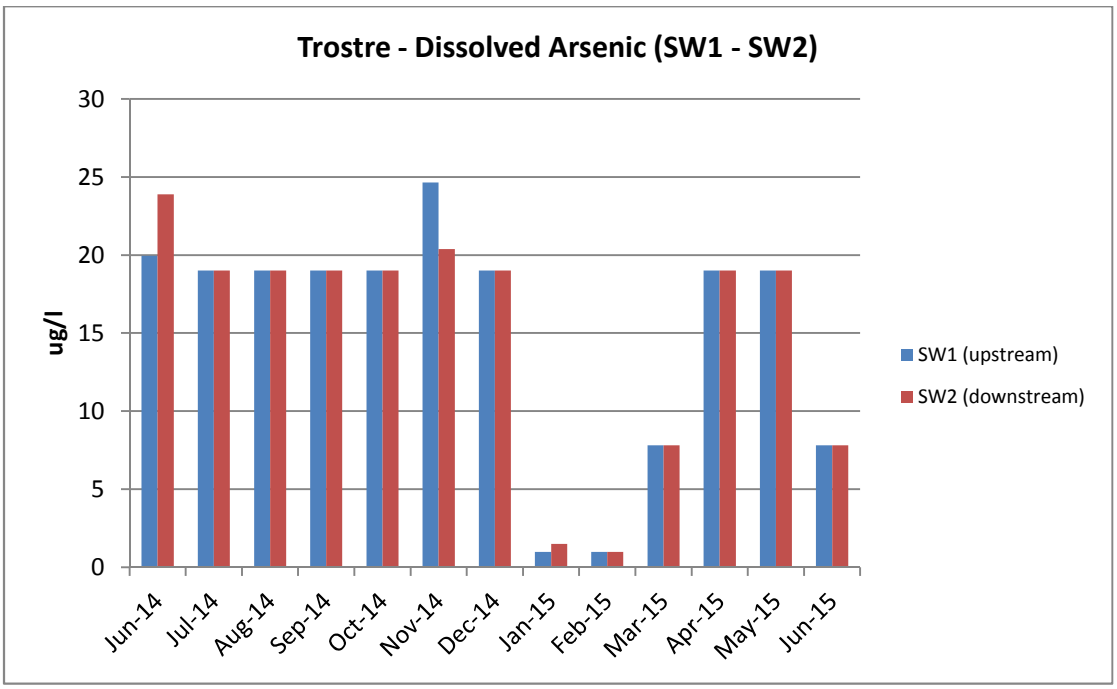
All results fell below the recommended limit.



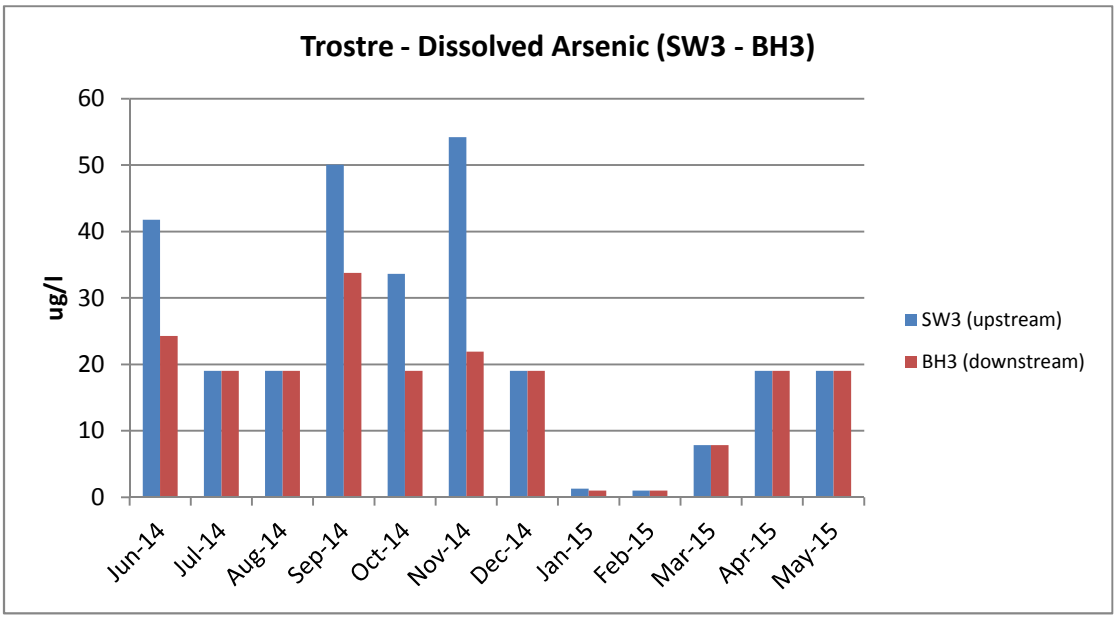
EQS – 50 ug/l – Dangerous Substances Directive.



EQS – 50 ug/l – Dangerous Substances Directive.

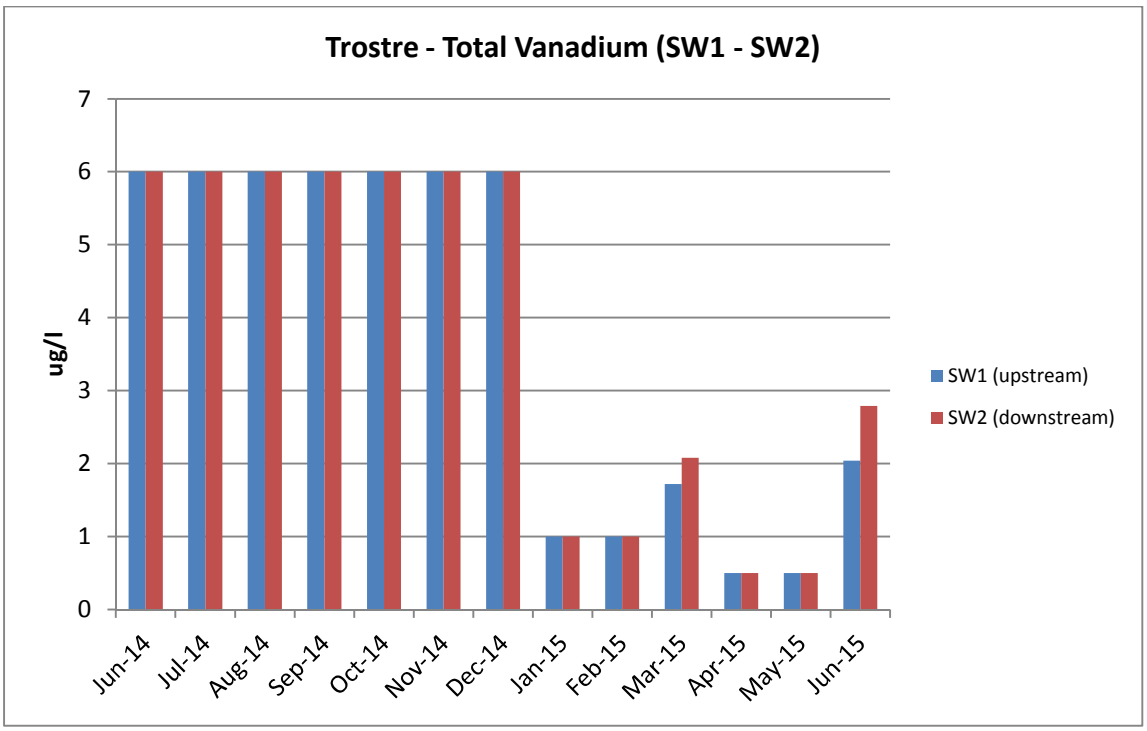


EQS – 50 ug/l – Dangerous Substances Directive.



EQS – 50 ug/l – Dangerous Substances Directive.

All results fell below the recommended limit during the monitoring period.



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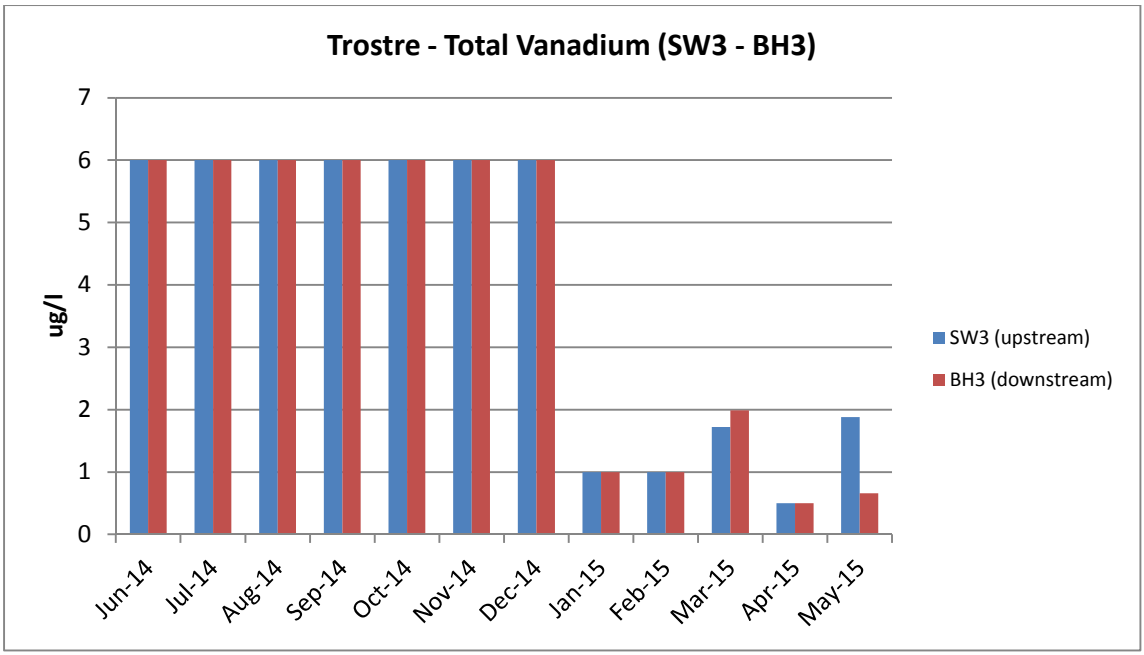
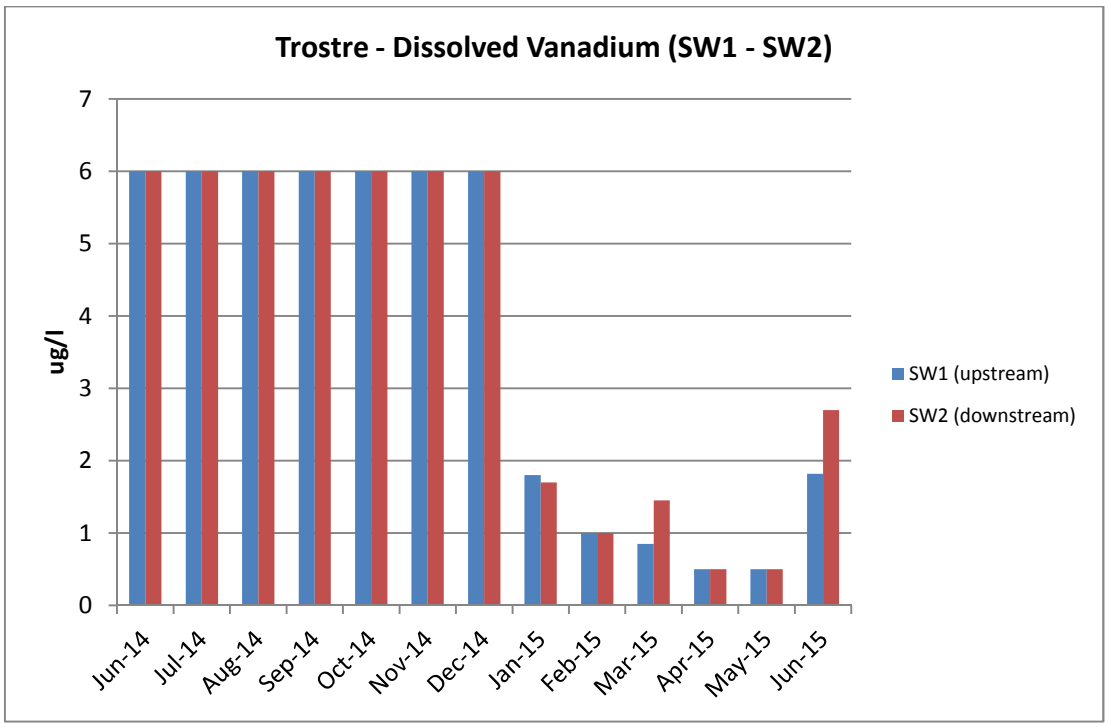
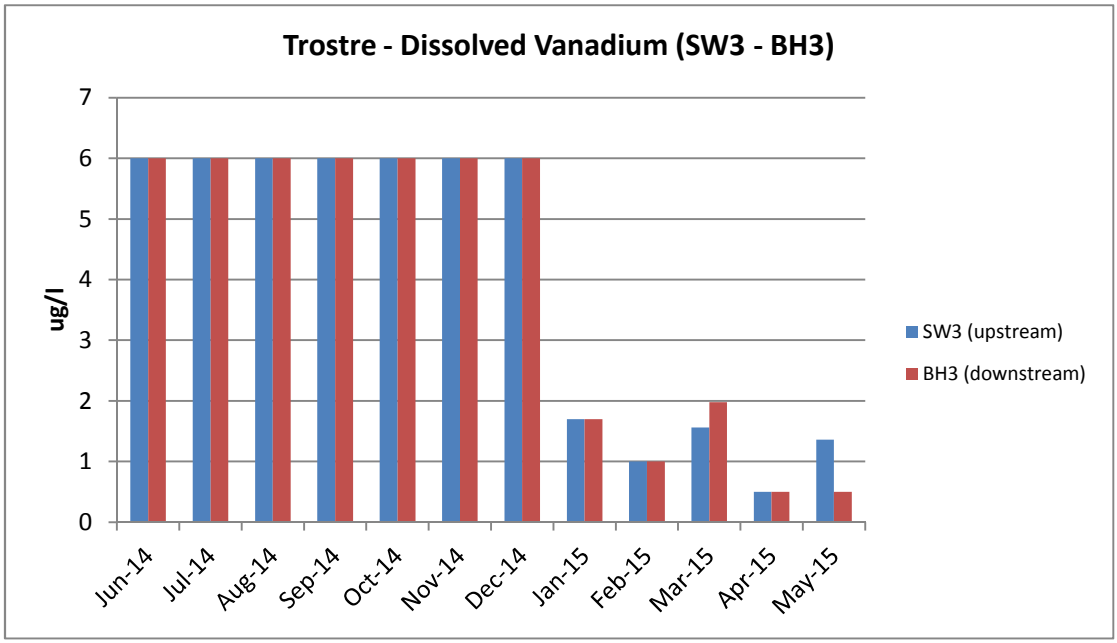


EQS – 20 ug/l – Dangerous Substances Directive.



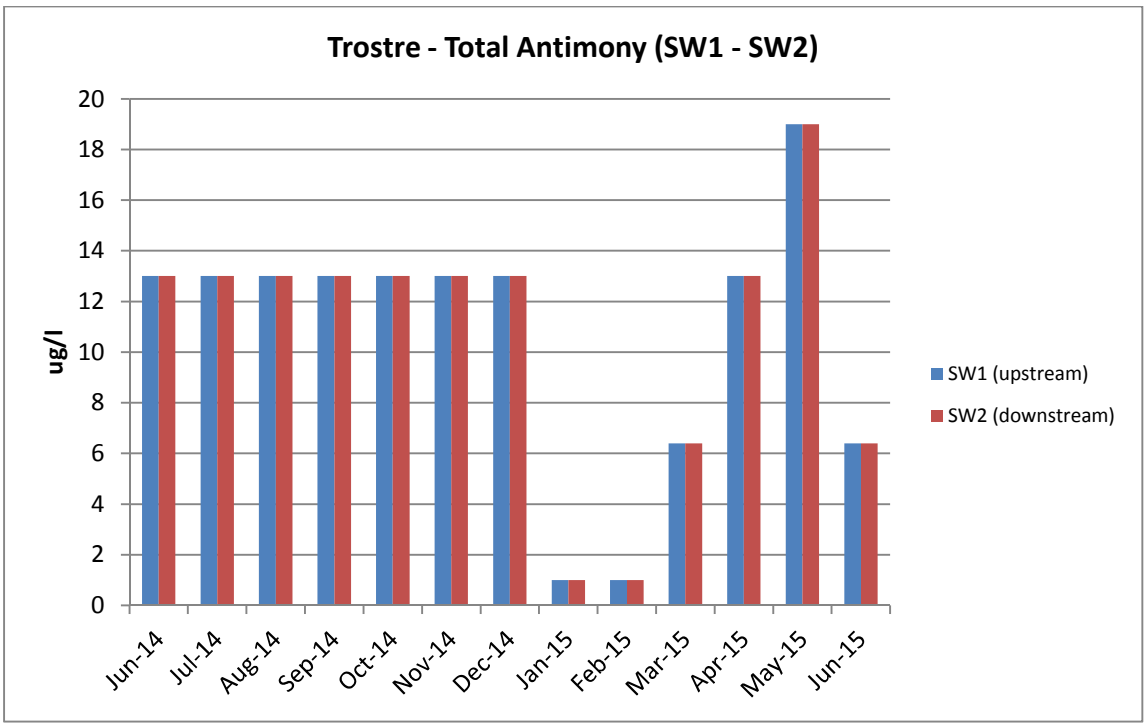
EQS – 20 ug/l – Dangerous Substances Directive.



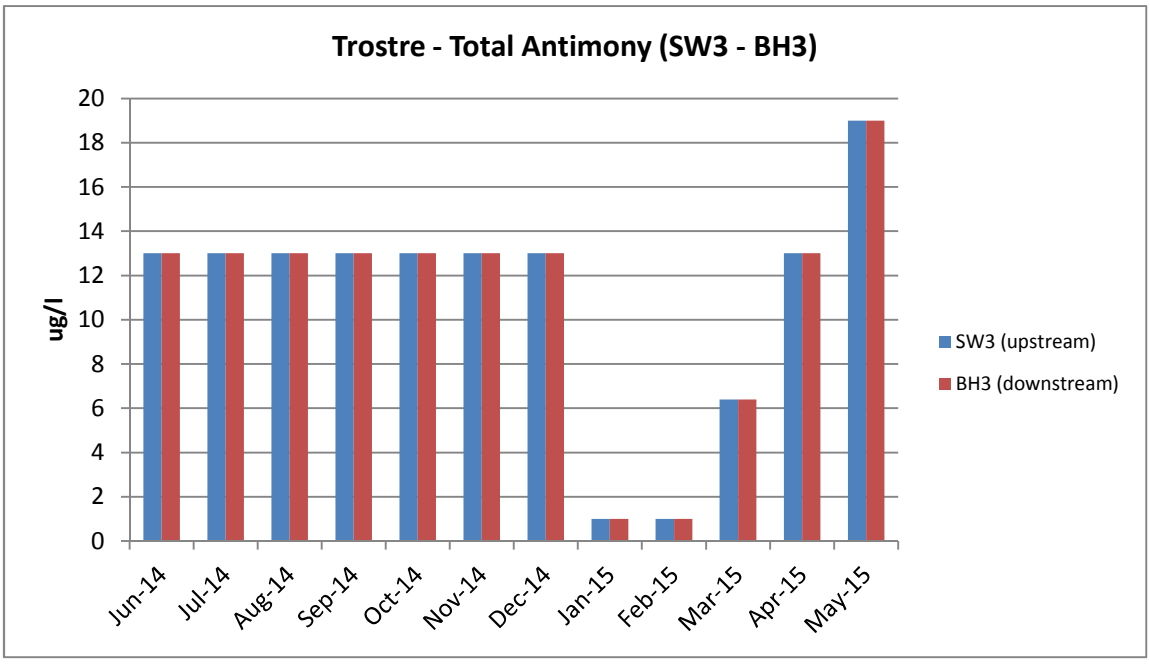
EQS – 20 ug/l – Dangerous Substances Directive.

There was a change in detection limit in the laboratory in January 2015; previously <6 ug/l, the new detection limit is <0.5 ug/l.

All results fell below the recommended limit.

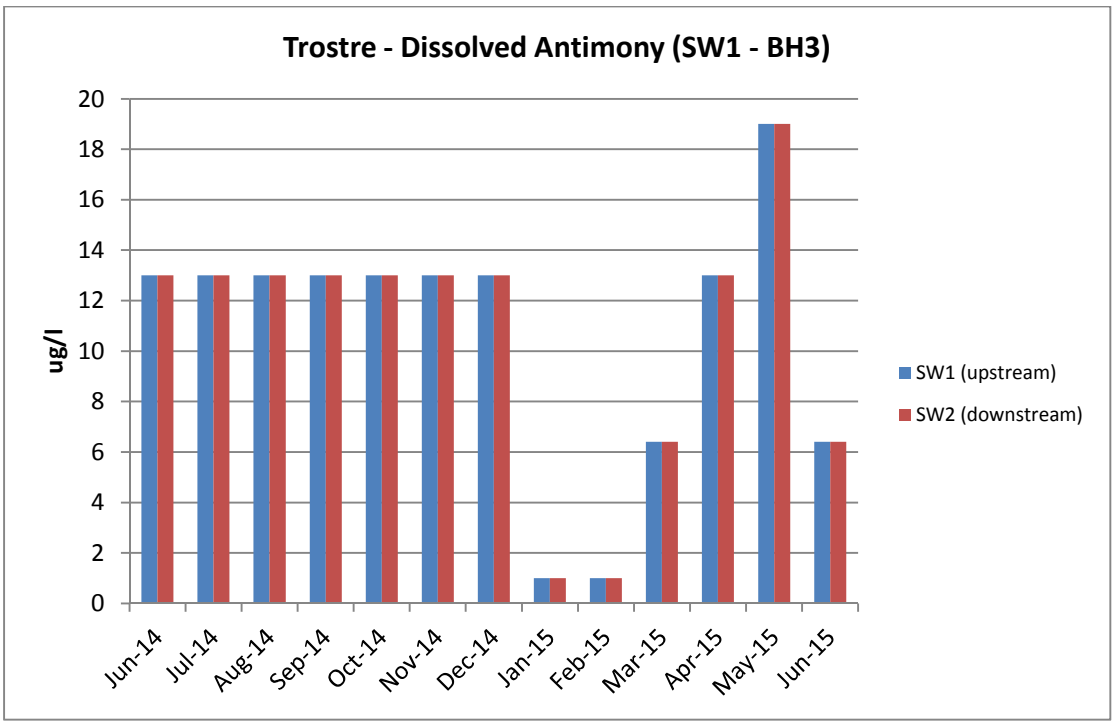


EQS – 5 ug/l – Dangerous Substances Directive.

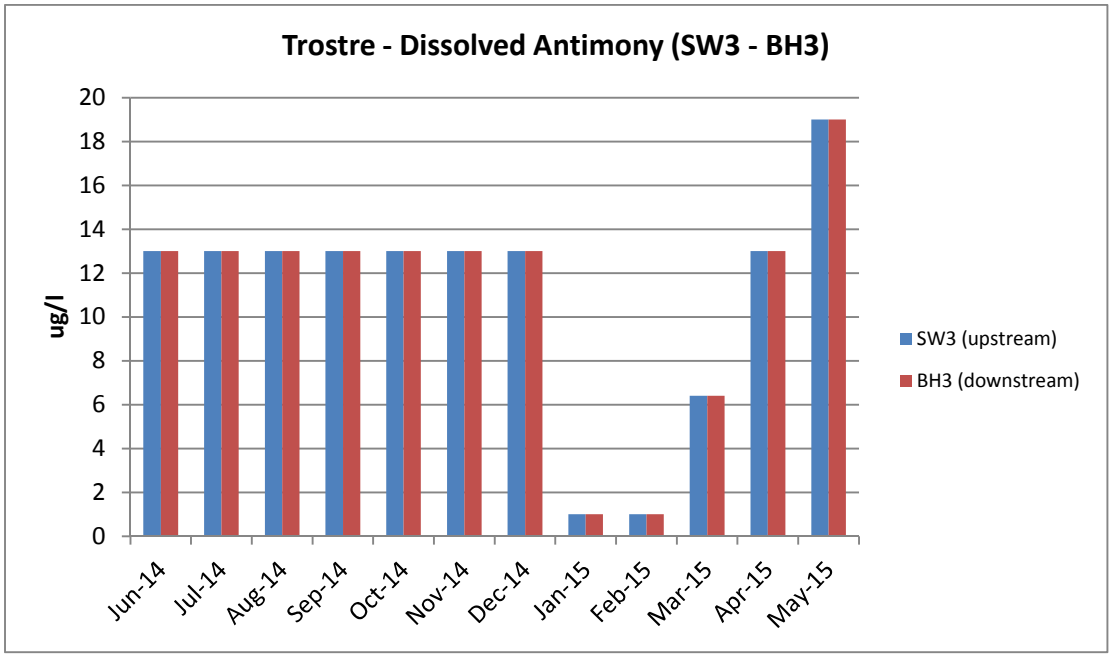


EQS – 5 ug/l – Dangerous Substances Directive.

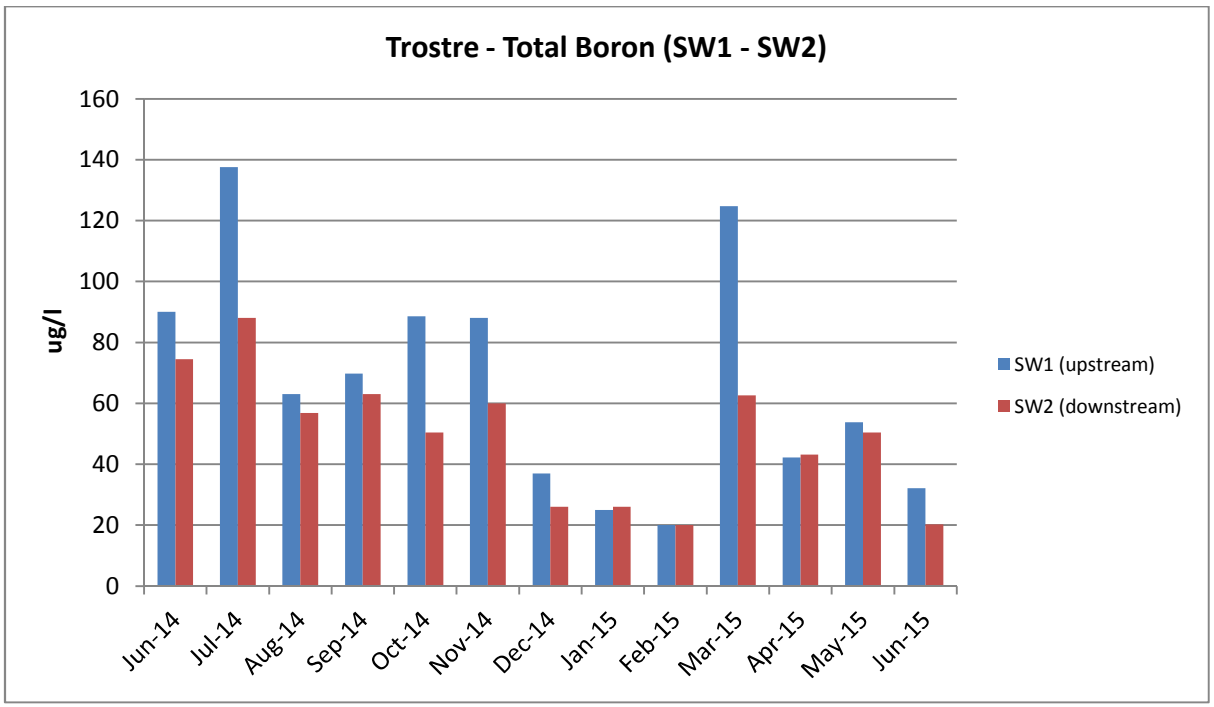
Despite laboratory detection limits being higher than the EQS, the results are the same for both upstream and downstream samples, indicating that the site is not having an effect on the concentration levels of antimony.



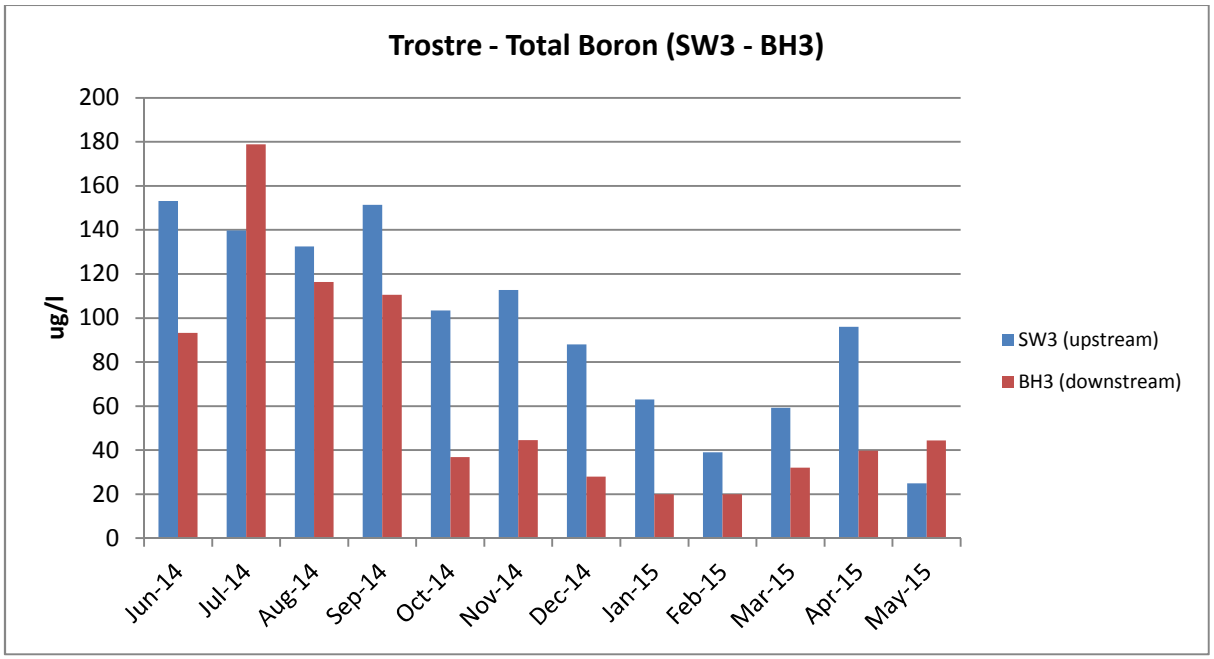
EQS – 5 ug/l – Dangerous Substances Directive.



EQS – 5 ug/l – Dangerous Substances Directive.

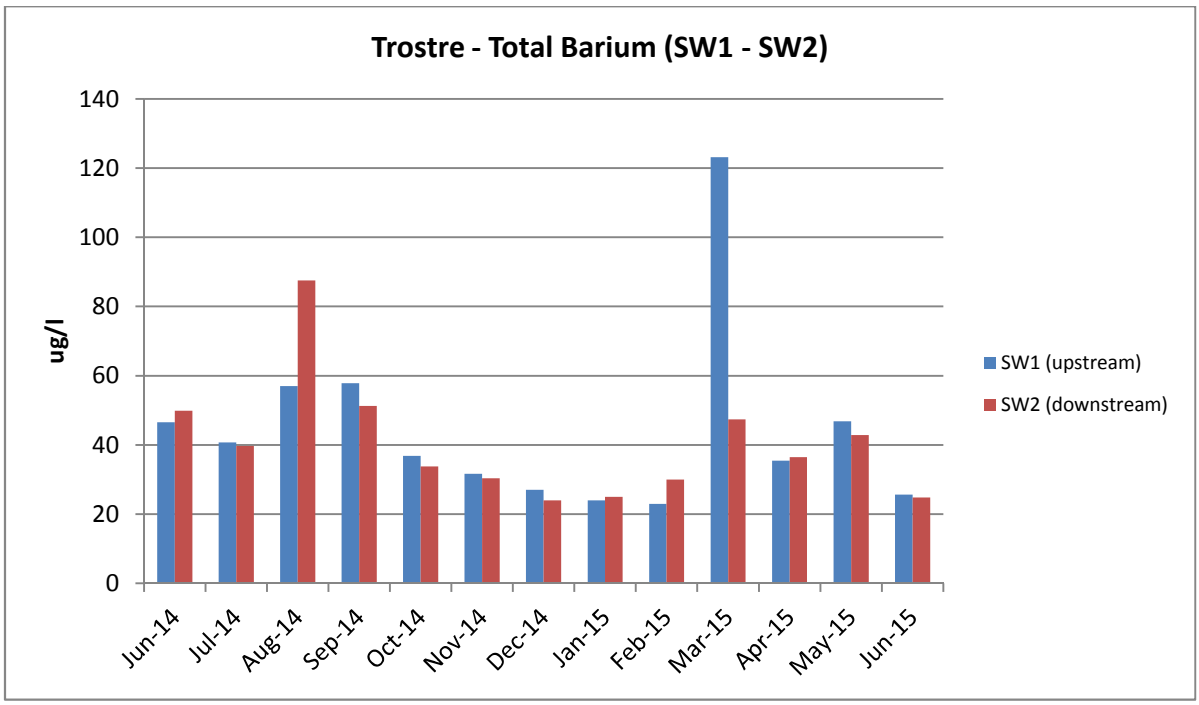


EQS – 2000 ug/l – Dangerous Substances Directive.

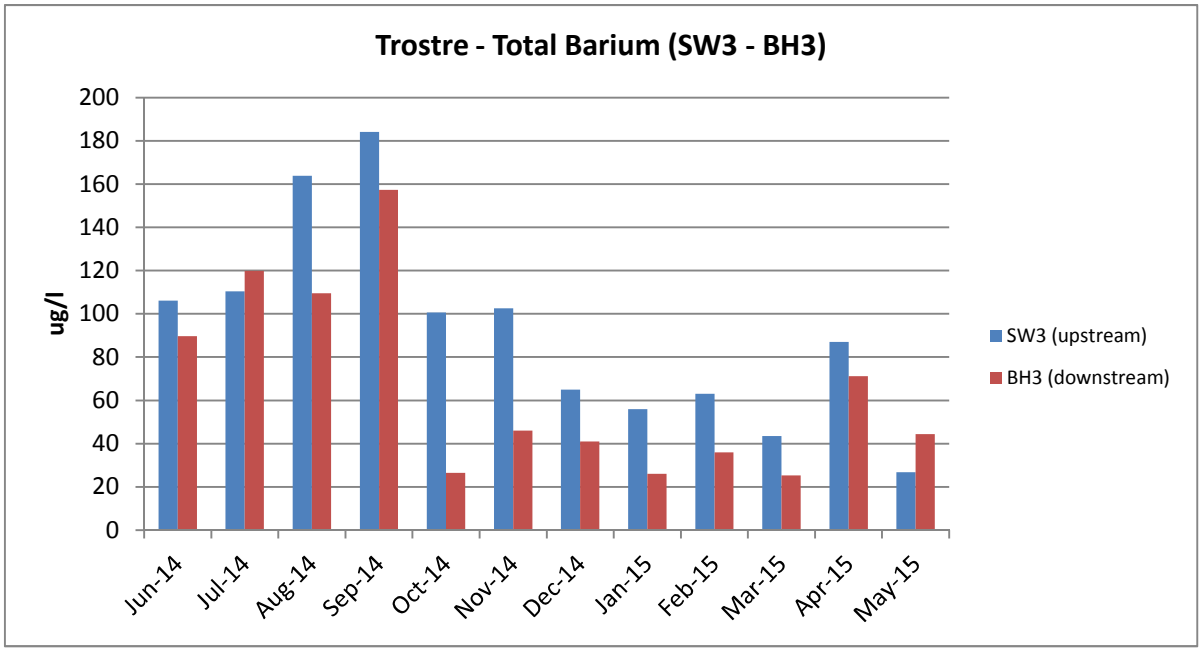


EQS – 2000 ug/l – Dangerous Substances Directive.

Results fell below the recommended level for Total Boron (2000 ug/l) in all four locations over the monitoring period.

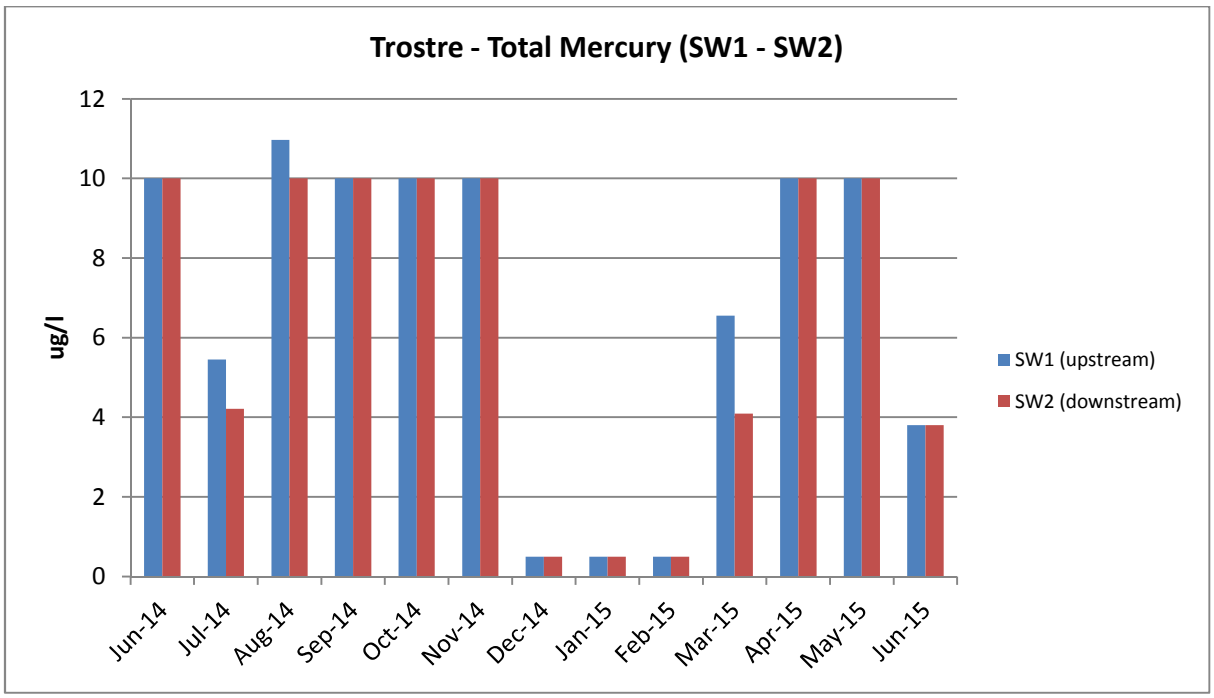


EQS – 100 ug/l – Surface Water Directive.

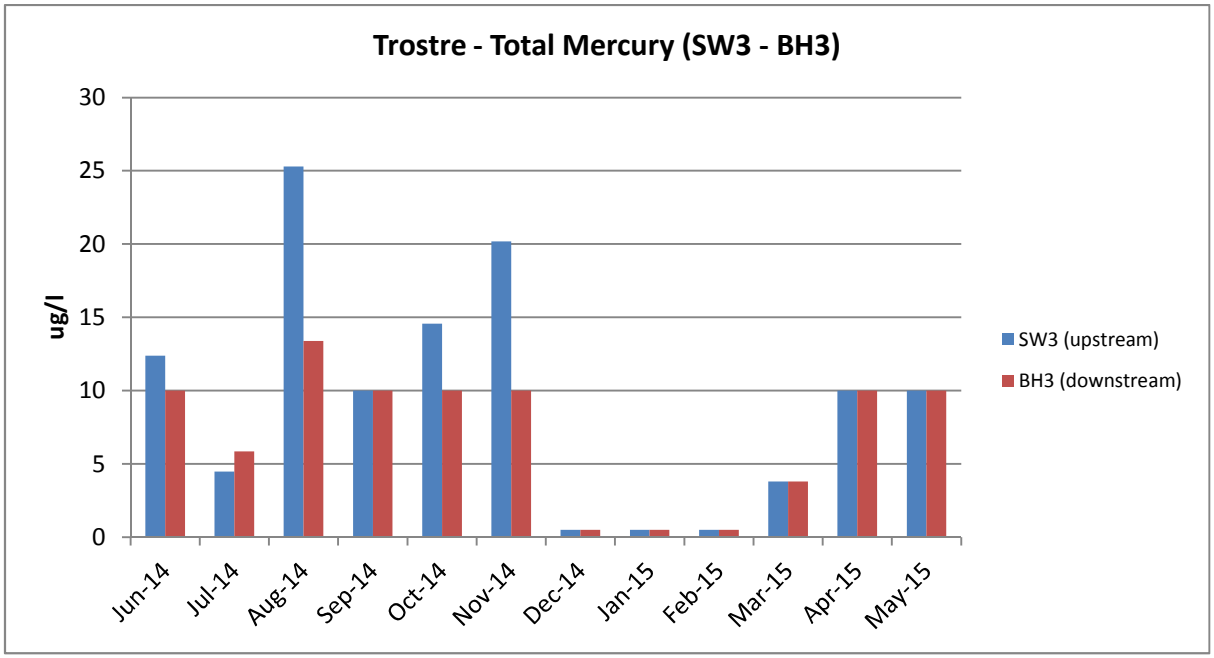


EQS – 100 ug/l – Surface Water Directive.

The results for Barium exceed the EQS of 100 ug/l in May 2015 at SW1; however this is surface water entering the site. Additionally between June 2014 and September 2014 in SW3 and BH3, however the results indicate this is due to the waters entering the site, underlining that the site is not having a major impact on the levels of Barium.

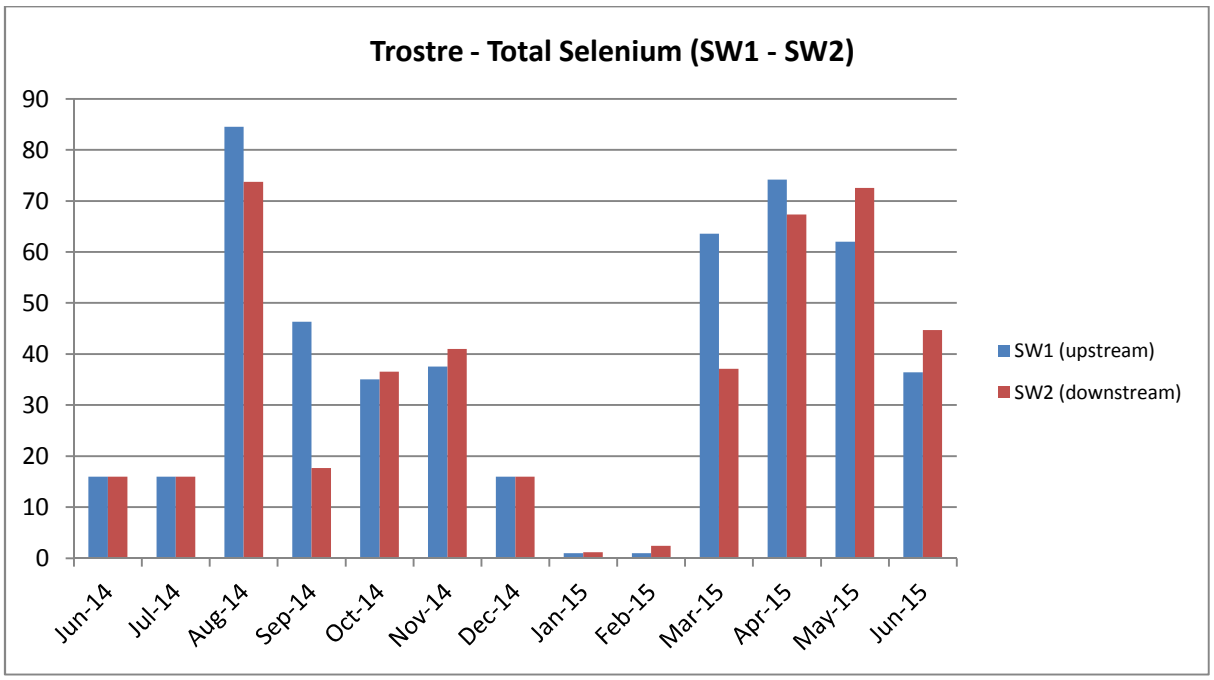


EQS – 1 ug/l – Dangerous Substances Directive.

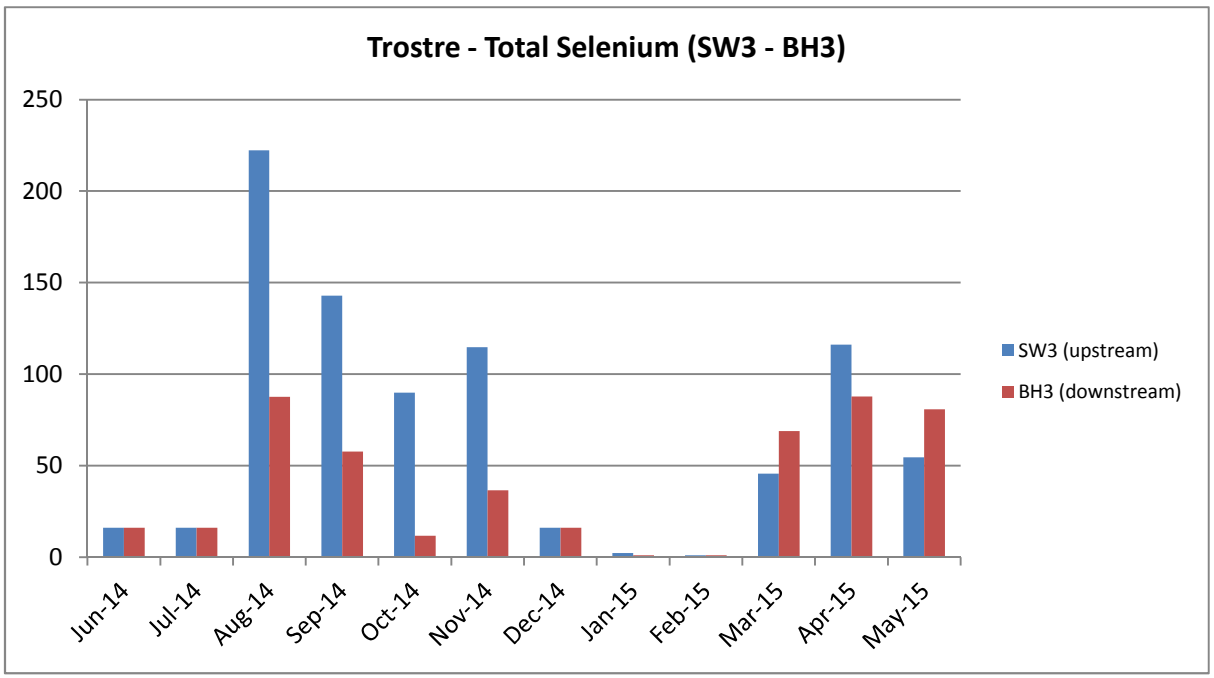


EQS – 1 ug/l – Dangerous Substances Directive.

The results showed that Total Mercury was generally recorded above the recommended limits, however with the exception of July 2014, the upstream values (SW1 and SW3) were higher than the results from the downstream samples (SW2 and BH3), underlining that the site is not having an impact on Mercury levels.

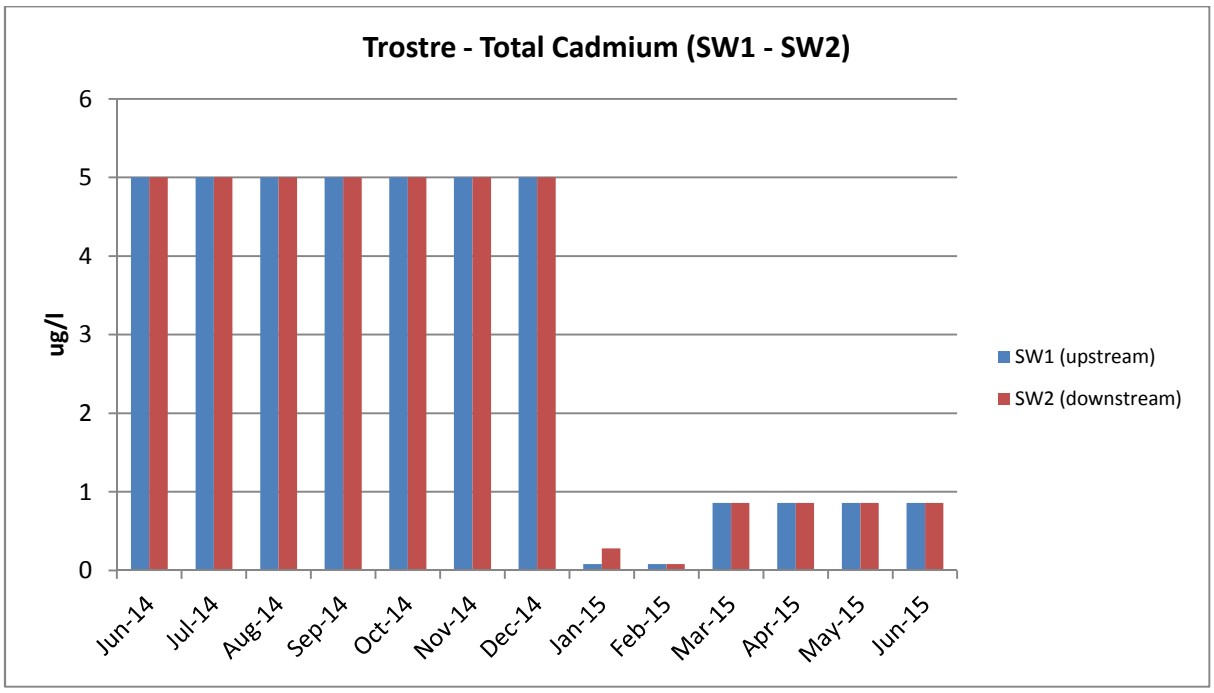


EQS – 10 ug/l – Dangerous Substances Directive.

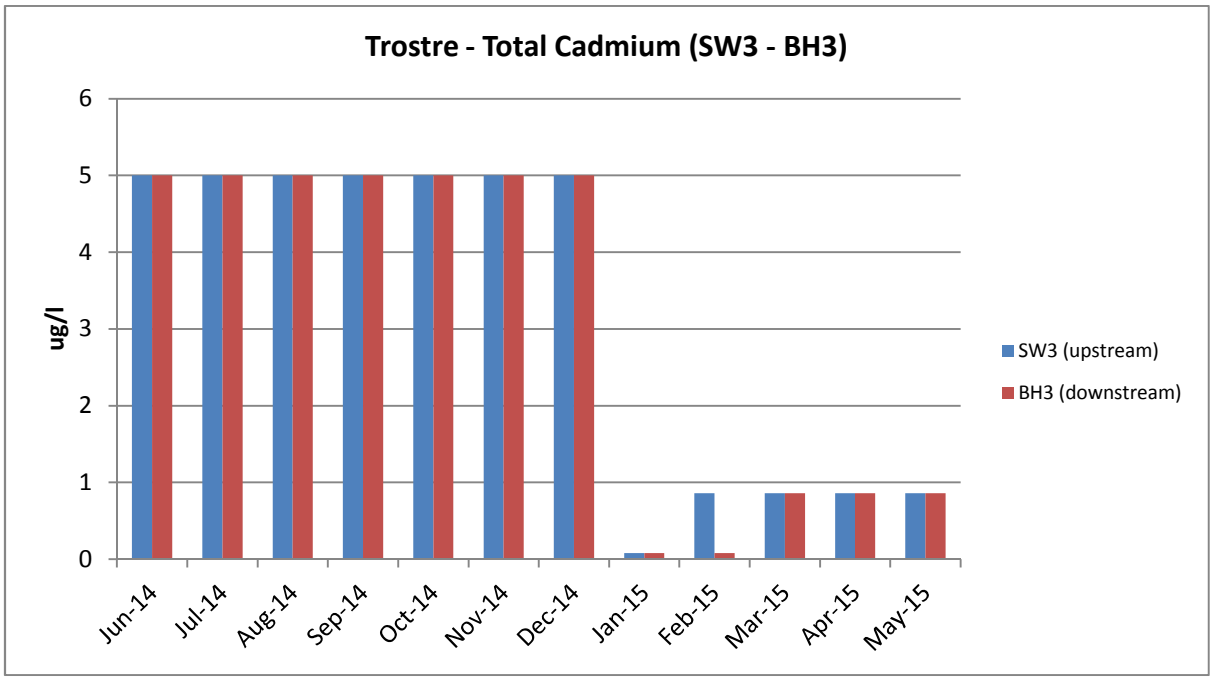


EQS – 10 ug/l – Dangerous Substances Directive.

Results were often over the EQS of 10 ug/l, however the graphs indicate this is due to surface waters entering the site. There was no increase of more than 10 ug/l between a downstream (SW2 and BH3) and an upstream (SW1 and SW3) result, meaning the site is not having an impact on Total Selenium levels that breach the EQS threshold.



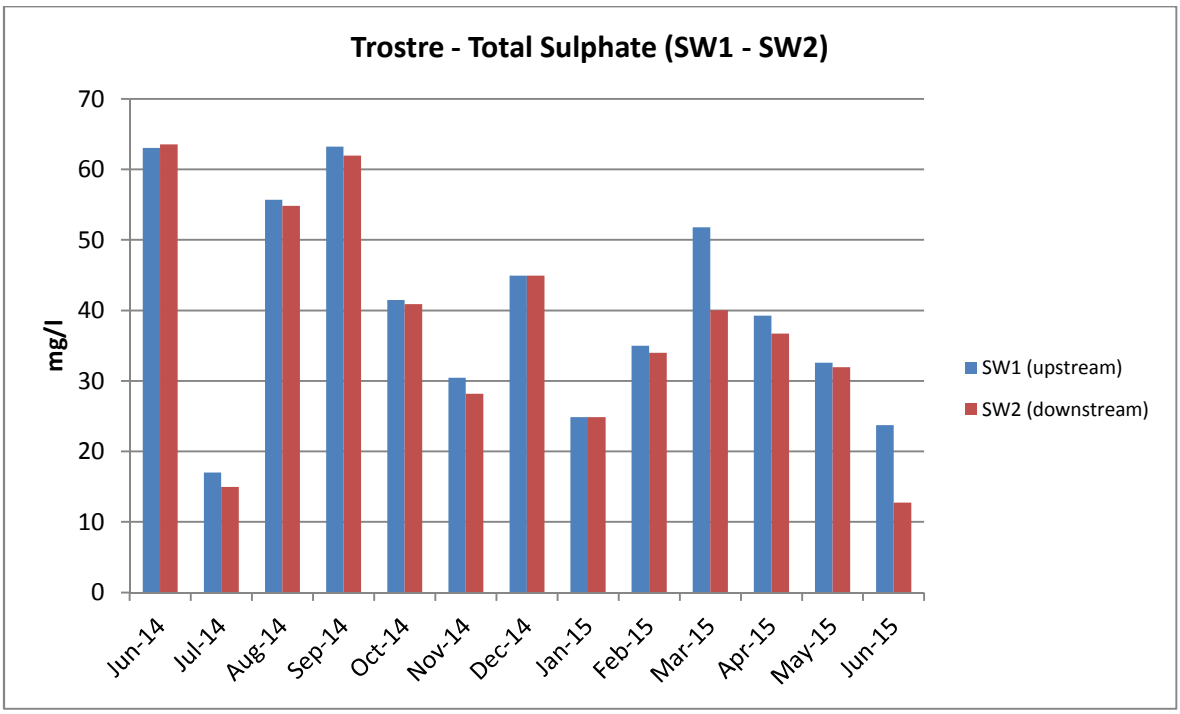
EQS – 5 ug/l – Dangerous Substances Directive.



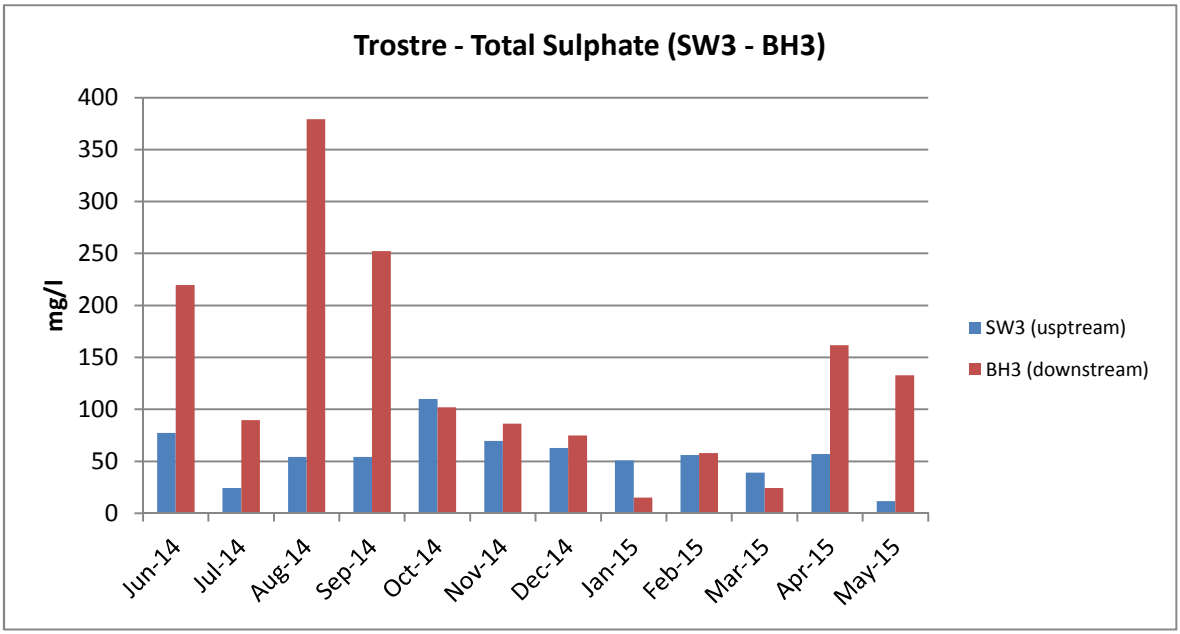
EQS – 5 ug/l – Dangerous Substances Directive.

There was a change in detection limit in the laboratory in January 2015; previously <5 ug/l, the new detection limit is <0.9 ug/l.

All results fell below the recommended limit.



EQS – 250 mg/l – Dangerous Substances Directive.



EQS – 250 mg/l – Dangerous Substances Directive.

August 2014 and September 2014 results at BH3 exceed the recommended limit, however all other results fall below the EQS.

The analysis indicates that values for: -

- pH and conductivity were within the limits throughout the entire monitoring period;
- Ammonia concentration was over the limit between June 2014 and September 2014, but these were from incoming surface waters;
- Chloride concentrations were within limits;
- COD exceeded limits in November 2014 at BH3, but fell below the limits in every other month;
- Biochemical Oxygen Demand (BOD) exceeded the limit on various occasions both downstream and upstream;
- Alkalinity has no limits, but higher results were obtained from upstream samples;
- Phenol and TPH were within the limits;
- Nickel, Lead (total and dissolved) results fell below the recommended limits;
- Total and Dissolved Copper never exceeded the limit
- Antimony downstream values were no higher than upstream;
- Total Zinc concentrations at SW1 in August 2014 and BH3 in July 2014 were above the limits, but levels have overall generally decreased over time;
- Total Iron was above recommended limits in August 2014 at SW2 and SW3, and in September and October 2014 at BH3, and March 2015 at SW1. No results have exceeded the limits in the last 7 months;
- Chromium, Arsenic and Vanadium (total and dissolved) all fell below the appropriate limit;
- Total Boron did not exceed the EQS;
- Total Barium exceeded the limits on a few occasions, but this was due to upstream concentrations, not a result of the site;
- Mercury and Selenium were above the limit during most months, but this is a result of high concentrations from incoming surface waters;
- Cadmium and Total Sulphate did not exceed the limits.

The results of determinands exceeding EQS's over the monitoring period June 2014 – June 2015 have been averaged and summarised in the table below:-

Table 8 – Summary of Water Determinands Exceeding EQS's

Determinand	EQS	Mean Concentration: June 2014 – June 2015			
		SW1 (upstream)	SW2 (downstream)	SW3 (upstream)	BH3 (downstream)
Ammoniacal Nitrogen	1 mgNH_4/l	0.12	0.13	0.91	0.32
COD	30 mg/l	12.8	10.5	10.2	16.6
Iron (total)	2000 ug/l	741	790	940	687
Iron (dissolved)	1000 ug/l	187	171	170	272'
BOD	3 mg02/l	5.31	4.86	4.37	6.78
Zinc (total)	50 ug/l	22.7	22.4	18.2	20.8
Barium	100 ug/l	44.2	40.2	88.8	66.0
Mercury	1 ug/l	6.79	6.43	8.9	7.0
Selenium	10 ug/l	37.7	34.0	68.0	40.0

Results exceeding the concentration levels are highlighted in yellow.

In the instances of BOD, mercury and selenium the mean concentrations exceed the EQS; but there is a clear indication that already high concentrations are present in the incoming surface waters, the contribution of the former landfill does not exceed the EQS.

Mercury and Selenium levels are lower in the downstream monitoring points than those found upstream, as is BOD with SW1 and SW2.

The analysis also indicates that values for ammoniacal nitrogen, chemical oxygen demand (COD), total and dissolved iron, zinc and barium exceeded the relevant EQS at some point in the previous 12 months. However the average concentration over the monitoring period for each determinand falls below any EQS.

12.0 DISCUSSION

12.1 Gas

Previous site investigations and monitoring have indicated elevated levels of methane (CH_4) and carbon dioxide (CO_2), above the limits set out by the EA.

However, as a result of the remediation of landfill carried out by ExCAL Ltd in July 2013, which included the removal of organic matter assumed to be responsible for the high levels of CH_4 due to anaerobic digestion, CH_4 and CO_2 levels have dropped and are consistently below the threshold of 1.5% and 5% respectively.

Within the 12 sets of data collected after the remediation, levels only exceeded the guidelines outlined by the EA during two of the months, both of which were soon after the removal of organic matter (October 2013 and February 2014). Once the results representing the entire site have been calculated for each month of monitoring, they fall below any EQS/GAC.

Between March 2014 and June 2015 no enhanced levels were recorded, and between November 2014 and June 2015 CH_4 was recorded at 0%.

Monitoring has demonstrated that gas is no longer being generated at a significant rate and is not having an unacceptable impact at a receptor. It can be assumed that stable conditions exist.

12.2 Water

Results of 12 months of monitoring of 3 surface water locations and one groundwater location have been summarised in this report.

Both inorganic and organic analysis of water samples from two upstream (background) locations (SW1 and SW3) and two downstream locations (SW2 and BH3) have shown the site is not having a significant impact on background levels.

There are a few occasions where determinand results are above the EQS, such as a COD of 96 mg/l recorded at BH3 in November 2014; however the BH3 average for the monitoring period falls below the EQS of 30 mg/l with a result of 16.6 mg/l.

In the majority of cases where downstream results exceed the EQS of a determinand, it is a result of high concentrations present in incoming surface waters.

12.3 Soil

Soil analysis was undertaken in 2010, the results of which are summarised under separate cover – 'Site Investigation Report' by ExCAL in August 2010 found in Appendix E – ExCAL Site Investigation Report.

At the time of analysis, the most elevated contaminant found was barium, with the highest result recorded at 440 mg/kg at a depth of 0.50m at TP3. Elevated levels of lead and arsenic were also found which pose a potential risk to human health.

12.4 Leachate

A contaminated leachate is not generated within the site, therefore no active control measures to protect groundwater and surface waters have been implemented.

12.5 Site Conceptual Model

A site conceptual model (SCM) based on the information presented in the proceeding sections has been developed (Table 9).

Table 9 – Site Conceptual Model

Potential source	Potential Pathway	Potential Receptor	Potential Probability & Consequence	Potential Risk	Comments
Soil contaminants (i.e. barium, arsenic and lead)	Ingestion/ Dermal Contact	Future on-site users (residential / commercial)	Unlikely / Severe	Moderate / Low	Risk will change dependent on end-use
		Construction workers	Likely / Severe	High	Intrusive works are likely to result in contact with potential contaminants if incorrect PPE and Health & Safety measures are used
		Maintenance workers	Unlikely / Severe	Moderate / Low	
	Permeation	Subsurface plastic water pipes	Likely / Severe	High	If inappropriate pipes are laid within contaminated ground
	Leaching	Groundwater in Secondary A Aquifer/ surface watercourse	Likely / Medium	Moderate	Exceedance of guidelines in background concentrations of contaminants in groundwater and surface water
	Root Uptake	Soft landscaping on-site (e.g. phytotoxicity)	Likely / Mild	Moderate / Low	Risk will change dependent on end-use and degree of soft landscaping
Asbestos	Inhalation	Any	Unlikely / Severe	Moderate / Low	No asbestos found on site.
Groundwater contaminants (i.e. barium, total iron, mercury and TPH)	Ingestion / Dermal Contact	Future on-site users (residents / commercial)	Unlikely / Severe	Moderate	Risk will change dependent on end-use
		Adjacent commercial/ residential land users	Unlikely/ Medium	Low	Exceedances in background concentrations of contaminants
		Construction workers	Likely / Severe	High	Intrusive works are likely to result in contact with potential contaminants
		Maintenance workers	Unlikely / Severe	Low	
	Permeation	Subsurface plastic water pipes	Likely / Medium	Moderate	If unsuitable pipes are laid within contaminated ground
	Lateral Groundwater Migration	Afon Dafen / River Dafen	Likely / Medium	Moderate	Higher concentrations of some contaminants in River Dafen than in groundwater and surface water
Ground gas (CO_2 and CH_4)	Inhalation / Explosion	Future on-site users (residents / commercial)	Unlikely / Mild	Very Low	Gases present risks from asphyxiation, explosion and toxic effects. Gases are likely to accumulate in confined spaces presenting increased risk. Gas monitoring has shown no methane to be present.
		Adjacent commercial/ residential land users	Unlikely / Mild	Very Low	
		Construction workers	Unlikely / Mild	Very Low	
		Maintenance workers	Unlikely / Mild	Very Low	

APPENDIX A

Environment Agency
‘how to surrender your permit’

13.0 CONCLUSION

Following a review of the water and gas monitoring data obtained over the last two years it is clear that the site is no longer having a detrimental impact on the surrounding environment and nearby receptors. Stable conditions now exist and we believe the permit is applicable to surrender.

Additional guidance for

Landfill (EPR 5.02)

and other permanent deposits of waste

How to surrender your environmental permit

We are the Environment Agency. It's our job to look after your environment and make it a better place – for you, and for future generations.

Your environment is the air you breathe, the water you drink and the ground you walk on. Working with business, Government and society as a whole, we are making your environment cleaner and healthier.

The Environment Agency. Out there, making your environment a better place.

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Version	Date	Change
2	3rd December 2012	Redrafted to reflect current best practice
1	September 2010	Issue of 'The surrender of permits for the permanent deposit of waste'

1. Introduction

1.1. Purpose of this document

This document gives guidance on what evidence we expect to be included in the surrender report supporting an application for the surrender of a permit for the permanent deposit of waste. It outlines the acceptable types of information for the different types of site, based on the risk posed to the environment.

Our policy on the surrender of environmental permits is set out in our Regulatory Guidance Note 9, 'Showing that land and groundwater are protected at:

- installations
- waste facilities
- mining waste operations
- non-nuclear radioactive substances facilities and mobile apparatus'

Guidance on how to gather relevant evidence throughout the lifetime of the site, how to close your site and the aftercare management is described in relevant sector guidance notes for your activity. There are sector guidance notes for mining waste facilities and landfills for inert, hazardous and non-hazardous waste. You should use the guidance appropriate for your sector.

Where you have activities at your site covered by permit conditions that do not include the permanent deposit of waste you may also need to keep site condition records. Guidance on how you comply with this requirement is provided in 'How to comply with your environmental permit', and H5 'Environmental Permitting Regulations, Site Condition Report Guidance and Templates'.

1.2. Activities covered by this guidance

This guidance may be used for all types of permanent deposits of waste permitted under the Environmental Permitting Regulations (England and Wales) 2010 and subsequent amendments. These include:

- landfills
- mining waste operations
- deposits of waste for recovery

These include activities that have a bespoke environmental permit and lower risk activities that have been operating under a standard rules permit.

2. General approach

2.1. Surrender criteria

The aim of an environmental permit is to set the standards you must achieve to ensure that you manage operations at your site to prevent or minimise pollution. You will have set out how you will achieve this in a number of documents approved under the permit (or previously approved under a waste disposal or management licence). Central to this is your understanding, set out in the conceptual model, of how the site can impact the surrounding environment. You will have included information on the setting of the site, the wastes that you have deposited and the pollution control measures that you employed. As your site has developed, the monitoring data that you have collected will have updated and refined your conceptual model.

To accept an application to surrender an environmental permit for a site involving the permanent deposit of waste, we must be satisfied that:

- the site has ceased accepting waste
- relevant closure procedures have been complied with
- an appropriate period of aftercare has passed to allow the waste to stabilise and to gather evidence to demonstrate that the pollution control measures are no longer necessary
- the deposits of waste are in a satisfactory state that, if left undisturbed, will not cause pollution of the environment

'Pollution control measures' can include both:

- Active pollution control measures, which require your intervention or maintenance, for example using a pumping system to maintain leachate levels below that of the surrounding groundwater level or maintaining water levels in a settlement pond.
- Passive pollution control measures, which degrade and whose performance is anticipated to deteriorate over time, for example a flexible membrane liner that over time will develop holes.

Active pollution control measures are likely to be required at higher risk sites. You will need to provide evidence that they will no longer be necessary because the waste has degraded to a point that the quality and quantity of the pollutants such as effluent, leachate or landfill gas will not pose a risk to people or the environment through an uncontrolled release.

Your surrender report must identify any impact on the surrounding environment, taking into account the use of the land. You must consider any receptors that are present and any specific land use approved by the planning authority.

Site infrastructure such as leachate extraction wells, monitoring boreholes and associated site infrastructure must be decommissioned to make them safe before we will accept an application to surrender your permit.

2.2. Evidence requirements

There are three types of surrender application that we accept for environmental permits. These are: basic, low risk and standard surrender applications. The amount of information that you are required to provide with the application will increase with the complexity of site. In determining the appropriate type of surrender application we will take into account:

- the types of waste deposited
- the controls that you have employed to protect the environment
- the sensitivity of the location

The different types of information that we require for the different surrender applications are set out in Figure 1 below.

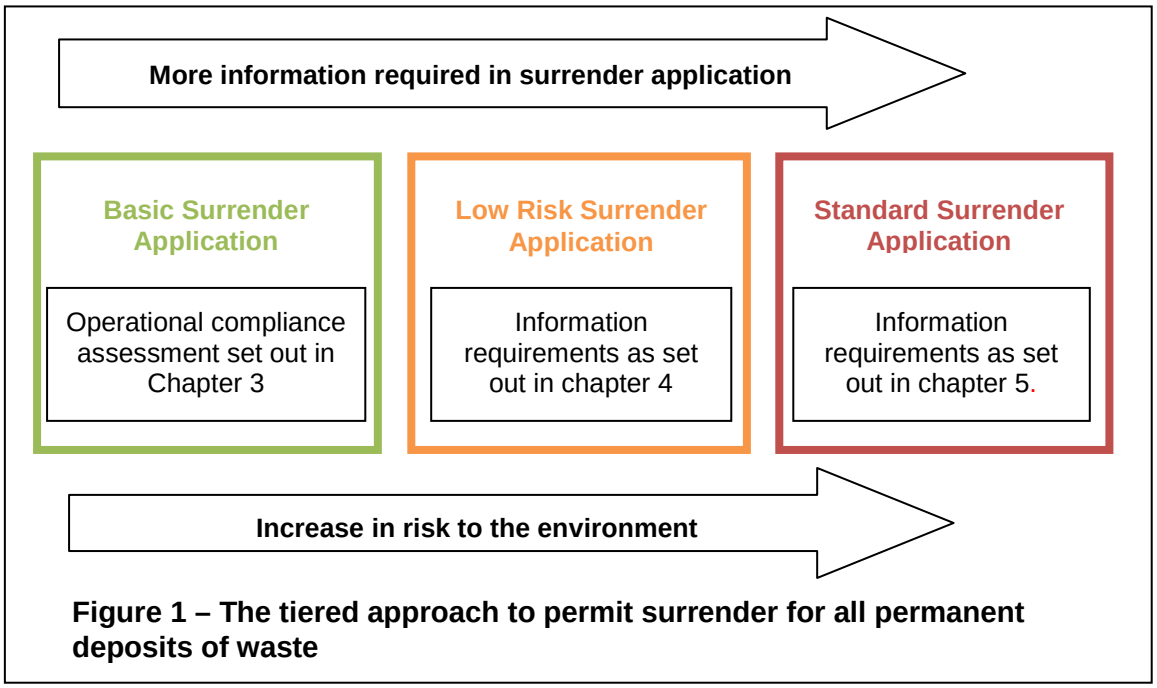


Figure 1 – The tiered approach to permit surrender for all permanent deposits of waste

It is important that you discuss the evidence to support the application to surrender with us when:

- you enter the formal closure procedures (this does not apply to recovery deposits)
- you breach a condition of the permit
- you are preparing your surrender application

Where you supply environmental monitoring data with your application, you will need to provide evidence that you obtained this data from monitoring infrastructure that is fit for purpose. For relevant monitoring points, this should include construction details and evidence that the condition has been regularly checked and repaired where necessary.

The monitoring we agreed when you ceased accepting waste for disposal at your site may not be sufficient to demonstrate that the waste mass is stable for the purposes of permit surrender. At the point of closure, monitoring is for emissions from the site to demonstrate compliance with limits in the permit. Additional data may be necessary to demonstrate surrender and you should contact us about this as part of your surrender pre-application discussions.

3. Basic surrender

For some deposit activities, we have adopted a lighter regulatory approach to permitting and compliance as they present a low risk to the environment. If we are satisfied that you have complied with your permit and there is no evidence to the contrary you will not normally be required to provide a surrender report with your application. These sites include:

- The management of inert wastes and unpolluted soil resulting from the prospecting, extraction, treatment and storage of mineral resources and the working of quarries, at mines and quarries (either under standard rules permit SR2009 No 8 or under a bespoke permit where the facility is not category A).
- Treatment of land for reclamation, restoration or improvement of land, up to 100,000 tonnes of waste (under standard rules permit SR2010 No 9 and 10).
- Use of waste in construction, up to 100,000 tonnes of waste (under standard rules permit SR2010 No 7 and 8).

4. Low risk surrender

This chapter provides guidance on how to establish whether an activity is in the low risk category and how we will assess the surrender application.

Operators of sites that accepted hazardous and non-hazardous biodegradable waste, or where active pollution control measures have been employed, will not be able to apply to surrender their permit using this approach.

The low risk surrender approach is based on a review of records collected during the operational phase that should include evidence of the waste you accepted.

For sites (or parts of sites) where the waste has been deposited in accordance with Landfill Directive requirements, the records you collect as part of your waste acceptance procedures will provide this evidence. In the case of a mining waste operation, the waste accepted will be reviewed against the site's waste management plan. In the case of a recovery deposit, this will consist of a review of the permit documents and waste acceptance procedures.

For sites (or parts of sites) where wastes were deposited to Pre-Landfill Directive standards you should review the information that you have on that waste to determine whether the site is in a suitable condition for a surrender application to be made. You will need to:

- assess the waste deposited
- assess the sensitivity of the site and its surrounding location

4.1. Landfill Directive inert waste

If you have been operating a landfill for inert waste, permitted in accordance with the requirements of the Landfill Directive, you have protected the environment through a combination of the geological barrier and controls on waste acceptance. You should be able to demonstrate, through waste records, that the waste accepted is genuinely inert. Guidance on the collection of these records is provided below.

During the operational phase of your landfill, we will have inspected the site, reviewed your records and carried out audits of your waste acceptance controls and procedures. These will have included reviews of the checks that you have taken together with an assessment of the results of any waste analysis. Where we have identified that you are not complying with your waste acceptance procedures, we will notify you at that time. If you improve your waste acceptance controls and remove unacceptable waste you should include evidence of this when characterising the waste in your landfill.

We will accept the landfill is in a condition for its permit to be surrendered where, based on the review of the waste acceptance controls, you can demonstrate that the Landfill Directive waste acceptance controls have been complied with during the life of the site.

We will accept that you have protected the environment based on:

- a construction quality assurance report to demonstrate that a geological barrier was constructed or a site investigation in the permit application to demonstrate that the natural geology provides the geological barrier
- a review of relevant environmental monitoring

4.1.2. Landfill Directive inert waste from a single source

Where the waste within your site is from a single large excavation (for example a mine, quarry, road cutting or tunnelling operation) you should be able to demonstrate, from the results of a comprehensive source report, that the waste accepted is inert and thus unlikely to cause pollution.

To benefit from this approach, you must obtain from the producer of the waste the relevant site investigation report(s) that will include a characterisation of the waste. You will need to confirm that the waste is not likely to be contaminated. You must check that any investigation was carried out in accordance with the appropriate British Standards (for example, BS5930:1999 and BS10175:2011).

We will inspect the waste records and carry out audits on your waste acceptance controls and procedures. This will include reviewing any site investigation reports, to ensure that the waste accepted was that identified within the report(s). Where non-inert or contaminated waste is identified, your records must demonstrate how this waste was managed.

4.2. Pre-Landfill Directive inert wastes

This section should be applied to sites that were operational before 16th July 2001 and contain wastes that pose a lower risk to the environment which were historically called “inert wastes”. Definitions of inert have changed across different regulatory regimes (particularly with the introduction of the Landfill Directive) and permits have a varied description of the permitted wastes. The low risk surrender assessment is applicable at sites where it is unlikely that significant quantities of leachate or landfill gas have been or will ever be generated. We use the terms low leaching potential and low gassing potential to describe these wastes.

4.2.1. Assessment of waste deposited

To determine whether you can apply the low risk surrender approach you should consider whether the wastes in your site have a low leaching or low gassing potential. Table 1 below sets out two categories of such wastes - Type A or Type B.

Table 1 - Description of low leaching and low gassing potential waste

Type A	Type B
General description Well characterised waste. Strong evidence that the waste types in the site are inert.	**General description** Waste is poorly characterised as it has come from various sources over a long period of time. Less information from site records of the waste types in the site. No wastes which have a biodegradable or leachable content, have entered the site in significant quantities.
Types of waste which fit into this category are: • inert uncontaminated soils. • clean minerals. • single source waste with known low biodegradable or leachable content.	Types of waste which fit into this category are: • multi-source ‘inert’ waste types (before the Landfill Directive defined what is inert) • construction, demolition and excavation waste
Types of evidence which may be used are: • Details of permitted and excluded waste types. • Waste input records – Records of the source and characteristics of the waste accepted at the site. • Compliance history – Compliance assessment records for the site showing there has been good compliance with waste acceptance conditions. • Waste characterisation records – The result from any site investigation involving the direct examination of the nature of the waste. • Landfill gas records – The results from any ad-hoc or routine landfill gas monitoring to indicate presence of biodegradable waste.	

You should examine the evidence that you have about your site and determine whether it fits within either of the categories. If there are records of non-compliance against your permit conditions (relating to the waste types accepted) that were not resolved at the time, we will

not normally accept that the waste falls into either Type A or Type B. However we may accept that the waste falls into Type B based on the findings of a site investigation.

If you consider your landfill to contain Type A waste, you must have a high level of confidence that the waste has low leaching and gassing potential. If monitoring suggests methane concentrations above 1.5% and carbon dioxide above 5%, you should class the waste as Type B, or undertake a further assessment to justify why the site should be Type A.

You can identify waste types, for example, by examining waste acceptance records or examining the results of the analysis of waste samples. Where you have kept good quality records that give an accurate description of the wastes you accepted, we will accept these provided that you also have a good compliance history.

Developing good records of waste received is best achieved during the operational phase of the site. We will check the accuracy of the records through auditing your procedures for waste acceptance and testing of the deposited waste. You must include evidence that you rejected or removed waste that was not permitted.

4.2.2. Pre-Landfill Directive inert wastes - sensitivity of the site

When considering the sensitivity of the site and its surroundings, you must consider how isolated the waste is from a receptor. The nature of the risk posed to a receptor is different when considering the leaching and gassing potential of the waste. Isolated sites are those where it is unlikely that any of the emissions from the site will ever reach a receptor in sufficient quantity to cause pollution.

Isolation can be due to the surrounding geology, topography or by distance between the site and a receptor. For example, where the site is situated in or over strata where pollutants from the site could not reach sensitive water courses or other sensitive receptors, we would accept that the site is isolated. You should have established the relevant source – pathway – receptor relationships for your site when you developed the conceptual model, either as part of your permit application or when you reviewed the pollution control measures at the site.

To determine what information you need to provide to us within the surrender application, you must consider the sensitivity of the site setting. The matrix in Table 2 below sets out what information should be included in the surrender report, based on the type of waste accepted and the sensitivity of and distance to a receptor. The types of information required for the leaching and gassing potential may be different at the same site. The type of surrender application you need to make will be based on the highest risk identified.

For example, where you have identified the gassing potential can be assessed using the low risk approach (category 1, 2 and 3 of Table 2) but the leaching potential has to be assessed using the standard approach (category 4 of Table 2) your surrender application will be considered to be a standard surrender application.

Small sites with a deposit of less than 25,000 tonnes may have a lower potential to cause pollution. The operators of such sites falling into categories 2a, 2b and 3 on Table 2 (below) should contact us to discuss the monitoring requirements for the site.

In some cases, the information you hold may be insufficient. You will therefore need to improve your aftercare monitoring programme to start to collect information to show the potential impact of your site. Chapter 5 sets out the type of information that you must collect.

Table 2 - Risk matrix for assessing whether a site will meet the criteria for a low risk surrender application

Leaching potential

Leaching potential of waste	Non – Productive	Secondary B	Secondary A	Principal not in Source Protection Zone (SPZ)	Principal in SPZ	Surface water course <100 m
Lower leaching potential Type A	1	1	2a	2a	2b	1
Lower leaching potential Type B	1	2b*	2b	3	3	3
Higher leaching potential	4	4	4	4	4	4
	Aquifer type					

Gassing potential

Gassing potential of waste	>250m	<250m
Lower gassing potential Type A	1	2a
Lower gassing potential Type B	2b	3
Higher gassing potential	4	4
	Proximity of receptor	

Information required for surrender assessment (See chapter 4.2 for more detail)

Low Risk Surrender Application

1 Your application can be based on review of waste acceptance records.

2a Your waste is low risk, so you can base your application on a review of waste acceptance records. However, given the location of your site in relation to a sensitive receptor you must consider the leaching and/ or gassing potential of the waste.

If gas concentrations on site are above 5% for carbon dioxide and/ or above 1.5% for methane, you must either class the waste in your site as Type B or provide a justification as to why it is Type A

2b You must base your application either on a direct assessment of the leaching or gassing potential of the waste, or through a risk assessment that shows that there is a suitable barrier to prevent pollution.

- To assess the risk to water, the results of a site investigation or routine monitoring must demonstrate that groundwater or surface water receptors are not being impacted by the leachate.
- To assess the risk from landfill gas you must either demonstrate that the concentration of gas within the waste is:
  - similar to background soil gas concentrations (either natural sources or as a result of non-landfill activities); or
  - below 5% for carbon dioxide and below 1.5% for methane; or
  - between 5% and 10% carbon dioxide and between 1.5 % and 5% methane, where the maximum hazardous gas flow rates (Qhgs as defined by BS 8485:2007) is 0.7 litres/hour. The maximum gas flow rate in any borehole must be less than 70 litres/hour.
  - Above 10% carbon dioxide and/or above 5% methane, you should monitor in accordance with Chapter 5 and submit a standard surrender application.

* A desk study may be sufficient at sites in Secondary B locations. This should be clarified in pre-application discussions.

3 You must base your application on an assessment of monitoring data to confirm that the site is having no impact on the surrounding environment:

- To assess the risk to water you must monitor the groundwater and any surface waters near the site both up gradient and down gradient of the site.
- To assess the risk from landfill gas, you must undertake monitoring for landfill gas within the waste as for 2b above and where gas is present above 5% carbon dioxide and/ or 1.5% methane, you should consider monitoring for landfill gas outside the site between the site and the closest receptor.

4 Not a low risk site, you must make a standard surrender application in all cases – See Chapter 5

4.2.3. Pre-Landfill Directive inert wastes - monitoring

If your site has accepted waste with a low leaching and gassing potential, but based on your assessment you decide that you need more monitoring data to determine whether the waste has achieved the completion criteria, you must monitor for a reasonable minimum period:

- For sites in Table 2 categories 2a and 2b, we recommend that you carry out monitoring to assess the impact from leachate quarterly, for a minimum of two consecutive years. To assess the impact from landfill gas the monitoring should be a minimum of monthly for 6 months.
- For sites falling in category 3, you should monitor landfill gas for a minimum of two consecutive years with at least two occasions when the atmospheric pressure is below 1000mb and falling.
- For sites falling into category 4, you will need to make a 'standard surrender' see chapter 5.

We will consider shorter monitoring periods where you can satisfy us that the monitoring is representative. For the requirements for continuous monitoring, see 5.22.

If your site falls within categories 2a, 2b or 3 of Table 2, you will have to undertake some monitoring for landfill gas to confirm that little or no biodegradable waste was accepted at the site when it was operational. Gas monitoring must represent the full depth of the waste that has a potential to produce gas. Landfill gas monitoring should be undertaken from permanent monitoring points installed within the waste at a frequency of no less than two boreholes per hectare, with a minimum of four boreholes per site.

Where a significant proportion of the waste mass is saturated, for example at high water table sites, you will need to design a site specific monitoring strategy to gather the necessary evidence. This monitoring strategy may include monitoring of water receptors, analysis of wastes and shallow gas monitoring.

For the majority of sites, we do not consider that spike (or searcher bar) monitoring is adequate to confirm whether biodegradable waste has been deposited, or to provide the evidence to demonstrate low gassing potential in support of a permit surrender application.

We expect the use of spike testing to be rare.

Where a site has taken entirely inert waste as defined by the Landfill Directive or 'Type A' waste as defined in Table 1, you may use data from spike monitoring where the waste is less than four metres deep. For example, where a site falls within category 2a of Table 2 and where the waste has a maximum thickness of less than four metres, you can consider the use of spike testing to gather data in support of a surrender application.

However, you must recognise the limitations of spike testing. Should concentrations greater than 1.5% methane be detected, you will need to gather further evidence to support the surrender application. This will most likely include permanent gas monitoring points within the waste, though other site investigation techniques such as soil sampling and trial pitting may also provide relevant information. You will also have to consider the thickness of any capping or restoration layer placed above the waste, as a thickness significantly greater than one metre is likely to prevent a spike test bar from penetrating the waste mass.

As a guide, where spike testing is used, sampling should be undertaken using 25m grid spacing.

If you are able to demonstrate that your site has accepted a single waste type with a known negligible gassing potential such as Pulverised Fuel Ash (PFA) waste, you should be able to rely on analysis of the waste to demonstrate that there is no significant organic content. In these cases you should not need to undertake landfill gas monitoring of the waste mass.

Where the site sensitivity requires that groundwater is monitored you should typically do this using a minimum of one up gradient and two down gradient monitoring points.

4.2.4. Sampling of the deposited waste mass

If following a review of the existing waste records, you are not satisfied that the waste has a low leaching or gassing potential, you can take samples of the waste from the site for analysis to demonstrate that it has a low leaching or low gassing potential. You must take a representative number of samples of the waste from different parts of the site.

Your sampling must extend throughout the site, both across its full area and through the entire depth of the waste. The number and the extent of samples must be collected, according to a programme designed to ensure that the samples are representative of the contents of the site. Guidance on designing a sampling programme is available in British Standards BS5930:1999 and BS10175:2011. Where you are sampling waste within a landfill with a lining system, you should ensure that the risk to that lining system is minimised.

Where we have informed you during the operational phase of the site that your waste acceptance controls have not been effective, you must increase the frequency of sampling in the area that we had concerns about. For closed sites where the waste was accepted under a previous regime, (e.g. waste management licensing) and the review of waste records and site inspection reports demonstrate that you had a poor compliance record, we expect a higher frequency of waste samples to be collected.

To characterise the deposited waste you must use a combination of:

- a visual inspection of the waste
- an assessment of the odour of the waste, to check for the presence of organic pollutants
- a chemical analysis for the concentration of the common pollutants within soils including metals, salts, and organic substances

We will accept the components listed in Table 3 below as a basis for the assessment. You should also investigate for the presence of landfill gas. Where you confirm that all of the waste is of low leaching/low gassing potential, you may use the results of the site investigation to show that the landfill meets the requirements for low risk surrender.

Table 3 – List of potential pollutants within soils

Metals [1]	Others[1]	Organic (indicators)[2]
Antimony (Sb) Arsenic (As) Barium (Ba) Cadmium (Cd) Chromium (Cr) Copper (Cu) Lead (Pb) Mercury (Hg) Molybdenum (Mo) Nickel (Ni) Selenium (Se) Zinc (Zn)	Chloride (Cl) Fluoride (F) Sulphate (SO_4) Total dissolved solids (TDS) Dissolved organic carbon (DOC) Phenol index	Total Organic Carbon (TOC) BTEX (Benzene, toluene, Ethylbenzene and Xylenes) Polychlorinated biphenyls (PCB's) Mineral Oil (C10 to C40) Polycyclic aromatic hydrocarbons (PAH's)
From the Council Decision 2002/33/EC, Annex, paragraph 2.1.2 [1] Leaching limit values BS EN 12457:2002 [2] Total concentration		

4.2.5. Restoration and slope stability

You must have restored your site in accordance with your closure plan and or permit requirements before making an application to surrender your permit.

You must review the length and gradient of slopes at the site and determine the likelihood of failure using an appropriate stability assessment for the level of risk posed by the slope. A slope specific analysis is not required for shallow slopes. We will not accept an application to surrender your permit where any waste slope or retaining structure is in an unstable condition.

5. Standard surrender

This chapter provides guidance for sites in the higher risk categories (Table 2, category 4) where the surrender assessment involves some form of intrusive investigation. This can involve:

- the monitoring of the pollutants generated within the waste
- the impact on the surrounding environment

For sites where active pollution control measures were required and for sites that took hazardous or non-hazardous waste, you must monitor for the presence of pollutants before submitting a surrender application.

5.1. Aftercare monitoring

Degradation of the waste within your site will be affected by a number of different factors. The degradation of waste within different parts of the site may occur at different rates. It is essential that you collect data about the generation of pollutants across the whole of the site during its entire life.

You must continue to monitor the generation of pollutants within the site and the condition of the landform during the aftercare phase, until you can show that the waste is unlikely to present a hazard to the environment. You must not consider applying to surrender your permit until the concentration of the pollutants within the site and the condition of the waste meet this requirement (the completion criteria). You must also continue to monitor the surrounding environment (groundwater, surface water and soil gasses) until you can show that there are no unacceptable releases from the site. A number of factors will govern the duration of aftercare monitoring, including:

- The stabilisation of conditions, including gas volume/pressure and leachate strength/level, within the site following the removal of any active control measures.
- The degradation of passive control measures.
- The travel time between the waste mass and the external monitoring infrastructure.

We will not accept an application to surrender an environmental permit while active control measures are required at the site. Once those control measures have stopped, it can take a number of years for the conditions at the site to stabilise. You must set out the methodology, monitoring provisions and contingency measures for removing active controls within the closure and aftercare plan.

You must monitor the conditions at the site to show when the control measures are no longer necessary. The types of monitoring will be different for the various types of control measures employed. Table 4 below gives some examples of measures that can be employed at a site, what steps or monitoring is required to show that the controls are no longer necessary and the timeframe for the conditions to stabilise.

You should consider how the various components of the landfill lining system may deteriorate over time. We will not accept surrender until you can demonstrate that further degradation of the lining system will not result in an unacceptable discharge.

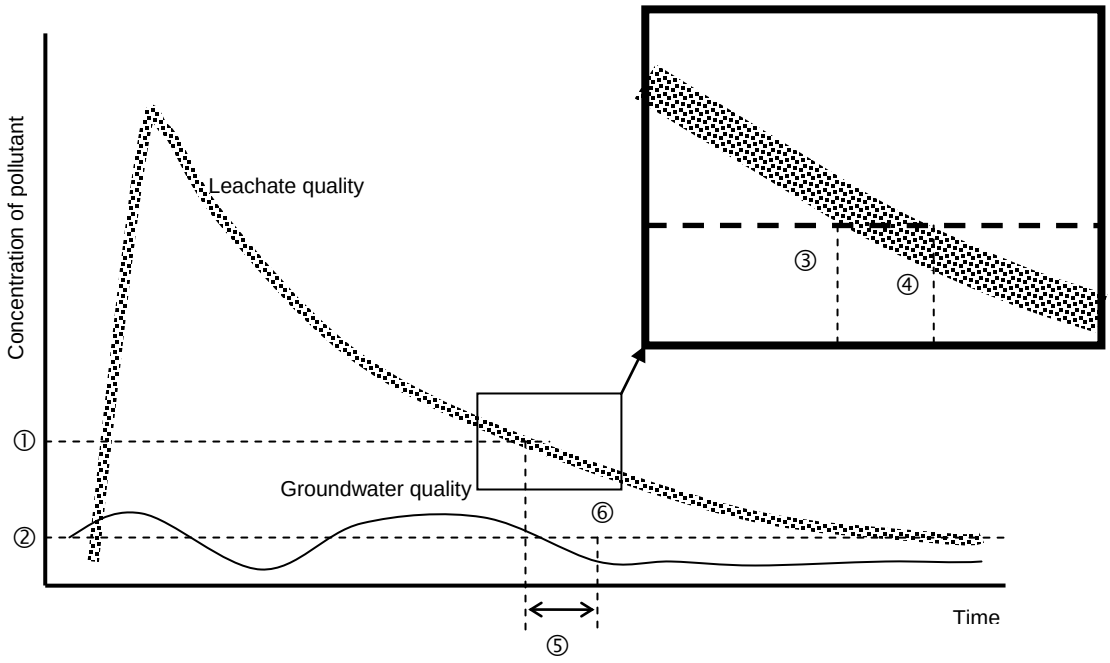
Table 4 – Stabilisation of the site following the removal of pollution control measures

Control measure	Action	Stabilisation monitoring
Control of groundwater levels	Cessation of pumping of groundwater from around the site	Monitoring of the levels until they have returned to a level consistent with the local water table
Control of leachate levels	Cessation of leachate extraction from the waste	Monitoring of the rise of leachate levels until they reach a consistent level
Extraction of landfill gas	Cessation of gas extraction from the waste mass	Monitoring of landfill gas concentration, extent and pressure until the generation rate of gas remain constant
Control of infiltration of water into landfill	Installation and maintenance of a low permeability cap	Monitoring of the settlement of the cap including; visual assessment for cracks or depressions, gas emissions rates through the cap to identify failures and monitoring of changes in leachate level through a water balance assessment
Collection and discharge of surface water	Removal of the discharge	None, once the discharge has been removed there is no impact to monitor

5.2. Leachate completion criteria

Where a contaminated leachate is generated within your site and you have used some form of active control measure to protect groundwater and surface waters, you must develop site specific completion criteria for your leachate. You will need to develop completion criteria for each priority pollutant identified within the leachate. You should set these leachate completion criteria at the concentrations for each substance that has been shown within the validated hydrogeological risk assessment, will not result in an unacceptable impact on groundwater or surface water.

Figure 2: Review of leachate quality data to determine when a permit can be surrendered



1. Leachate completion criteria as determined through hydrogeological risk assessment.
2. Environmental quality standard or site specific concentration for groundwater.
3. Leachate concentration at points in the site meeting the completion criteria.
4. Leachate concentration consistently meeting the completion criteria.
5. Travel time from the waste to the monitoring point.
6. Point at which the permit can be surrendered on the basis of the leachate criteria.

In setting the individual completion criteria you should take into account the permeability, retardation and attenuation characteristic of the lining system for the appropriate period and the likely leakage rate through that liner. You should set the criteria at a level that demonstrates that the requirements of the Groundwater Daughter Directive are complied with and no Environmental Quality Standards in any sensitive water courses are breached. General guidance on the assessment of risk to groundwater and surface waters is provided within our guidance H1 – Environmental Risk Assessment. Specific advice on the risk assessment of impacts to the groundwater environment from landfills is provided within Annex J3 to H1, Hydrogeological risk assessments for landfills and the derivation of groundwater control levels and compliance limits.

5.2.1. Leachate monitoring

During the development of the site and early in its operational phase, you will only be able to develop indicative completion criteria. These will be in the form of wide concentration ranges for the priority pollutants you expect the waste to generate. You should use these ranges within the site risk assessment to ensure that you provide appropriate pollution control measures at the site. As the site develops and you get a better understanding of leachate quality through monitoring, you will be able to refine your model to reduce the size of the uncertainty in these concentration ranges.

Where there is the potential for leachate breakout to occur, by the overtopping of leachate containment systems, you should consider the impact from direct contact with people, water, flora and fauna. The leachate at its completion criteria must not contain any substances at a concentration that could cause harm to human health or the environment through direct toxicity.

Some older landfills (or parts of landfills) were designed without a low permeability lining system and may not have the infrastructure to collect samples of leachate. Without this ability, it will be difficult for you to assess the leachate completion criteria directly. You must therefore adopt an alternative scheme to assess leachate completion. For example it may be possible to obtain samples of leachate from perched levels within the site or by extracting pore water from solid samples by centrifugation. However these samples are likely to be limited in providing an indication of the characterisation of the whole site. In such circumstances you may use a combination of:

- monitoring of the impact on groundwater from the landfill
- monitoring of the landfill gas generation rate

5.2.2. Groundwater monitoring

Once you have reached the completion criteria for a particular substance in the leachate, you must continue to monitor the surrounding environment for a suitable period of time to demonstrate that no unacceptable discharge or impact on the environment has occurred. You should base the length of this monitoring period on the travel time from the waste to the monitoring point

You should monitor groundwater using a minimum of one up hydraulic gradient and two down hydraulic gradient boreholes per groundwater system with the down gradient boreholes to be spaced a maximum of 100m apart.

For sites where the leachate completion criteria are being assessed based on groundwater quality, we will consider the site to have met them where you can show that the emissions from the site are not causing a breach of a compliance limit set within the permit. Where a priority pollutant has been identified within the leachate and there is no compliance limit within the permit, you must demonstrate that there is no significant increase over background quality for that substance.

In using such a strategy, there is a risk of assessing the results of such a monitoring exercise too soon in the aftercare phase of the site. For this reason, the approach suggested in above should only be adopted once you are satisfied that sufficient data has been collected to show that a reasonable time has elapsed and suitable conditions have been reached to allow for the substantial degradation of the wastes. You may be able to use gas generation records from the site to support this.

5.3. Landfill gas completion criteria

Where your site contains biodegradable waste, landfill gas will be generated. Where you identify gas generation, you must not consider making a surrender application until you can demonstrate through monitoring that the gas is no longer being generated at a significant rate (see below). You will have to consider this rate on a site specific basis and consider the likelihood of the gas escaping from the site, causing an unacceptable impact at a receptor. This can include human receptors, sensitive flora and fauna and emissions to the atmosphere.

We will not accept a surrender application where gas concentrations measured in boreholes outside the waste show gas migration and a breach of compliance limits.

We will not accept a surrender application where gas is causing harm to flora on or around the site. Where there is visual evidence of impact from gas on the surrounding environment, and this is a result of a previous escape of gas you must provide evidence to demonstrate that that pollution is no longer occurring. For example, you could provide monitoring data of the concentration of the gas within the ground between the waste and the affected plant life.

5.3.1. Landfill gas monitoring requirements

You must monitor and record the following determinants in each monitoring round:

- methane (%v/v)
- carbon dioxide (%v/v)
- oxygen (%v/v)
- atmospheric pressure (mbar)
- differential pressure (mbar)
- flow (l/hr)

You must carry out landfill gas monitoring over a minimum period of two years with a minimum of 12 readings being taken during that period, including:

- when the site surface may be sealed, for example following periods of heavy rain when the ground is saturated or when the ground is frozen
- when atmospheric pressure is less than 1000mbar and falling
- during or immediately following a rapid fall in atmospheric pressure (as a guide this would be a drop of at least 6mbar within a three hour period)

Landfill gas monitoring must represent the full depth of the waste that has a potential to produce gas. Monitoring must be undertaken from permanent monitoring points installed within the waste at a frequency of no less than two boreholes per hectare, with a minimum of four boreholes per site.

5.3.2. Continuous monitoring

We may accept a shorter period of more intensive monitoring to demonstrate that stable conditions exist. This intensive monitoring must take the form of continuous monitoring of concentrations of gases, differential and atmospheric pressure and should include the meteorological events outlined above. You must also undertake periodic flow measurements.

Where continuous monitoring shows variation in differential pressure under different climatic conditions or gas concentrations such that scenario 2 or 3 below would apply, you must undertake additional flow monitoring.

You must place the continuous monitoring instruments in representative monitoring boreholes within the waste. You will need to justify the location of these boreholes based on initial monitoring results. You must consider short term or seasonal variations in the water table where these might affect the results of monitoring. We advise that you discuss your proposed continuous monitoring plan with us as part of your pre-application discussions.

5.3.3. Scenario 1 completion criteria

We will accept that the completion criteria to have been met when you can show that the site has achieved the conditions set out in scenario 1 below.

Scenario 1 Completion criteria

Gas concentration

Maximum methane concentration is less than 1.5%v/v

Maximum carbon dioxide concentration is less than 5%v/v

Standard of evidence

A minimum of 12 datasets over two consecutive years.

Note: You must ensure that these limits have been met throughout the entire waste body and that the gas concentrations have not been exceeded at any time during the two year period. Alternatively, if you can show that the concentration of methane and carbon dioxide within the waste is similar to background concentrations (either natural sources or because of non-landfill activities) in the surrounding environment we will accept that the gas completion criteria have been met.

5.3.4. Site characteristic hazardous gas flow

We accept that relying on a simple concentration of gas within the site means that it may be several decades before you can apply to surrender your permit and that the concentration of gas alone does not reflect the true risk associated with the gas. We also recognise that there may be high concentrations of gas within the site that are essentially static.

Where the concentrations of gas within the waste are greater than the criteria limits in Scenario 1, you can still demonstrate that the site meets the completion criteria. You can determine the gas generation rate by considering the concentration and flow rate of the gases in the monitoring boreholes. We will accept that the site meets its completion criteria when the following conditions apply:

- Concentration of gas and the site characteristic hazardous gas flow rates (Qhgs as defined by BS 8485:2007) measured in on-site monitoring boreholes is less than 0.7l/h.
- The maximum flow rate recorded in any individual borehole is less than 70l/h[1].

This Qhgs is for the whole site so you will need to assess individual borehole readings (s6.2 BS 8485:2007).

The site characteristic hazardous gas flow rate defined in BS 8485:2007 is a method used to assess the risk associated with developing buildings on contaminated land. We will accept this method to assess whether your site is in an acceptable state for you to apply to surrender your permit. The gas completion criteria reflect the characteristic gas situation 2 in BS 8485:2007, Table 1. This does not guarantee that the site is suitable for development without further site investigation or assessment.

[1] The maximum concentrations and flow rates may have been measured in different boreholes.

5.3.5. Scenario 2 and 3 completion criteria

Where concentrations of gas in the site are greater than the criteria limits in Scenario 1 above, you must demonstrate that you have based the derived Qhgs on sufficient monitoring.

We will accept either of the following two scenarios:

- Scenario 2 is where the observed methane concentration is less than 5%v/v (the lower explosive limit) and there is therefore little risk that gas migration off site could present an explosion hazard.
- Scenario 3 covers situations where the methane concentration is greater than the lower explosive limit. We will require a higher standard of evidence to allow us to accept surrender of permits for sites that fall into Scenario 3 and you will need to demonstrate, by extended monitoring, that the derived Qhgs includes the worst case scenarios for landfill gas migration.

Scenario 2 Completion criteria

Gas concentration

Maximum methane concentration is less than 5%v/v and

Maximum carbon dioxide concentration is less than 10%v/v

Flow rate

Qhgs is less than 0.7l/h

Maximum flow in any borehole is less than 70l/hr

Standard of evidence

A minimum of 12 datasets over two consecutive years.

This must include gas concentrations in external boreholes between the site and nearby receptors if this is not already required by your permit.

Where continuous monitoring is used this must be for a minimum of 2 months.

Scenario 3 Completion criteria

Measured gas concentration

Maximum methane concentration is greater than 5%v/v or

Maximum carbon dioxide concentration is greater than 10%v/v

Flow rate

Qhgs is less than 0.7l/h

Maximum flow in any borehole is less than 70l/hr

Standard of evidence

A minimum of 24 datasets over two consecutive years.

This must include gas concentrations in external boreholes around the site perimeter if this is not already required by your permit.

Where continuous monitoring is used this must be for a minimum period of six months

5.3.6. Other gases

If your site has accepted waste types that have the potential to produce significant quantities of gases other than methane and carbon dioxide, for example hydrogen sulphide or hydrogen, you will need to demonstrate that production of these gases is no longer significant and that there are no unacceptable risks associated with any residual gases within the waste mass.

5.4. Hazardous wastes

Where you have accepted hazardous or special wastes within your site, you must ensure that the technical measures that you have employed to isolate that waste from the surrounding environment will remain in place if the site is left undisturbed. You must include within your surrender assessment a description of the wastes that you have accepted and a review of those technical measures. The presence of hazardous waste should not prevent us accepting a surrender application.

For landfills that closed under the Landfill Directive and mining waste facilities for hazardous wastes you would have completed this assessment prior to the closure of the site, cell or phase, and documented it within your closure report. For all other sites you must include the results of your assessment within the next review of your closure and aftercare plan or when you are assessing the site's completion criteria.

You must base the description of the wastes on waste acceptance and deposit records collected during the operational phase of the site. Where these records are not available (e.g. because the hazardous waste was deposited before 1996) or where we have questioned the reliability of these records, you must consider whether to treat the whole phase or site as if it contains the hazardous waste permitted or to undertake a suitable site investigation:

- For landfills classified as hazardous under the Landfill Directive you must provide a summary of the different waste types and their hazards within each phase or cell.
- For landfills classified as non-hazardous under the Landfill Directive you must provide details of the location of any cell used for the deposit of asbestos or stable non-reactive hazardous waste, and a summary of the wastes accepted and their associated hazards.
- For landfills that closed before the Landfill Directive, you must provide details of the phases and cells that contain co-disposed hazardous and non-hazardous waste, their location within the site and their associated hazards.
- For mining waste facilities with deposits of hazardous wastes, you must provide a summary of the waste management plan, characteristics of the waste and their associated hazards.

You must make sure that any hazardous waste is isolated from direct contact by a suitable thickness of soil or robust capping layer. As the hazard from some hazardous wastes will not diminish over time, the degree of robustness of the separation layer or cap should be designed based on the potential harm that the waste can cause. In order to accept the surrender of your permit, we will need to be confident that your technical measures will not be compromised and that the wastes will not be disturbed. Potential issues that we might need to take into consideration include:

- potential damage to technical measures caused by animal burrowing
- a change in the course of a stream or river causing erosion of these measures
- damage due to coastal erosion

5.5. Settlement completion criteria and slope stability

We will not accept an application to surrender your permit where:

- there is evidence that waste settlement is still taking place
- any waste slope or retaining structure is in an unstable condition, for example where there is a risk in the short medium or long term that a slope failure is likely

We may not accept an application to surrender your permit where:

- there is a potential for slope instability following active erosion, for example coastal erosion or erosion due to changes in the course of streams and rivers

For sites that closed under the Landfill Directive, you must carry out an annual topographical survey of your entire site during the aftercare phase. This is also best practice at sites that closed before July 2001. You should determine the rate of settlement of the waste by comparing the levels with the levels found during the previous survey. We will accept that settlement is complete when there is no significant difference between two successive annual topographical level surveys. If you have only accepted a granular mineral waste, we will accept a review of the compaction characteristics of the waste.

Where you have provided a cap or separation to protect the environment, either through isolating the waste or controlling the rate of emissions, you must ensure that it remains effective for that purpose. Following the completion of settlement you must review the integrity of that cap or separation layer. We will not accept an application to surrender the permit where settlement has rendered the integrity of the barrier ineffective. You should use a combination of visual inspection of the barrier, with monitoring emissions from the site (e.g. landfill gas) and monitoring of conditions within the site (e.g. leachate level).

Where you have provided a stability risk assessment within your permit application or closure report, you must demonstrate that the final landform (through the provision of a topographical survey) is consistent with a ‘stable profile’ in the assessment. You must also provide evidence in the surrender application that there is no movement of the waste slopes, for example from a site walkover. Where such movement has been identified you must tell us how you have stabilised that slope.

Where you have not provided a stability risk assessment either with the permit application or the closure report, you must review the stability of the final landform. You must review the length and gradient of slopes at the site and determine the likelihood of failure using an appropriate stability assessment for the level of risk posed by the slope. A slope specific analysis is not required for shallow slopes.

6. Surrender report

You must base your surrender assessment for any permanent waste deposit site on information collected and assessed during the entire life of the site. You must ensure that at each critical stage of the life of the site, such as closure or switching off active control measures, the progress of the site towards the final completion criteria is reviewed. In addition we expect you to include an assessment of the progress against the completion criteria in the reviews of your risk assessments and permit conditions. As a result you should be confident that your site will meet the completion criteria before you apply to surrender your permit.

You must provide us with a surrender report to support your surrender application, except where you are using the basic approach. We will not duly make an application for surrender where you do not include a surrender report. Your report must bring together all the relevant information and decisions made during the life of the site so that we can determine whether to grant the application. You will not need to re-submit monitoring data and reports that you have previously supplied under the permit. However, you must summarise the findings of any relevant reports and trends in the monitoring data within the surrender report. You must clearly reference all supporting evidence including title, date and author as a minimum within the surrender report.

The amount of information that you will need to provide within the surrender report will depend on the type of surrender application you are making. Table 5 below sets out the type of information that we would expect to be included in your application.

Table 5 – Information to be provided within the surrender report

Key: ✓ Required
~ May be required
× Not Required

Information within the surrender report	Landfill Directive inert or Low Risk 1	Low Risk 2a/2b & 3	Standard
A review of the history of the permit including: • a summary of the conceptual model for the facility • key dates in the development of the permit (changes between different regimes, key variations, transfers, partial surrenders) • location and sensitivity of environmental receptors • aquifer status • proximity and sensitivity of surface water courses • proximity of housing and human receptors • Natura 2000 sites and SSSI's • pollution control measures installed at the site	✓	✓	✓

Surrender report

Information within the surrender report	Landfill Directive inert or Low Risk 1	Low Risk 2a/2b & 3	Standard
Confirmation of completion in accordance with permit conditions.	✓	✓	✓
Characterisation of waste deposited at the site, including details of: • the description of the waste • the quantities of each waste type • the waste acceptance procedures employed • the audits/inspections of waste acceptance procedures (including frequency and outcomes) • any site investigations of deposited waste (including extent of the investigation, date of the investigation and findings)	✓	✓	✓
Details of any acceptance of non-compliant waste, including • characterisation of the waste accepted • location and extent of the non-compliant waste • methodology for removal of waste (including on-site checks and disposal route) • evidence confirming removal of waste from site	✓	✓	✓
The completion criteria for each pollutant generated within the site, together with a description of how they were established, including reference to any detailed risk assessment used to derive the criteria.	×	×	✓
Details of the construction of any pollution control measure employed at the site, including details of geological barrier beneath the site, including: • the design of the measure • the construction quality assurance of the measure • the effective lifespan of the measure; including dates they were turned off or no longer required • any accident/incident that has affected the effectiveness /integrity of the measure	×	~	✓
A review of any changes to the performance of the pollution control measures during the life of the site.	×	~	✓
Details of the make up and generation rate of any leachate and how it has changed over the life of the site.	×	~	✓
Details of the make up and generation rate of the landfill gas and how it has changed over the life of the site.	×	✓	✓
Topographical surveys of the final landform. Stability and settlement assessment of the waste (required at low risk sites with significant slopes).	~	~	✓

Surrender report

Information within the surrender report	Landfill Directive inert or Low Risk 1	Low Risk 2a/2b & 3	Standard
Details of monitoring infrastructure: • Borehole Logs, response zones and construction details of monitoring points • Record of regular inspection of the condition of monitoring points and remediation carried out	✗	✓	✓
A review of the monitoring results demonstrating no impact at any sensitive receptor including: • leachate quality • groundwater • surface water • landfill gas (within the waste and surrounding the site)	✗	~	✓

7. Glossary of terms

Aftercare	The period after [definite] closure of the site but prior to surrender during which maintenance and monitoring work is needed to ensure the restored landfill does not cause pollution of the environment.
Closure	A distinct stage within the regulatory 'life-cycle' of a landfill or mining waste facility which occurs after the site has ceased accepting waste, but before it is definitely closed and can enter the aftercare phase. During this stage we ensure that the operator puts in place all the required infrastructure and procedures to manage the site in the aftercare phase. Mining Waste Facilities are required to close under Article 12 of the Mining Waste Directive. Guidance on these procedures can be found in government guidance. Landfills are required to close under Article 13 of the Landfill Directive (this did not apply to landfills that ceased accepting waste prior to 16th July 2001). Recovery deposits are not subject to any statutory closure procedures set out in legislation. Site specific closure requirements may be identified within the environmental permit (e.g. provision of a capping layer).
Closure and aftercare plan	A document that sets out how you will close your site and manage it in the aftercare phase. It will include: • how you will close the landfill following the cessation of waste acceptance • under what conditions you will cease the active management of the landfill • under what conditions you will consider the landfill to be in a condition to surrender the permit
Completion criteria	The concentration of pollutants within the waste and the condition of the site under which the waste is unlikely to present a hazard to the environment.
Conceptual model	A simplified representation or working description of how the real system is believed to behave based on analysis of field data.
Surrender report	A report produced by the operator to be submitted with an application to surrender an environmental permit that sets out how the site meets the relevant completion criteria.

8. References

Environment Agency guidance

- Regulatory Guidance Note 9 'Showing that land and groundwater are protected at:
  - Installations;
  - Waste facilities;
  - Mining waste operations;
  - Non-nuclear radioactive substances facilities and mobile apparatus.
- How to comply with your environmental permit Additional guidance for: Landfill (EPR 5.02).
- • Environmental Permitting Regulations: Inert Waste Guidance Standards and Measures for the Deposit of Inert Waste on Land'.
- How to comply with your environmental permit. Additional guidance for mining waste operations
- H1 Environmental risk assessment for permits, annex J. Hydrogeological risk assessments for landfills and the derivation of groundwater control and trigger levels.

Defra and Welsh Assembly Government guidance

- Environmental Permitting Guidance: The Mining Waste Directive

Other references

- British Standard BS 5930:1999 Code of practice for site investigations.
- British Standard BS 10175:2001 Investigation of potentially contaminated sites – Code of practice.
- British Standard BS 8485:2007 Code of practice for the characterization and remediation from ground gas in affected developments.
- British Standard BS EN 12457:2002 Characterisation of waste. Leaching. Compliance test for leaching of granular waste materials and sludges.

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APPENDIX B

Geotechnical Logs

EXCAL LIMITED
SITE INVESTIGATION
AUGUST 2010

Contract : The Avenue, Llanelli

Client : Excal UK Limited

Borehole No. BH1

Dates : -

Location :

Job Number : X101450

Engineer : Excal UK Limited

Ground Level :

Coordinates:

Run Details					Test Details		Samples		STRATA				Water
Core Run	TCR	SCR	RQD	FI	Depth	Test Results	Depth	Type-No.	Depth (Thick-ness	Description	Legend	Depth (Thick-ness	
1.20	100						1.20 - 2.70	C1	(1.70)	MADE GROUND: Light brown slightly silty gravelly sand (f-c). Gravel is angular to subangular fine to coarse of sandstone and siltstone. Occasional gravel size fragment of brick.		(1.70)	
									1.70	Light brown sand (f-c) with occasional gravel size fragment of shell.		1.70	
									(0.25)			(0.25)	
2.70	33						2.70 - 4.20	C2	1.95	MADE GROUND: Black and dark brown slightly clayey slightly silty sand and gravel. Sand is fine to coarse. Gravel is angular to rounded fine to coarse of coal, clinker, ash, sandstone and siltstone.		1.95	
4.20	87						4.20 - 5.70	C3	(5.85)			(5.85)	
5.70	100						5.70 - 7.20	C4					
7.20	93						7.20 - 8.70	C5					
8.70	100						8.70 - 10.20	C6	7.80	MADE GROUND: Black slightly clayey slightly silty sandy angular fine to coarse gravel of clinker, brick and ash.		7.80	
									(0.70)			(0.70)	
									8.50	NO RECOVERY.		8.50	
									(0.40)			(0.40)	
									8.90	Soft black slightly sandy clayey SILT. ...Becoming firm from 9.20m.		8.90	
									(1.40)			(1.40)	

Drilling Progress and Water Observations					Groundwater			Flush		
Date / Time	Depth	Casing	Case Dia.	Water	Struck	Sealed	Flow Rate Remarks	Depth	Type	Returns

Remarks: Comacchio 305 Drill Rig. Hand dug inspection pit from GL to 1.20m. Dynamic sampling with in-situ testing from 1.20m to 15.00m

QUANTUM
Ty Berwig, Bynea
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email: enquiries@quantum-gb.co.uk

Operator:	Logged By.	Sheet No.	Scale:	
P.Kenny	DM	1 Of 2	1:60.83	All measurements in metres unless otherwise stated

AGS

Contract : The Avenue, Llanelli

Client : Excal UK Limited

Borehole No. BH1

Dates : -

Location :

Job Number : X101450

Engineer : Excal UK Limited

Ground Level :

Coordinates:

Run Details					Test Details		Samples		STRATA				
Core Run	TCR	SCR	RQD	FI	Depth	Test Results	Depth	Type-No.	Depth (Thick-ness	Description	Legend	Depth (Thick-ness	Water
10.20	100						10.20 - 11.70	C7		Soft black slightly sandy clayey SILT.			
									10.30 (0.40)	Grey brown clayey sandy subangular fine to coarse GRAVEL of sandstone.		10.30 (0.40)	
11	100								10.70 (0.60)	Firm to stiff grey mottled brown slightly sandy slightly gravelly CLAY. Gravel is subangular fine to medium of sandstone, siltstone and mudstone.		10.70 (0.60)	
									11.30 (0.10)	Very soft black and brown sandy SILT.		11.30 (0.10)	
11.70							11.70 - 12.70	C8	11.40 (0.60)	Brown very clayey gravelly SAND (f-c). Gravel is subrounded to rounded fine to coarse of sandstone.		11.40 (0.60)	
12	100								12.00 (0.70)	Stiff grey and brown slightly sandy gravelly CLAY. Gravel is subrounded to rounded fine to coarse of sandstone.		12.00 (0.70)	
12.70							12.70 - 13.20	N/R9	12.70 (0.50)	...Wet from 12.20m to 12.30m. ...Refusal at 12.70m.		12.70 (0.50)	
13	0												
13.20							13.20 - 14.70	C10	13.20	NO RECOVERY.		13.20	
14	100								(1.80)	Grey brown very clayey sandy subrounded to rounded fine to coarse GRAVEL of sandstone and siltstone. ...Slightly clayey from 14.35m.		(1.80)	
14.7													
15									15.00	End of borehole at 15.00m. Terminated on Engineers instruction.		15.00	

Drilling Progress and Water Observations					Groundwater			Flush		
Date / Time	Depth	Casing	Case Dia.	Water	Struck	Sealed	Flow Rate Remarks	Depth	Type	Returns
					12.20		Groundwater encountered from 12.20m to 12.30m.			

Remarks: Comacchio 305 Drill Rig. Hand dug inspection pit from GL to 1.20m. Dynamic sampling with in-situ testing from 1.20m to 15.00m

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Operator:	Logged By.	Sheet No.	Scale:	
P.Kenny	DM	2 Of 2	1:60.83	All measurements in metres unless otherwise stated

AGS

Contract: Trostre Landfill

Client: Carmarthenshire County Council

Trial Pit No. **TP1**

Dates: 11/8/2010

Location: Car Park B Trostre

Job Number: 45-05-01

Engineer: R Holmes

Ground Level:

Coordinates:

STRATA

Depth (Thick-ness)	Description	Legend	Depth (Thick-ness)	Water
0.00 (0.30)	MADE GROUND: Loose light grey gravel to cobble of limstone agregate surface cover over grey slightly silty very gravelly sand with angular to subangular pebbles and cobbles of limestone		0.00 (0.30)	
0.30 (1.70)	MADE GROUND: Black silty very sandy gravelly clay with cobbles, made ground and cobbles are of brick, concrete, siltstone and mudstone.		0.30 (1.70)	
2.00 (0.50)	Firm brown silty CLAY		2.00 (0.50)	
2.50 (1.00)	Brown silty CLAY with cobbles of siltstone and mudstone		2.50 (1.00)	
3.50	Excavation ended at 3.5 Meters		3.50	

PHOTOGRAPHS

Excavation Progress and Water Observations

Date/Time	Depth	Water

Groundwater

Struck	Sealed	Flow Rate Remarks
		No groundwater encountered.

General Remarks

Slight smell at 2m

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Operator:	Logged By:	Sheet No.	Scale:	
R Holmes	RH	1 of 6	1:58.64	All measurements in metres unless otherwise stated

Contract: Trostre Landfill

Client: Carmarthenshire County Council

Trial Pit No. **TP2**

Dates: 11/8/2010

Location: Car Park B Trostre

Job Number: 45-05-01

Engineer: R Holmes

Ground Level:

Coordinates:

STRATA

Depth (Thick-ness)	Description	Legend	Depth (Thick-ness)	Water
0.00 (0.50)	MADE GROUND: Loose light grey gravel to cobble of limstone agregate surface cover over grey slightly silty very gravelly sand with angular to subangular pebbles and cobbles of limestone		0.00	
0.50 (2.50)	MADE GROUND: Black silty very sandy gravelly clay with cobbles, made ground and cobbles are of brick, concrete, siltstone and mudstone.		0.50 (2.50)	
3.00 (0.50)	Brown silty CLAY with cobbles of siltstone and mudstone		3.00 (0.50)	1
3.50	Excavation ended at 3.5 Meters		3.50	

PHOTOGRAPHS

Excavation Progress and Water Observations

Date/Time	Depth	Water

Groundwater

Struck	Sealed	Flow Rate Remarks
3.50m		

General Remarks

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R Holmes	RH	1 of 6	1:58.64	All measurements In metres unless otherwise stated

Contract: Trostre Landfill

Client: Carmarthenshire County Council

Trial Pit No. **TP3**

Dates: 11/8/2010

Location: Car Park B Trostre

Job Number: 45-05-01

Engineer: R Holmes

Ground Level:

Coordinates:

STRATA

Depth (Thick-ness)	Description	Legend	Depth (Thick-ness)	Water
0.00 (0.30) 0.30	MADE GROUND: Loose light grey gravel to cobble of limstone agregate surface cover over grey slightly silty very gravelly sand with angular to subangular pebbles and cobbles of limestone		0.00 (0.30) 0.30	
(2.70)	MADE GROUND: Black silty very sandy gravelly clay with cobbles, made ground and cobbles are of brick, concrete, siltstone and mudstone.		(2.70)	
3.00 (0.50)	Brown silty CLAY with cobbles of siltstone and mudstone		3.00 (0.50)	
3.50	Excavation ended at 3.5 Meters		3.50	

Excavation Progress and Water Observations			Groundwater			General Remarks
Date/Time	Depth	Water	Struck	Sealed	Flow Rate Remarks	

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Operator:	Logged By:	Sheet No.	Scale:	
R Holmes	RH	1 of 6	1:58.64	All measurements In metres unless otherwise stated

Contract: Trostre Landfill

Client: Carmarthenshire County Council

Trial Pit No. **TP4**

Dates: 11/8/2010

Location: Car Park B Trostre

Job Number: 45-05-01

Engineer: R Holmes

Ground Level:

Coordinates:

STRATA

Depth (Thick-ness)	Description	Legend	Depth (Thick-ness)	Water
0.00 (0.30)	MADE GROUND: Loose light grey gravel to cobble of limstone agregate surface cover over grey slightly silty very gravelly sand with angular to subangular pebbles and cobbles of limestone		0.00 (0.30)	
0.30 (2.70)	MADE GROUND: Black silty very sandy gravelly clay with cobbles, made ground and cobbles are of brick, concrete, siltstone and mudstone.		0.30 (2.70)	
3.00 (0.50)	Brown silty CLAY with cobbles of siltstone and mudstone		3.00 (0.50)	
3.50	Excavation ended at 3.5 Meters		3.50	

PHOTOGRAPHS

Excavation Progress and Water Observations

Date/Time	Depth	Water

Groundwater

Struck	Sealed	Flow Rate Remarks

General Remarks

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Operator:	Logged By:	Sheet No.	Scale:	
R Holmes	RH	1 of 6	1:58.64	All measurements In metres unless otherwise stated

Contract: Trostre Landfill

Client: Carmarthenshire County Council

Trial Pit No. **TP5**

Dates: 11/8/2010

Location: Car Park B Trostre

Job Number: 45-05-01

Engineer: R Holmes

Ground Level:

Coordinates:

STRATA

Depth (Thick-ness)	Description	Legend	Depth (Thick-ness)	Water
0.00 (0.30)	MADE GROUND: Loose light grey gravel to cobble of limstone agregate surface cover over grey slightly silty very gravelly sand with angular to subangular pebbles and cobbles of limestone		0.00 (0.30)	
0.30 (1.70)	MADE GROUND: Black silty very sandy gravelly clay with cobbles, made ground and cobbles are of brick, concrete, slltstone and mudstone.		0.30 (1.70)	
2.00 (0.50)	Firm brown silty CLAY		2.00 (0.50)	
2.50 (1.00)	Brown silty CLAY with cobbles of slltstone and mudstone		2.50 (1.00)	
3.50	Excavation ended at 3.5 Meters		3.50	

PHOTOGRAPHS

Excavation Progress and Water Observations

Date/Time	Depth	Water

Groundwater

Struck	Sealed	Flow Rate Remarks

General Remarks

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Operator:	Logged By:	Sheet No.	Scale:	
R Holmes	RH	1 of 6	1:58.64	All measurements in metres unless otherwise stated

Contract: Trostre Landfill

Client: Carmarthenshire County Council

Trial Pit No. **TP6**

Dates: 11/8/2010

Location: Car Park B Trostre

Job Number: 45-05-01

Engineer: R Holmes

Ground Level:

Coordinates:

STRATA

Depth (Thick-ness)	Description	Legend	Depth (Thick-ness)	Water
0.00			0.00	
(0.50)	MADE GROUND: Loose light grey gravel to cobble of limstone agregate surface cover over grey slightly silty very gravelly sand with angular to subangular pebbles and cobbles of limestone		(0.50)	
0.50			0.50	
(2.50)	MADE GROUND: Black silty very sandy gravelly clay with cobbles, made ground and cobbles are of brick, concrete, siltstone and mudstone.		(2.50)	
3.00	Brown silty CLAY with cobbles of siltstone and mudstone		3.00	
(0.50)			(0.50)	
3.50	Excavation ended at 3.5 Meters		3.50	

PHOTOGRAPHS

Excavation Progress and Water Observations			Groundwater			General Remarks
Date/Time	Depth	Water	Struck	Sealed	Flow Rate Remarks	

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Operator:	Logged By:	Sheet No.	Scale:	
R Holmes	RH	6 of 6	1:58.64	All measurements In metres unless otherwise stated

Contract : Llanelli Landfill Site, Trostre

Client : Excal UK Limited

Borehole No. BH1

Dates : 25/08/10 - 25/08/10

Location :

Job Number : X101448

Engineer : Excal UK Limited

Ground Level :

Coordinates:

m B.G.L.	Samples Depth	Samples Type No. - UBlows	NO TESTS PERFORMED	STRATA Depth (Thickness)	DESCRIPTION	Legend	Depth (Thickness)	Water	Install/ Backfill
0					MADE GROUND: Dark brown and black slightly silty sandy angular fine to coarse gravel size fragments of brick, ash, siltstone and clinker. Occasional fragment of leather.				
	0.50 - 0.60 -	B1 D2							
1									
	1.50 - 1.60 -	B3 D4		(2.90)			(2.90)		
2					...From 2.50m. Becoming silty/clayey.				
	2.50 - 2.60 -	B5 D6							
3				2.90	Soft brown sandy slightly gravelly silty CLAY. Gravel is subangular fine to coarse of siltstone and sandstone.		2.90		
	3.50 - 3.60 -	B7 D8		(1.10)			(1.10)		
4				4.00	End of borehole at 4.00m. Terminated on Engineers instruction.		4.00		

Water Observations			Casing		Groundwater			Chiselling		
Date / Time	Depth	Water	Depth	Cas. Dia.	Struck	Behaviour	Sealed	From	To	Hours
			3.00	200mm		No groundwater encountered.				

Remarks: Dando 150. Hand dug inspection pit from GL to 1.20m. Cable percussive drilling to base of borehole.

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Operator:	Logged By.	Sheet No.	Scale:	
P.O.	DM	1 Of 1	1:60.98	All measurements in metres unless otherwise stated

AGS

Contract : Llanelli Landfill Site, Trostre

Client : Excal UK Limited

Borehole No.
BH2

Dates : 25/08/10 - 25/08/10
Location :

Job Number : X101448
Engineer : Excal UK Limited

Ground Level :
Coordinates:

m B.G.L.	Samples Depth	Samples Type No. - UBlows	NO TESTS PERFORMED	STRATA Depth (Thickness)	STRATA DESCRIPTION	STRATA Legend	STRATA Depth (Thickness)	Water	Install/ Backfill
0					MADE GROUND: Dark brown sandy slightly gravelly clay. Gravel is angular to subrounded fine to coarse of sandstone, siltstone, plastic and ash.				
	0.50 - 0.60 -	B1 D2							
1									
	1.50 - 1.60 -	B3 D4		(3.00)			(3.00)		
2									
	2.50 - 2.60 -	B5 D6							
3				3.00	Soft brown sandy slightly gravelly silty CLAY. Gravel is subangular fine to coarse of sandstone and siltstone.		3.00		
	3.50 - 3.60 -	B7 D8		(1.00)			(1.00)		
4				4.00	End of borehole at 4.00m. Terminated on Engineers instruction.		4.00		

Water Observations			Casing		Groundwater			Chiselling		
Date / Time	Depth	Water	Depth	Cas. Dia.	Struck	Behaviour	Sealed	From	To	Hours
			3.00	200mm		No groundwater encountered.				

Remarks: Dando 150. Hand dug inspection pit from GL to 1.20m. Cable percussive drilling to base of borehole.

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Operator:	Logged By.	Sheet No.	Scale:	
P.O.	DM	1 Of 1	1:60.98	All measurements in metres unless otherwise stated

AGS

Contract : Llanelli Landfill Site, Trostre

Client : Excal UK Limited

Borehole No.
BH3

Dates : 25/08/10 - 25/08/10
Location :

Job Number : X101448
Engineer : Excal UK Limited

Ground Level :
Coordinates:

m B.G.L.	Samples Depth	Samples Type No. - UBlows	NO TESTS PERFORMED	STRATA Depth (Thick-ness)	STRATA DESCRIPTION	STRATA Legend	STRATA Depth (Thick-ness)	Water	Install/ Backfill
0					MADE GROUND: Dark brown and black clayey sandy angular to subangular fine to coarse gravel size fragments of of ash, coal, brick, clinker, sandstone and ceramic.				
	0.50 - 0.60 -	B1 D2							
1									
	1.50 - 1.60 -	B3 D4		(3.00)			(3.00)		
2					...From 2.50m. Becoming slightly clayey.				
	2.50 - 2.60 -	B5 D6							
3				3.00	Brown sandy slightly gravelly CLAY. Gravel is subangular fine to coarse of sandstone and siltstone.		3.00		
	3.50 - 3.60 -	B7 D8		(1.00)			(1.00)		
4				4.00	End of borehole at 4.00m. Terminated on Engineers instruction.		4.00		

Water Observations			Casing		Groundwater			Chiselling		
Date / Time	Depth	Water	Depth	Cas. Dia.	Struck	Behaviour	Sealed	From	To	Hours
			3.00	200mm		No groundwater encountered.				

Remarks: Dando 150. Hand dug inspection pit from GL to 1.20m. Cable percussive drilling to base of borehole.

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Operator:	Logged By.	Sheet No.	Scale:	
P.O.	DM	1 Of 1	1:60.98	All measurements in metres unless otherwise stated

AGS

Contract : Llanelli Landfill Site, Trostre

Client : Excal UK Limited

Borehole No.
BH4

Dates : 26/08/10 - 26/08/10
Location :

Job Number : X101448
Engineer : Excal UK Limited

Ground Level :
Coordinates:

m B.G.L.	Samples Depth	Samples Type No. - UBlows	NO TESTS PERFORMED	STRATA Depth (Thick-ness)	DESCRIPTION	Legend	Depth (Thick-ness)	Water	Install/ Backfill
0									
	0.50 - 0.60 -	B1 D2			MADE GROUND: Black slightly silty sandy angular fine to coarse gravel size fragments of coal, ash, clinker and brick.				
1									
	1.50 - 1.60 -	B3 D4		(3.20)			(3.20)		
2									
	2.50 - 2.60 -	B5 D6							
3									
	3.50 - 3.60 -	B7 D8		3.20	Soft light brown sandy slightly gravelly silty CLAY. Gravel is angular to subangular fine to coarse of sandstone and siltstone.		3.20		
4				(1.30)			(1.30)		
				4.50	End of borehole at 4.50m. Terminated on Engineers instruction.		4.50		

Water Observations

Date / Time	Depth	Water

Casing

Depth	Cas. Dia.
3.00	200mm

Groundwater

Struck	Behaviour	Sealed
	No groundwater encountered.	

Chiselling

From	To	Hours

Remarks: Dando 150. Hand dug inspection pit from GL to 1.20m. Cable percussive drilling to base of borehole.

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P.O.	DM	1 Of 1	1:60.98	All measurements in metres unless otherwise stated

AGS

MOTT MACDONALD
GROUND INVESTIGATION 2005
CLIENT SUPPLIED DATA

Contract : PEMBERTON DEVELOPMENT SECOND GROUND INVESTIGATION

Client : CARMARTHENSHIRE COUNTY COUNCIL

Trial Pit No. TP230A

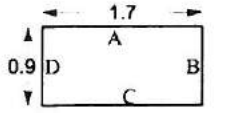
Dates : 15/03/05 - 15/03/05
Location : Llanelli

Job Number : 7932
Engineer : MOTT MACDONALD

Ground Level : 7.46 m A.O.D. *Level to Ordnance Datum*
Coordinates: 252674.08 E 199737.06 N *Co-ordinates to National Grid*

m B.G.L.	Samples Depth	Samples Type No.	Samples U100 Blows	Tests Depth	Tests Test Results	STRATA Depth (Thick-ness)	STRATA DESCRIPTION	Legend	Red. Level . A.O.D.	Water
	0.10 -	D1					MADE GROUND: Firm to dark grey to black sandy gravelly CLAY with strong hydocarbon odour and cobbles of brick, sandstone, timber and some slag. Gravel of angular to subrounded fine to coarse sandstone, brick, timber, ceramic and slag.			
1	1.00 -	D2								
						(3.00)				
2	2.00 -	D3								
3						3.00	Trial Pitt terminated at 3.0m depth - unable to progress.		4.46	

PLAN Bearing 110°



Groundwater : None encountered

Stability : Slight insability throughout

Shoring : None used

Remarks :

Equipment Used: JCB 3CX

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Operator:	Logged By.	Sheet No.	Scale:	
NT	KH	1 Of 2	1:27.64	All measurements in metres unless otherwise stated

AGS

Contract : PEMBERTON DEVELOPMENT SECOND GROUND INVESTIGATION

Client : CARMARTHENSHIRE COUNTY COUNCIL

Trial Pit No. TP230

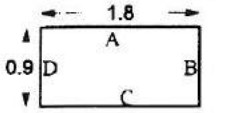
Dates : 15/03/05 - 15/03/05
Location : Llanelli

Job Number : 7932
Engineer : MOTT MACDONALD

Ground Level : 7.17 m A.O.D. *Level to Ordnance Datum*
Coordinates: 252695.47 E 199697.53 N *Co-ordinates to National Grid*

m B.G.L.	Samples Depth	Samples Type No.	Samples U100 Blows	Tests Depth	Tests Test Results	STRATA Depth (Thick-ness)	STRATA DESCRIPTION	Legend	Red. Level . A.O.D.	Water
	0.10 -	D1				(0.10) 0.10	Soft dark grey to black sandy gravelly CLAY with rootlets (TOPSOIL).			
							MADE GROUND: Soft to firm dark grey sandy gravelly CLAY with some brick, concrete and sandstone cobbles. Gravel of angular to subrounded fine to coarse sandstone, brick, concrete, ceramic and some coal tar and faint hydocarbon odour.		7.07	
1	1.00 -	D2								
						(2.90)				
2	2.00 -	D3								
3						3.00	Trial Pit terminated at 3.0m depth.		4.17	

PLAN Bearing 110°



Groundwater : None encountered

Stability : Sight instability thoughout

Shoring : None used

Remarks :

Equipment Used: JCB 3CX

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Operator:	Logged By.	Sheet No.	Scale:	
NT	KH	1 Of 2	1:27.64	All measurements in metres unless otherwise stated

AGS

Contract : PEMBERTON DEVELOPMENT SECOND GROUND INVESTIGATION

Client : CARMARTHENSHIRE COUNTY COUNCIL

Trial Pit No. TP229

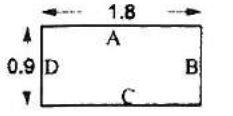
Dates : 15/03/05 - 15/03/05
Location : Llanelli

Job Number : 7932
Engineer : MOTT MACDONALD

Ground Level : 7.07 m A.O.D. *Level to Ordnance Datum*
Coordinates: 252911.95 E 199737.74 N *Co-ordinates to National Grid*

m B.G.L.	Samples Depth	Samples Type No.	U100 Blows	Tests Depth	Tests Test Results	Depth (Thick-ness)	STRATA DESCRIPTION	Legend	Red. Level . A.O.D.	Water
	0.00 -	D1					MADE GROUND: Firm dark grey to black sandy gravelly CLAY with faint hydrocarbon odour and many sandstone and brick cobbles. Gravel of angular to subrounded fine to coarse sandstone, brick, timber, glass, plastics, ceramics, metal and some slag and rare coal.			
1	1.00 -	D2				(2.00)				
2	2.00 -	B+D3		2	Vane - P=100	2.00	Firm to stiff grey brown to mottled orange brown sandy gravelly CLAY/SILT with pockets of very sandy silt and fine to medium sand. Gravel of angular to subangular fine to coarse sandstone.		5.07	
						(1.00)				
3						3.00	Trial Pit terminated at 3.0m depth.		4.07	

PLAN Bearing 212°



Groundwater : Seepage at 2.00m

Stability : Slight instability in Made Ground

Shoring : None used

Remarks :

Equipment Used: JCB 3CX

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Operator:	Logged By.	Sheet No.	Scale:	
NT	KH	1 Of 2	1:27.64	All measurements in metres unless otherwise stated

AGS

Contract : PEMBERTON DEVELOPMENT SECOND GROUND INVESTIGATION

Client : CARMARTHENSHIRE COUNTY COUNCIL

Trial Pit No. TP232

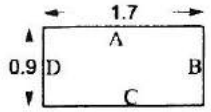
Dates : 15/03/05 - 15/03/05
Location : Llanelli

Job Number : 7932
Engineer : MOTT MACDONALD

Ground Level : 7.00 m A.O.D. *Level to Ordnance Datum*
Coordinates: 252870.19 E 199681.28 N *Co-ordinates to National Grid*

m B.G.L.	Samples Depth	Samples Type No.	Samples U100 Blows	Tests Depth	Tests Test Results	STRATA Depth (Thickness)	STRATA DESCRIPTION	Legend	Red. Level . A.O.D.	Water
	0.10 -	D1				(1.40)	MADE GROUND: Firm dark grey to black sandy gravelly CLAY with strong hydocarbon odour and many brick and sandstone cobbles. Gravel of angular to subangular fine to coarse sandstone, brick, timber, glass, ceramic, plastic, metal and some slag and rare coal and coal tar.			
1	1.40 -	B+D2				1.40	Stiff orange brown to mottled grey sandy sightly gravelly friable CLAY/SILT with some pockets of damp brown silt. Gravel of angular to subangular fine to coarse sandstone.		5.60	
2	2.00 -	D3		2	Vane - P=150	(1.10)				
						2.50	Trial Pit terminated at 2.50m depth.		4.50	

PLAN Bearing 110°



Groundwater : Seepage at 1.40m

Stability : Stable

Shoring : None used

Remarks :

Equipment Used: JCB 3CX

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Operator:	Logged By.	Sheet No.	Scale:	
NT	KH	1 Of 2	1:27.64	All measurements in metres unless otherwise stated

AGS

Contract : PEMBERTON DEVELOPMENT SECOND GROUND INVESTIGATION

Client : CARMARTHENSHIRE COUNTY COUNCIL

Borehole No. BH213

Dates : 12/04/05 - 12/04/05
Location : Llanelli

Job Number : 7932
Engineer : MOTT MACDONALD

Ground Level : 7.72 m A.O.D. *Level to Ordnance Datum*
Coordinates: 252922.22 E 199717.74 N *Co-ordinates to National Grid*

m B.G.L.	Samples Depth	Samples Type No. - UBlows	Tests Depth	Tests Test Results	Depth (Thickness)	DESCRIPTION	Legend	Red. Level . A.O.D.	Water	WELL Install/ Backfill
						MADE GROUND: Medium dense dark grey to black very clayey gravelly fine to coarse ash SAND with some timber and brick cobbles. Gravel of angular to subangular fine to coarse brick, timber, sandstone, ceramic and rare slag and coal.				
1	0.70 -	B1			(1.80)					
	1.20 -	D2	1.2	SPT (S) 14 (10-10-7-3-2-2)						
	1.60 -	B3								
2	2.00 -	D4	2	SPT (S) 10 (1-2-1-2-3-4)	1.80 (0.40)	Soft brown grey to grey sandy slightly gravelly CLAY with rootlets. Gravel of angular to subangular fine to coarse sandstone.		5.92		
	2.50 -	B5			2.20	Firm to locally stiff orange brown to brown grey sandy gravelly CLAY with some sandstone cobbles and pockets of pale grey damp silt. Gravel of angular to subangular fine to coarse sandstone and some mudstone.		5.52		
3	3.00 -	U6 - 100/50%								
	3.30 -	D7			(2.10)					
	3.50 -	B8								
4	4.00 -	D9	4	SPT (S) 80/205mm (7-3-10-20-20/55mm-)						
	4.40 -	B10			4.30 (0.30)	Possible weathered mudstone: Recovered as firm to stiff grey to dark grey sandy gravelly CLAY. Gravel of angular to subangular fine to coarse mudstone.		3.42		
	4.60 -	NR11			4.60	Terminated at 4.60m		3.12		

Water Observations			Casing		Groundwater			Chiselling		
Date / Time	Depth	Water	Depth	Cas. Dia.	Struck	Behaviour	Sealed	From	To	Hours
12/04/2005	4.60		3.00	200mm		None encountered		4.40	4.60	0100

Remarks: Dando 2000 using 200mm tools. 50mm gas standpipe installed.

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Operator:	Logged By.	Sheet No.	Scale:	
PC	KH	1 Of 1	1:60.98	All measurements in metres unless otherwise stated

AGS

Contract : PEMBERTON DEVELOPMENT SECOND GROUND INVESTIGATION

Client : CARMARTHENSHIRE COUNTY COUNCIL

Borehole No. DH213

Dates : 03/05/05 - 03/05/05
Location : Llanelli

Job Number : 7932
Engineer : MOTT MACDONALD

Ground Level : 7.37 m A.O.D. *Level to Ordnance Datum*
Coordinates: 252917.71 E, 199730.36 N *Co-ordinates to National Grid*

Run Details: Core Run	Depth (Thick-ness)	STRATA: Description	Legend	Red. Level . A.O.D.	Water
		TIP FILL **			
	(2.50)				
	2.50	SANDY CLAY **		4.87	
	(0.80)				
	3.30	SANDY CLAY & STONES **		4.07	
	(1.70)				
	5.00	BOULDER CLAY **		2.37	
	(1.50)				
	6.50	SANDSTONE **		0.87	
	(3.00)				
	9.50	SANDY MUDSTONE **		-2.13	

Drilling Progress and Water Observations

Date / Time	Depth	Casing	Core Dia.	Water

Groundwater

Struck	Sealed	Flow Rate Remarks
9.50		Medium inflow

Flush

Depth	Type	Returns
0 - 50	AIR	100

Remarks: Tracked mounted rotary rig using 115mm ODEX. ** Drillers Description

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Operator:	Logged By.	Sheet No.	Scale:	
DW	KH	1 Of 6	1:60.83	All measurements in metres unless otherwise stated

AGS

Contract : PEMBERTON DEVELOPMENT SECOND GROUND INVESTIGATION

Client : CARMARTHENSHIRE COUNTY COUNCIL

Borehole No. DH213

Dates : 03/05/05 - 03/05/05
Location : Llanelli

Job Number : 7932
Engineer : MOTT MACDONALD

Ground Level : 7.37 m A.O.D. *Level to Ordnance Datum*
Coordinates: 252917.71 E 199730.36 N *Co-ordinates to National Grid*

Run Details		STRATA			
Core Run	Depth (Thick-ness)	Description	Legend	Red. Level . A.O.D.	Water
	(1.50)	SANDY MUDSTONE **			
	11.00	SANDSTONE **		-3.63	
	(9.00)				

Drilling Progress and Water Observations					Groundwater			Flush		
Date / Time	Depth	Casing	Core Dia.	Water	Struck	Sealed	Flow Rate Remarks	Depth	Type	Returns

Remarks: Tracked mounted rotary rig using 115mm ODEX. ** Drillers Description

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Operator:	Logged By.	Sheet No.	Scale:	
DW	KH	2 Of 6	1:60.83	All measurements in metres unless otherwise stated

AGS

Contract : PEMBERTON DEVELOPMENT SECOND GROUND INVESTIGATION

Client : CARMARTHENSHIRE COUNTY COUNCIL

Borehole No. DH213

Dates : 03/05/05 - 03/05/05
Location : Llanelli

Job Number : 7932
Engineer : MOTT MACDONALD

Ground Level : 7.37 m A.O.D. *Level to Ordnance Datum*
Coordinates: 252917.71 E 199730.36 N *Co-ordinates to National Grid*

Run Details: Core Run	Depth (Thick-ness)	STRATA: Description	Legend	Red. Level, A.O.D.	Water
	20.00	MUDSTONE **		-12.63	
	(1.00)				
21	21.00	DARK MUDSTONE & COAL **		-13.63	
	(1.50)				
22	22.50	COAL **		-15.13	
23	(1.00)				
	23.50	DARK MUDSTONE & COAL **		-16.13	
	(0.50)				
24	24.00	SILTY MUDSTONE **		-16.63	
25					
26					
27	(6.00)				
28					
29					

Drilling Progress and Water Observations					Groundwater			Flush		
Date / Time	Depth	Casing	Core Dia.	Water	Struck	Sealed	Flow Rate Remarks	Depth	Type	Returns

Remarks: Tracked mounted rotary rig using 115mm ODEX. ** Drillers Description

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Operator:	Logged By.	Sheet No.	Scale:	
DW	KH	3 Of 6	1:60.83	All measurements in metres unless otherwise stated

AGS

Contract : PEMBERTON DEVELOPMENT SECOND GROUND INVESTIGATION

Client : CARMARTHENSHIRE COUNTY COUNCIL

Borehole No. DH213

Dates : 03/05/05 - 03/05/05
Location : Llanelli

Job Number : 7932
Engineer : MOTT MACDONALD

Ground Level : 7.37 m A.O.D. *Level to Ordnance Datum*
Coordinates: 252917.71 E 199730.36 N *Co-ordinates to National Grid*

Run Details		STRATA			
Core Run	Depth (Thick-ness)	Description	Legend	Red. Level . A.O.D.	Water
	30.00	SANDSTONE WITH QUARTZ **		-22.63	
31					
32					
33					
34					
	(8.80)				
35					
36					
37					
38					
	38.80	COAL **		-31.43	
39	(1.20)				

Drilling Progress and Water Observations					Groundwater			Flush		
Date / Time	Depth	Casing	Core Dia.	Water	Struck	Sealed	Flow Rate Remarks	Depth	Type	Returns

Remarks: Tracked mounted rotary rig using 115mm ODEX. ** Drillers Description

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Operator:	Logged By.	Sheet No.	Scale:	All measurements in metres unless otherwise stated
DW	KH	4 Of 6	1:60.83	AGS

Contract : PEMBERTON DEVELOPMENT SECOND GROUND INVESTIGATION

Client : CARMARTHENSHIRE COUNTY COUNCIL

Borehole No. DH213

Dates : 03/05/05 - 03/05/05
Location : Llanelli

Job Number : 7932
Engineer : MOTT MACDONALD

Ground Level : 7.37 m A.O.D. *Level to Ordnance Datum*
Coordinates: 252917.71 E 199730.36 N *Co-ordinates to National Grid*

Run Details		STRATA			
Core Run	Depth (Thick-ness)	Description	Legend	Red. Level . A.O.D.	Water
	40.00	MUDSTONE **		-32.63	
	(1.00)				
	41.00	SANDSTONE **		-33.63	
	(9.00)				

41 42 43 44 45 46 47 48 49

Drilling Progress and Water Observations

Date / Time	Depth	Casing	Core Dia.	Water
03/05/2005 00:00	50.00	7.00	115	

Groundwater

Struck	Sealed	Flow Rate Remarks

Flush

Depth	Type	Returns

Remarks: Tracked mounted rotary rig using 115mm ODEX. ** Drillers Description

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Operator:	Logged By.	Sheet No.	Scale:	
DW	KH	5 Of 6	1:60.83	All measurements in metres unless otherwise stated

AGS

Contract : PEMBERTON DEVELOPMENT SECOND GROUND INVESTIGATION

Client : CARMARTHENSHIRE COUNTY COUNCIL

Borehole No. DH213

Dates : 03/05/05 - 03/05/05
Location : Llanelli

Job Number : 7932
Engineer : MOTT MACDONALD

Ground Level : 7.37 m A.O.D. *Level to Ordnance Datum*
Coordinates: 252917.71 E 199730.36 N *Co-ordinates to National Grid*

Run Details						STRATA			
	Core Run					Depth (Thick-ness)	Description	Legend	Red. Level . A.O.D.	Water
						50.00	Terminated at 50.00m		-42.63	

Drilling Progress and Water Observations					Groundwater			Flush		
Date / Time	Depth	Casing	Core Dia.	Water	Struck	Sealed	Flow Rate Remarks	Depth	Type	Returns

Remarks: Tracked mounted rotary rig using 115mm ODEX. ** Drillers Description

QUANTUM
Bynea House, Bynea
Llanelli, Carmarthenshire, SA14 9SU
Tel: 01554 744880
Fax: 01554 776150
email: enquiries@quantum-gb.co.uk

Operator:	Logged By.	Sheet No.	Scale:	
DW	KH	6 Of 6	1:60.83	All measurements in metres unless otherwise stated

AGS

Contract : PEMBERTON DEVELOPMENT SECOND GROUND INVESTIGATION

Client : CARMARTHENSHIRE COUNTY COUNCIL

Trial Pit No. TP231

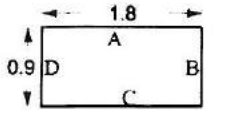
Dates : 15/03/05 - 15/03/05
Location : Llanelli

Job Number : 7932
Engineer : MOTT MACDONALD

Ground Level : 6.60 m A.O.D. *Level to Ordnance Datum*
Coordinates: 252799.49 E, 199690.35 N *Co-ordinates to National Grid*

m B.G.L.	Samples: Depth	Samples: Type No.	Samples: U100 Blows	Tests: Depth	Tests: Test Results	Depth (Thickness)	STRATA: DESCRIPTION	Legend	Red. Level A.O.D.	Water
0	0.00 -	D1					MADE GROUND: Firm dark grey to black sandy gravelly CLAY with faint hydrocarbon odour, many sandstone, brick, rare concrete, slag and coal. Gravel of angular to subrounded fine to coarse sandstone, mudstone, brick, glass, ceramics and some slag and rare cementitious asbestos.			
1	1.00 -	D2				(2.70)				
2	2.00 -	D3								
	2.70 -	B+D4		2.7	Vane - P=100	2.70				
						(0.30)	Firm to stiff pale grey to mottled orange brown very sandy gravelly CLAY/SILT with some pockets of dark brown damp silt and plant remains. Gravel of angular to subrounded fine to coarse sandstone.		3.90	
3						3.00	Trial Pit terminated at 3.0m depth.		3.60	

PLAN Bearing 110°



Groundwater : Seepage at 1.80m

Stability : Stable

Shoring : None used

Remarks :

Equipment Used: JCB 3CX

QUANTUM
Dynea House, Dynea
Llanelli, Carmarthenshire, SA14 9SU
Tel: 01554 744880
Fax: 01554 776130
email: enquiries@quantum-gb.co.uk

Operator:	Logged By.	Sheet No.	Scale:	
NT	KH	1 Of 2	1:27.64	All measurements in metres unless otherwise stated

AGS

APPENDIX C

ExCAL Site Investigation 2013

TROSTRE FORMER LANDFILL, LLANELLI

SITE INVESTIGATION

JULY 2013

Prepared for:

Cyngor Sir Gâr Carmarthenshire County Council

ExCAL House, Capel Hendre Industrial Estate, Ammanford,
Carmarthenshire. SA18 3SJ
Tel: 01269 831606
Fax: 01269 841867

LLOYD'S REGISTER QUALITY ASSURANCE ISO9001

DOCUMENT CONTROL SHEET

PROJECT:	**TROSTRE FORMER LANDFILL, LLANELLI**
TITLE:	**SITE INVESTIGATION**

PROJECT REF:	**44-05-05-13**
REPORT No.:	44-05-05.R1

PREPARED BY:

A Prigmore:.....

APPROVED BY:

S Whitehouse:.....

Version	Date	Amendments
Original	July 2013	

TROSTRE FORMER LANDFILL, LLANELLI

SITE INVESTIGATION

Contents **Page**

1.0 INTRODUCTION

1.1 Summary

ExCAL Limited have been commissioned by Carmarthenshire County Council to undertake a Site Investigation to determine the potential source of the Methane gas detected in their former inert landfill site in Trostre, Llanelli; *Land off Trostre Works Link Road*.

Methane gas is generated as a product of the anaerobic digestion of organic matter.

Previous monitoring has recorded elevated methane concentrations around BH1 and BH3, with the highest concentrations being around BH3.

Trenches were excavated around the area with the most elevated methane concentrations (Borehole 3) and the excavated material was closely inspected to determine whether or not any organic matter was present in the soil and if so the type and extent.

The excavations encountered a high concentration wood fragments and other organic waste in the areas to the south and west of the borehole.

The identified organic matter was blackened which is typical of the effects of anaerobic biodegradation, a by-product of which is methane gas.

This report contains a summary of the findings with supporting photographic records. The investigation has identified areas that require further works to resolve the issue and a description of the proposed scope of this is included at Section 6.0 of this report.

1.2 Limitations

This report has been prepared for the benefit of Carmarthenshire County Council and its contents should not be relied upon by others without the written authority of ExCAL Ltd. If any unauthorized third party makes use of this report they do so at their own risk and ExCAL Ltd owes them no duty of care or skill.

2.0 SITE DESCRIPTION

The study site is the former Trostre inert Landfill which lies near the Town of Llanelli in Carmarthenshire, South Wales. The site location is shown in Drawing 44-05-01-09.D01 Appendix A.

The Ordnance Survey Grid Reference for the approximate centre of the site is NGR: 252799 199700

The site is roughly 3ha in size and comprises gravel hardstanding, surrounded by some vegetation and is used primarily as a car park.

3.0 SITE INVESTIGATION DESIGN

3.1 Extent of Excavation

An excavator was used to dig trenches near the methane hotspot.

All of the material excavated was visually inspected for the presence of organic matter. Any organic matter detected was recorded and where appropriate photographed.

In an attempt to identify the extent of the organic matter around borehole 3, excavations were progressively extended away from the borehole until none was encountered in the trial pit.

The extent of excavation is shown on Drawing 44-05-05.D02 in Appendix A.

Where possible, the trenches were excavated through the fill material to a sufficient depth to identify the top of the original ground level that exists below the waste mass.

3.2 Materials Encountered

The investigation identified a brown silty clay material at a general depth of 3m, indicating the previous ground level.

Soils to the east of borehole 3 had a low concentration of visible organic matter.

Soils to the south borehole 3 contained numerous fence posts, which showed signs of biodegradation. The organic matter extended to a distance of around 4m from the borehole.

Soils to the north of borehole 3 contained some organic matter to a distance of around 4m from the borehole.

Soils to the west of the borehole contained a large amount of organic matter. Up to a distance of around 6m from the borehole, fence posts similar to those found to the south were encountered which showed signs of biodegradation. From 6m on, remains of tree root systems and grassy material were found consistently up to and including 9m from the borehole.

The waste examined from this area had a strong odour, typical of organic materials biodegrading under anaerobic conditions.

4.0 INTERPRETATION OF FINDINGS

4.1 General

The findings for the investigation to the west support those of the original site investigation.

Inert soils and fill deposits exist to a depth of around 3m, below which a brown silty clay was encountered, which represents the original ground level.

Wood and organic fractions are interspersed within some of the inert fill.

Biodegradation of the organic materials is the most likely source for the methane gas that has been consistently recorded in Borehole 3, over the last 12 months.

5.0 RECOMMENDATIONS

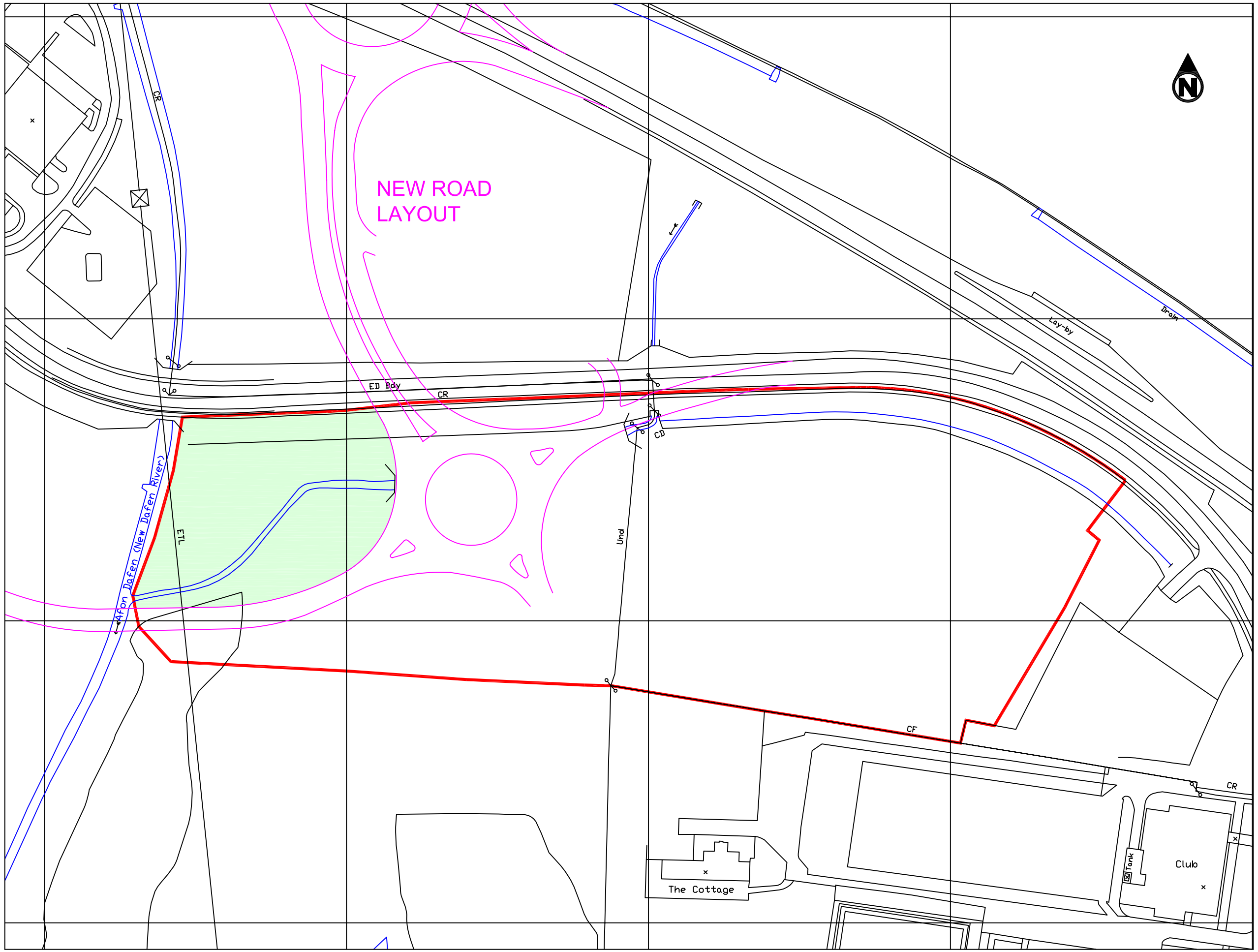
In order to reduce methane concentrations, the organic waste will need to be removed. This could be achieved by excavating the soils, segregating and removing the organic matter and then replacing the inert materials.

The segregated organic matter should be disposed of to a suitably licensed recycling facility.

It is estimated that the length of time required to complete the excavation and replacement could be between 10 and 15 days.

APPENDIX A

Drawings



Notes: | **A3**

MONITORING
BOREHOLE LOCATIONS

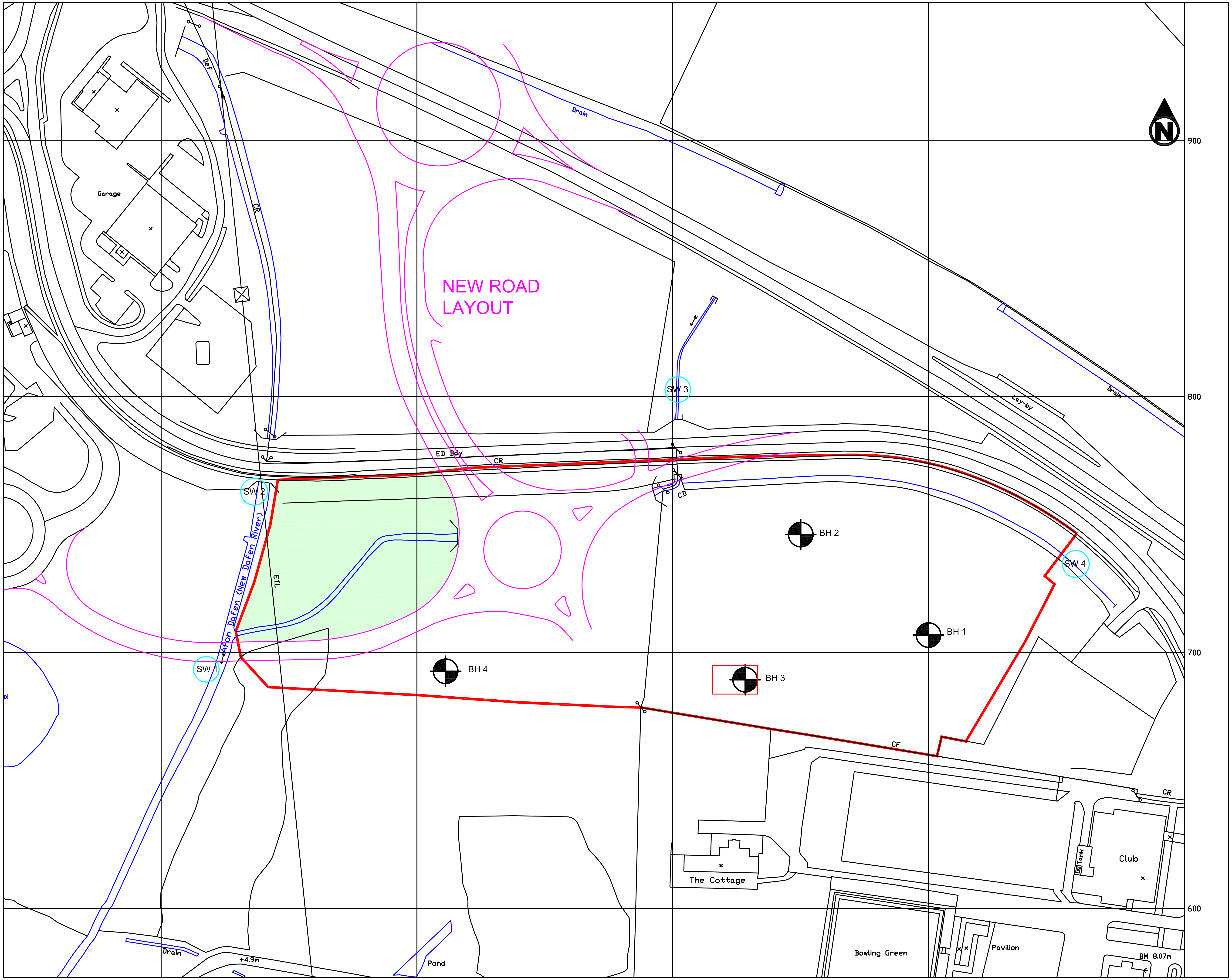
Job:
Carmarthenshire County Council
Methane Investigation, Trostre

Title:
Site Location

Date:	**July 2013**
Scale:	**1:1250**
Drawn by:	**AP**
Checked by:	**SW**

EXCAL LIMITED
1 St Mary's Street
Carmarthen
Carmarthenshire
SA31 1TN
Tel: 01267 234231 Fax: 01267 234232
Website: www.excaluk.com E-mail: reception@excaluk.com

Drawing No:	44-05-05.D001
Revision No:	**Date:**



Notes:

A3

GROUNDWATER AND LANDFILL GAS MONITORING BOREHOLE (EXCAL LIMITED)

LANDFILL BOUNDARY

SW1 SURFACE WATER MONITORING LOCATIONS (EXCAL LIMITED)

EXTENT OF EXCAVATION

Job: Carmarthenshire County Council
Site Investigation,Trostre Landfill

Title: ExCAL Excavation Extent

Date:	**April 2013**
Scale:	**1:1250**
Drawn by:	**AP**
Checked by:	**SW**

ExCAL LIMITED
ExCAL House
Capel Hendre Industrial Estate
Carmarthenshire
SA18 3SJ
Tel: 01269 831606 Fax: 01269 841867
Website: www.excaluk.com E-mail: reception@excaluk.com

Drawing No: 44-05-05.D02

Revision No: | **Date:**

APPENDIX B

Images

Excavation to the South of Borehole

Job: Carmarthenshire County Council		
Title: Site Investigation, Former Landfill, Trostre, Llanelli	Drawn: AP	Checked: SW
	Date: May 2013	

EXCAL Limited

Capel Hendre Industrial Estate
Ammanford
Carmarthenshire
SA18 3SJ

Tel: (01269) 831606 Fax: (01269) 841867
Website: www.excaluk.com Email: info@excaluk.com

Reinstated Site

Job: Carmarthenshire County Council		
Title: Site Investigation, Former Landfill, Trostre, Llanelli	Drawn: AP	Checked: SW
	Date: May 2013	

EXCAL Limited
Capel Hendre Industrial Estate
Ammanford
Carmarthenshire
SA18 3SJ
Tel: (01269) 831606 Fax: (01269) 841867
Website: www.excaluk.com Email: info@excaluk.com

Excavation to the North of Borehole

Job: Carmarthenshire County Council		
Title: Site Investigation, Former Landfill, Trostre, Llanelli	Drawn: AP	Checked: SW
	Date: May 2013	

EXCAL Limited
Capel Hendre Industrial Estate
Ammanford
Carmarthenshire
SA18 3SJ
Tel: (01269) 831606 Fax: (01269) 841867
Website: www.excaluk.com Email: info@excaluk.com

Excavated Material

Job: Carmarthenshire County Council		
Title: Site Investigation, Former Landfill, Trostre, Llanelli	Drawn: AP	Checked: SW
	Date: May 2013	

EXCAL Limited
Capel Hendre Industrial Estate
Ammanford
Carmarthenshire
SA18 3SJ
Tel: (01269) 831606 Fax: (01269) 841867
Website: www.excaluk.com Email: info@excaluk.com

Excavation to the East of Borehole

Job: Carmarthenshire County Council		
Title: Site Investigation, Former Landfill, Trostre, Llanelli	Drawn: AP	Checked: SW
	Date: May 2013	

EXCAL Limited

Capel Hendre Industrial Estate
Ammanford
Carmarthenshire
SA18 3SJ

Tel: (01269) 831606 Fax: (01269) 841867
Website: www.excaluk.com Email: info@excaluk.com

Excavation to the West of Borehole

Job: Carmarthenshire County Council		
Title: Site Investigation, Former Landfill, Trostre, Llanelli	Drawn: AP	Checked: SW
	Date: May 2013	

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Capel Hendre Industrial Estate
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Carmarthenshire
SA18 3SJ
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Website: www.excaluk.com Email: info@excaluk.com

APPENDIX C

Costs of Remediation

Costs of Remediation of Trostre Inert Landfill

In order to reduce methane concentrations to an acceptable level it will be necessary to remove organic matter from the waste mass.

Excavation will take place using a 16 tonne backactor. Organic material will be segregated into skips for disposal.

Costs associated with the works are estimated below: -

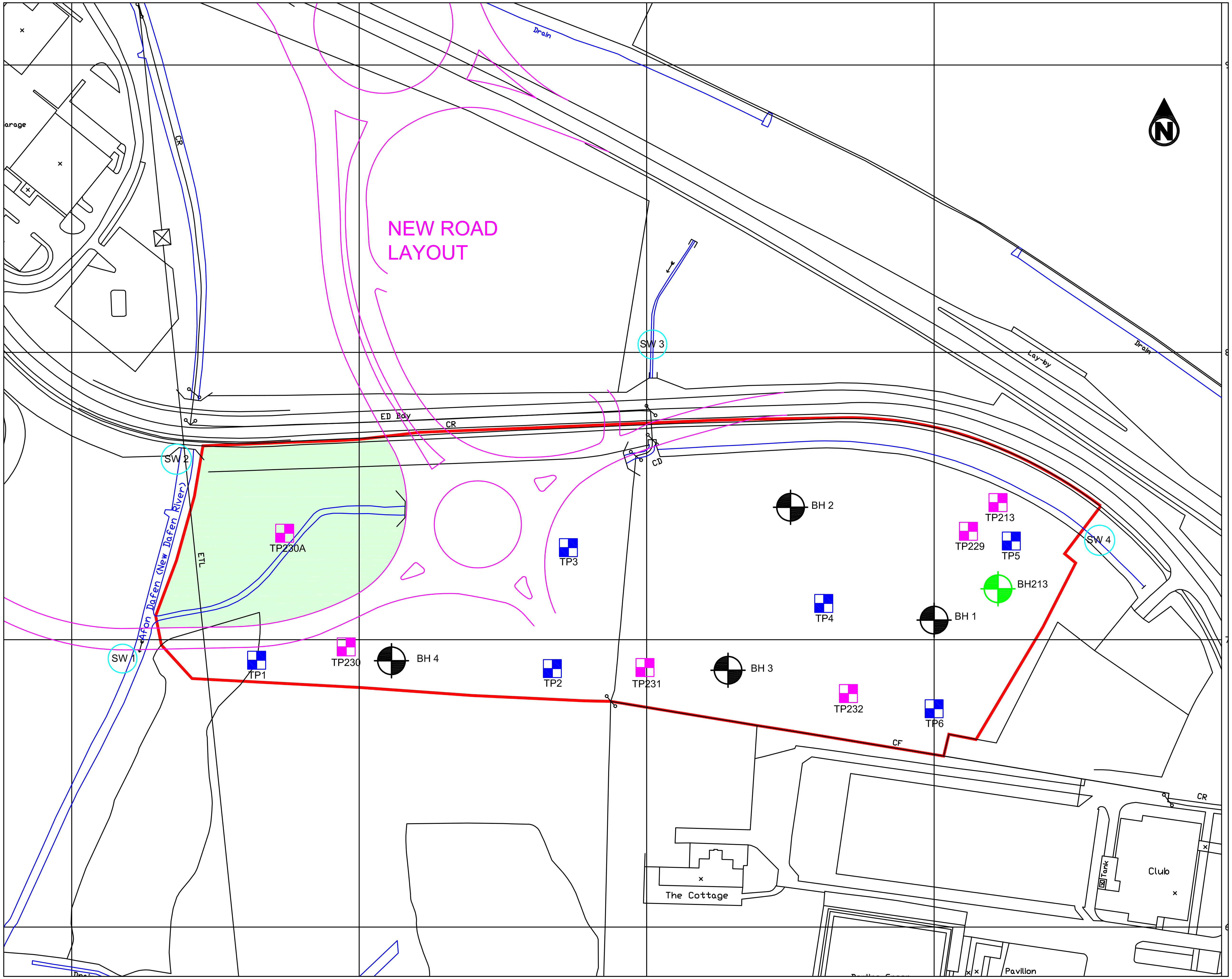
Excavator and driver	£256/day (£1,280/week)
Disposal of segregated material	£122.50/tonne
Welfare unit	£195/week
Supervision and segregation of organic matter (3 man team)	£1,050/day (£5,250/week)

We estimate that the works will take approximately 15 days (3 weeks).

Total Estimated Cost	
Excavator	£3,840
Welfare	£585
Supervision/segregation	£15,750
Disposal (estimate 10t)	£1,225
Total (excluding VAT)	**£21,400**

APPENDIX D

Drawing



Notes: A3

(blue)	TRIAL PIT LOCATIONS (EXCAL LIMITED)
(black)	GROUNDWATER AND LANDFILL GAS MONITORING BOREHOLE (EXCAL LIMITED)
(red)	LANDFILL BOUNDARY
SW1	SURFACE WATER MONITORING LOCATIONS (EXCAL LIMITED)
(magenta)	TRIAL PIT LOCATIONS (MOTT MACDONALD)
(green)	LANDFILL GAS MONITORING BOREHOLE (MOTT MACDONALD)

Job:
Carmarthenshire County Council
Site Investigation,Trostre Landfill

Title:
Monitoring Locations

Date:	**October 2011**
Scale:	**1:1250**
Drawn by:	**RH / SA**
Checked by:	**CW**

ExCAL LIMITED
1 St Mary's Street
Carmarthen
Carmarthenshire
SA31 1TN
Tel: 01267 234231 Fax: 01267 234232
Website: www.excaluk.com E-mail: reception@excaluk.com

Drawing No: 44-05-02.D02
Revision No: **Date:**

APPENDIX E

ExCAL Site Investigation Report 2010

TROSTRE LANDFILL SITE, LLANELLI

SITE INVESTIGATION REPORT

AUGUST 2010

Prepared for:

ExCAL Limited
ExCAL House
Capel Hendre Industrial Estate
Ammanford
Carmarthenshire
SA18 3SJ

Tel No: 01269 831606
Fax No: 01269 841867

DOCUMENT CONTROL SHEET

PROJECT:	**TROSTRE LANDFILL SITE, LLANELLI**
TITLE:	**SITE INVESTIGATION REPORT**

PROJECT REF:	**44-05-02-11**
REPORT No.:	44-05-02

PREPARED BY:

S Archer: .....

APPROVED BY:

S Whitehouse:.....

Version	Date	Amendments
Original	October 2011	

TROSTRE LANDFILL SITE, LLANELLI

SITE INVESTIGATION REPORT

Contents **Page**

1.0 INTRODUCTION

Previous investigations at a former inert landfill site in Trostre, Llanelli; *Land off Trostre Works Link Road*, NGR: 252799 199700, owned by Carmarthenshire County Council (CCC), conducted by Mott MacDonald in 2005 indicated elevated levels of the following determinands:

- barium, naphthalene, indeno[1,2,3-cd]pyrene and benzo[a]pyrene in soil samples
- cyanide, barium, selenium and antimony in groundwater samples

The levels of these determinands exceed Soil Guideline Values (SGV's), Generic Assessment Criteria (GAC's) and Environmental Quality Standards (EQS's) listed in Tables 2 and 3.

Monthly gas monitoring between May 2005 and October 2005 indicated consistently elevated levels of carbon dioxide (CO_2) and methane (CH_4).

A site investigation was commissioned by Carmarthenshire County Council (CCC) and conducted by ExCAL Limited at the former inert landfill site on 11 and 25 to 26 August 2010 to establish the nature of the waste deposited and provide a point of comparison for continued monitoring.

The site location is shown in Drawing 44-05-01.D02.

2.0 SITE DETAILS

2.1 Site Description

A description of the site has been generated from a review of the existing information (Preliminary Risk Assessment (PRA) (October 2009).

The site is surrounded by commercial and industrial land and is bisected by access roads and a roundabout. It is bounded to the south and west by mature trees and shrubs and to the north by shrubs and tall grasses. The access roads predominantly cover the central western portion of the site. The area of the site to the west of the roads is elevated above the remainder of the site and comprises tall grasses and shrubs. The area east of the roads is surfaced with crushed aggregate and bunded with soil.

The nearest surface water is contained within a part culverted drainage trench, which runs parallel to the northern boundary of the site, passing beneath the roads and elevated ground to meet the River Dafen to the west.

Trostre Tin Plate Works exists approximately 100m to the south of the site and the A484 road passes northwest to southeast adjacent to the north-eastern boundary of the site.

Information supplied by the client on the contamination status of the site states that material obtained on-site and used for surface re-profiling is within the lower threshold concentration limits quoted in *Guidance for the disposal of contaminated soils*. This is evidenced in the Environment Agency letter dated 24 June 2002 (reference DJ/CL/SITE/Trostre).

The site licence was issued on 2 March 1994 and the site ceased to accept waste on the 26 February 2000.

2.2 Site History

Analysis of the available historical maps provides a basis for the assessment of potential historic contamination through associated land-use. A summary of the history of the site is provided in Table 1 below.

Table 1 – Significant features, changes and developments on-site and in surrounding areas

Dates	Scale	Significant features, changes and developments	
		On site	Surrounding areas
1878 – 1901	1:1,250 & 1:10,560	Undeveloped farmland with two water courses; one running southwest across the site to the River Dafen and another running through the centre of the site to a small pond on the southern site boundary.	Residential dwellings surround the site to the northeast, east, south and southwest – *Forest Villa* is adjacent to the eastern boundary of the site and *Maes ar Ddafen Fach* is 50m south. River Dafen bounds the site to the west. Access track west of the site. Surface water (pond) 100m south.
1901 – 1907	1:1,250 & 1:10,560	No change.	Coal shaft 5m south and an air shaft 60m southeast.
1907 – 1916	1:1,250 & 1:10,560	No change.	Coal shaft mapped as *Old Shaft (Coal)* indicating that it is now disused. 3no. additional buildings adjacent to south.
1916 – 1953	1:1,250 & 1:10,560	No change.	Cefncaeau residential development 200m northeast. Works and electricity sub-station 110m south. Buildings adjacent to southeast.
1953 – 1969	1:1,250 & 1:2,500	No change.	Buildings to southeast replaced by tennis courts, bowling green and pavilion. Works 110m south developed with additional buildings.
1969 – 1994	1:1,250 & 1:10,000	No change.	Construction of A484 and access roads to north. Further development at Works 110m south. Garage and buildings 150m northwest.
1994 – 2000	N/A	Site used as an inert waste landfill (Licence No. LLN/WD/007)	Major development north and west including retail park, sports stadium (*Parc Y Scarlets*) and other commercial properties.
2000 – 2011	1:1,250 & 1:10,000	Development of access roads and roundabout. Area east of access roads used as a car park. Concrete lined drainage ditch and watercourse running through centre of site redirected to join watercourse running southwest across site into River Dafen.	

2.2.1 Summary

The site remained undeveloped until 1994 when the land was used as an inert waste landfill. The landfill ceased to accept waste in 2000 and was subsequently used for infrastructure to surrounding developments. Notable developments in the surrounding areas include the presence of a coal shaft 5m south (1901 – 1907) and the Works 110m south (1916 – present) of the site boundary. None of the historical uses of the site should cause site to become contaminated by the determinants found in the Mott MacDonald report 2005.

3.0 ENVIRONMENTAL SETTING

3.1 Geology

GroundSure Reports did not identify any Made Ground in the area. The Mott MacDonald ground investigation (2005), however, confirmed Made Ground in all exploratory holes to a maximum proven depth of 3.00m below ground level (bgl). Typically, Made Ground comprised brick, concrete, ceramics, timber, metal, glass, coal, slag and coal tar.

The superficial geology of the western half of the site is Alluvium (Quaternary age) comprising clay, silt, sand and gravel. The superficial geology of the eastern half of the site is Devensian Till (Quaternary age) comprising a mixture (diamicton) of glacially derived materials. Silty clay was encountered at depths between 1.40m bgl and a maximum proven depth of 6.50m bgl during Mott MacDonald's ground investigation (2005).

The underlying bedrock is the Swansea Member (Carboniferous age), which is described in the British Geological Survey (BGS) Lexicon of Named Rock Units as comprising green-grey lithic arenites ("Pennant Sandstones") with thin mudstone/siltstone and seatearth interbeds and mainly thin coals.

Bedrock was encountered during the ground investigation undertaken by Mott MacDonald (2005) and proven from 6.50m bgl to a maximum depth of 50.00m bgl. Sandstone, mudstone and coal were encountered at various depths.

3.2 Hydrogeology

The Environment Agency (EA) website shows that the site is not located in a groundwater Source Protection Zone (SPZ).

The superficial deposits (Alluvium and Devensian Till) are shown by the EA website to be a Secondary (undifferentiated) aquifer. The bedrock (Swansea Member) is shown to be a Secondary 'A' aquifer.

A Secondary 'A' aquifer is defined as containing permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

A Secondary (undifferentiated) aquifer is assigned in cases where it has not been possible to attribute either category 'A' or 'B' to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.

Catchment areas for source protection zones are located approximately 8km southwest of the site. There is no known groundwater abstraction located within 1km of the site.

3.3 Hydrology

The nearest surface water is an unnamed tributary of the Afon Dafen (River Dafen) crossing the site from northeast to southwest and joining the Afon Dafen immediately adjacent to the western boundary of the site. The source of the tributary is located approximately 100m north of the site and is culverted beneath recently constructed access roads and a roundabout.

The site is within 250m of a Zone 2 and Zone 3 floodplain. There is a groundwater flooding susceptibility within 50m of the site and the BGS confidence rating for this susceptibility area is moderately low.

3.4 Designated Environmentally Sensitive Sites

There are no environmentally sensitive sites within 500m of the site.

4.0 SITE INVESTIGATION

4.1 Introduction

The site investigation comprised 6no. trial pits completed on 11th August 2010 and 4no. cable percussion boreholes completed between 25th and 26th August 2010.

4.2 Sampling Strategy

Sample locations were chosen based on the PRA (October 2009) to assess the following key contaminants of concern: -

- Metals and Metalloids (including their compounds)
- Polycyclic Aromatic Hydrocarbons (PAH)
- Total Petroleum Hydrocarbons (TPH)
- BTEX (Benzene, Toluene, Ethylbenzene, Xylene)
- Phenols
- Cyanide (Free)
- Total Organic Content (TOC)
- Sulphur
- Sulphide
- pH
- Asbestos
- Methane (CH_4)
- Carbon Dioxide (CO_2).

Future monitoring of contaminants in groundwater and gas was facilitated through the installation of monitoring wells within the cable percussion boreholes.

4.3 Laboratory Analysis

Samples of soil and groundwater from the trial pits were analysed for the following suite of chemicals: -

- Cyanide (total)
- Sulphide
- Organic matter
- Boron (hot water soluble)
- Sulphate (2:1 water soluble) as SO4
- Sulphate (total) by BS1377 (HCl extract)
- Arsenic
- Barium
- Beryllium
- Cadmium
- Chromium
- Copper
- Lead
- Mercury
- Nickel

- Selenium
- Vanadium
- Zinc
- Total Petroleum Hydrocarbons
- pH.

5.0 Results

The analysis results are given in Table 6 and 7 below.

The results of the soil sample analyses were compared to the values provided in Table 2. Where no guideline values are available or analysis results are below detection limits only the raw data is reported. Values exceeding SGV's / GAC's are highlighted in yellow.

5.1 Introduction

Chemical analysis of soil and water samples has been compared to available guidelines; CLEA Soil Guideline Values (SGV's), LQM/CIEH Generic Assessment Criteria (GAC) and Environmental Quality Standards (EQS's). Tables 2 and 3 summarise the list of compiled values and sources of the guidelines used for comparison.

Table 2 – SGV's and GAC's for Soil

Contaminant	SGV / GAC
Cyanide (total) (mg/kg)	3.7*4
Sulphide (mg/kg)	-
Organic matter (%)	-
Boron (hot water soluble) (mg/kg)	-
Sulphate (2:1 water soluble) as SO4 (g/L)	-
Sulphate (total) by BS1377 (HCl extract) (%)	-
Arsenic (mg/kg)	32*1
Barium (mg/kg)	230*2
Beryllium (mg/kg)	N/A
Cadmium (mg/kg)	1.8*3
Chromium (mg/kg)	130*1
Copper (mg/kg)	2,300*4
Lead (mg/kg)	450*1
Mercury (mg/kg)	8.0*3
Nickel (mg/kg)	130*1
Selenium (mg/kg)	120*3
Vanadium (mg/kg)	-
Zinc (mg/kg)	3,800*3
TPH (mg/kg)	-
pH	-

*1 CLEA Soil Guideline Value (SGV) – residential
*2 CLEA SGV – commercial
*3 CLEA SGV – allotments
*4 LQM & CIEH. 2009. *The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd Ed.)*

Table 3 – EQS and GAC's for Water Samples

Determinand	EQS / GAC	Determinand	EQS / GAC
pH	6.5 – 10 [*2]	Anthracene	0.021 mg/l [*5]
Biological Oxygen Demand	<5 mg/l [*3]	Fluoranthene	0.23 mg/l [*5]
Chemical Oxygen Demand	30 mg/l [*3]	Pyrene	0.13 mg/l [*5]
Electrical Conductivity	N/A	Benzo[a]anthracene	0.0038 mg/l [*5]
Alkalinity	None	Chrysene	0.0020 mg/l [*5]
Chloride	250 mg/l [*2]	Benzo[b]fluoranthene	0.0020 mg/l [*5]
Ammoniacal Nitrogen	0.5 mg NH_4/l [*2]	Benzo[k]fluoranthene	0.0008 mg/l [*5]
Cyanide (total)	0.05 mg/l [*1]	Benzo[a]pyrene	0.0038 mg/l [*5]
Iron (dissolved)	2,000 µg/l [*1]	Dibenzo[a,h]anthracene	0.0006 mg/l [*5]
Iron (total)	2,000 µg/l [*1]	Indeno[1,2,3-cd]pyrene	0.0002 mg/l [*5]
Sulphide	N/A	Benzo[g,h,i]perylene	0.00026 mg/l [*5]
Total Organic Carbon	None	PCBs as Aroclor	None
Sulphate	250 mg/l [*1]	Catechols	None
Antimony	5 µg/l [*2]	Phenol	None
Arsenic (dissolved)	10 µg/l [*2]	Cresols	None
Arsenic	10 µg/l [*2]	Xylenols	None
Barium	100 µg/l [*1]	Naphthols	None
Beryllium	None	Trimethyl phenols	None
Boron	1,000 µg/l [*2]	2-sec-Butyl-4-6-dinitrophenol	None
Cadmium	5 µg/l [*1]	4-Chloro-3-methylphenol	None
Chromium (dissolved)	50 µg/l [*1]	2-Chorophenol	None
Chromium (total)	50 µg/l [*1]	2,4-Dichlorpohenol	None
Copper (dissolved)	50 µg/l [*1]	2,6-Dichlorophenol	None
Copper	50 µg/l [*1]	2,4-Dimethylphenol	None
Lead (dissolved)	50 µg/l [*1]	2,4-Dinitrophenol	None
Lead	50 µg/l [*1]	2-Methyl-4-6-dinitrophenol	None
Mercury	1 µg/l [*2]	2-Methylphenol	None
Nickel (dissolved)	20 µg/l [*2]	3-Methylphenol	None
Nickel	20 µg/l [*2]	4-Methylphenol	None
Selenium	10 µg/l [*1]	2-Nitrophenol	None
Antimony (dissolved)	5 µg/l [*2]	4-Nitrophenol	None
Antimony	5 µg/l [*2]	Pentachlorophenol	None
Vanadium (dissolved)	20 µg/l [*4]	Phenol	None
Vanadium	20 µg/l [*4]	2,3,4,5-Tetrachlorophenol	None
Zinc (dissolved)	3,000 µg/l [*1]	2,3,4,6-Tetrachlorophenol	None

Determinand	EQS / GAC	Determinand	EQS / GAC
Zinc	3,000 µg/l[*1]	2,3,5,6-Tetrachlorophenol	None
TPH (Aqueous Phase)	50 µg/l[*1]	2,3,4-Trichlorophenol	None
PAH (total EPA 16)	None	2,3,5-Trichlorophenol	None
Naphthalene	19 mg/l[*5]	2,3,6-Trichlorophenol	None
Acenaphthylene	4.2 mg/l[*5]	2,4,5-Trichlorophenol	None
Acenaphthene	3.2 mg/l[*5]	2,4,6-Trichlorophenol	None
Fluorene	1.9 mg/l[*5]	3,4,5-Trichlorophenol	None
Phenanthrene	0.53 mg/l[*5]		

*1 Surface Waters (Abstraction for Drinking Water) (Classification) Regulations 1996
*2 Water Supply (Water Quality) Regulations 2000
*3 Council Directive concerning the quality required of surface water intended for the abstraction of drinking water in the Member States (Surface Water Directive) (Repealed)
*4 Water Research Council (WRC). 1984. *Determination of pollutants in effluents: Proposed environmental quality standards for vanadium in water and associated materials.*
*5 LQM & CIEH. 2009. *The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd Ed.)*

5.2 Ground Conditions

Made Ground typically comprising brick, coal ash, clinker, plastic, ceramics and concrete was encountered in all exploratory holes from ground level to a maximum proven depth of 8.90m bgl.

Superficial deposits comprising clay, silt, sand and gravel, but predominantly silty clay were encountered in all exploratory holes from a minimum depth of 2.00m bgl to a maximum proven depth of 15.00m bgl.

No bedrock was encountered during the site investigation.

Groundwater was encountered in BH1 between 12.20m and 12.30m bgl and in TP2 at 3.50m bgl.

Olfactory indications of contamination were noted in TP1 within Made Ground.

Table 4– Analysis results for soil samples.

Soil - 11 August 2010													
Contaminant	SGV / GAC	TP1 1.50 m	TP1 3.50 m	TP2 1.50 m	TP2 3.50 m	TP3 0.50 m	TP3 2.50 m	TP4 1.50 m	TP4 2.50 m	TP5 1.50 m	TP5 2.50 m	TP6 0.50 m	TP6 3.50 m
Cyanide (total) (mg/kg)	3.7[*4]	6.1	0.7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sulphide (mg/kg)	-	6.6	12	4.2	9.8	11	9.7	10	14	9.6	4.9	7.6	3.4
Organic matter (%)	-	21	14	11	16	24	14	10	13	8.8	1.6	8.1	9.5
Boron (mg/kg)	-	2.5	4.7	0.8	0.9	0.9	1.5	0.7	1.2	1.2	0.6	0.5	0.7
Sulphate (2:1 water soluble) (g/L)	-	0.37	0.20	0.06	0.10	0.22	0.83	0.59	0.22	0.40	0.01	0.09	0.02
Sulphate (total) (HCl extract) (%)	-	0.11	0.03	0.04	0.05	0.09	0.21	0.14	0.09	0.12	0.02	0.07	0.07
Arsenic (mg/kg)	32[*1]	31	28	24	17	**34**	**35**	24	30	23	10	10	**34**
Barium (mg/kg)	230[*2]	190	**260**	140	120	**440**	**300**	**250**	210	140	40	110	81
Beryllium (mg/kg)	N/A	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cadmium (mg/kg)	1.8[*3]	0.22	1.8	0.19	0.20	0.54	0.30	0.14	0.57	0.30	0.10	0.25	0.37
Chromium (mg/kg)	130[*1]	14	41	19	18	30	22	15	27	45	21	13	22
Copper (mg/kg)	2,300[*4]	84	110	75	58	180	190	99	84	38	17	40	60
Lead (mg/kg)	450[*1]	200	180	98	90	340	**1200**	140	170	79	17	56	70
Mercury (mg/kg)	8.0[*3]	0.34	0.41	0.16	0.13	0.61	0.75	0.40	0.23	0.19	0.10	0.10	0.10
Nickel (mg/kg)	130[*1]	25	33	28	21	42	26	18	31	17	20	18	11
Selenium (mg/kg)	120[*3]	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.36	<0.2	<0.2
Vanadium (mg/kg)	-	18	41	19	15	28	26	14	28	52	21	9.2	29

Soil - 11 August 2010													
Contaminant	SGV / GAC	TP1 1.50 m	TP1 3.50 m	TP2 1.50 m	TP2 3.50 m	TP3 0.50 m	TP3 2.50 m	TP4 1.50 m	TP4 2.50 m	TP5 1.50 m	TP5 2.50 m	TP6 0.50 m	TP6 3.50 m
Zinc (mg/kg)	3,800 *3	140	250	140	120	290	270	180	320	120	37	110	80
TPH (mg/kg)	-	290	430	200	190	210	170	270	130	590	< 10	73	< 10
pH	-	8.3	8.2	8.1	8.2	8.0	9.4	7.8	8.0	8.2	6.8	7.8	6.8

All measurements in metres represent metres below ground level.
*1 CLEA Soil Guideline Value (SGV) – residential
*2 CLEA SGV – commercial
*3 CLEA SGV – allotments
*4 LQM & CIEH. 2009. *The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd Ed.)*

The Mean Value Tests indicate that the US_{95} value for arsenic is 28.23 mg/kg, lead is 220.30 mg/kg and for barium is 244.67 mg/kg, and therefore the site is below the SGV for arsenic and lead and above the SGV for barium.

Groundwater was sampled within TP2 and results of the analyses have been compared to EQS / GAC (see Table 3) as presented in Table 7.

Table 5– Analysis results for ground water samples.

Water		11 August 2010
Contaminant	**EQS / GAC**	**TP2 3.50m bgl**
Cyanide (total) (mg/l)	0.05*1	< 0.05
Sulphide (mg/l)	None	<0.050
Total Organic Carbon (mg/l)	N/A	34
Sulphate (mg/l)	250*1	12
Arsenic (µg/l)	10*2	1.5
Barium (µg/l)	100*1	**180**
Beryllium (mg/l)	N/A	<1
Boron (µg/l)	1000*2	260
Cadmium (µg/l)	5*1	<0.08
Chromium (total) (µg/l)	50*1	<1.0
Copper (µg/l)	50*1	<1.0
Lead (µg/l)	50*1	<1.0
Mercury (µg/l)	1*2	<0.50
Nickel (µg/l)	20*2	<1.0
Selenium (µg/l)	10*1	<1.0
Vanadium (µg/l)	None	<1.0
Zinc (µg/l)	3000*1	46
Total Petroleum Hydrocarbons (TPH) (µg/l)	50*1	<10

pH	6.5 – 10 *2	7.1
*1 Surface Waters (Abstraction for Drinking Water) (Classification) Regulations 1996 *2 Water Supply (Water Quality) Regulations 2000		

6.0 CONCLUSIONS AND RECOMMENDATIONS

Soil samples taken during the site investigation on 11th August 2010 indicated elevated levels of arsenic, barium and lead that pose a potential risk to human health.

The groundwater sample taken during the site investigation on 11th August 2010 indicated elevated levels of barium that poses a risk to human health.

It is recommended that further samples are obtained for analysis due to elevated levels indicated above.

7.0 REFERENCES

- BS 10175:2011 *Investigation of potentially contaminated sites: Code of Practice*
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