

Review of data relevant to the characterisation of leachate from Burgess Field waste dump, Oxford

Groundwater Programme Internal Report IR/15/037



BRITISH GEOLOGICAL SURVEY

GROUNDWATER PROGRAMME INTERNAL REPORT IR/15/037

Review of data relevant to the characterisation of leachate from Burgess Field waste dump, Oxford

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Aerial view of Burgess Field waste dump during flooding in January 2007.

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Summary

This report provides a summary of data available for the Burgess Field waste dump, Oxford. These include historical data records held by the Oxford City Council for free gas concentrations, selected inorganic chemistry and groundwater levels (between 1989 and 1996). They also include inorganic chemistry and groundwater levels collected from selected piezometers by the British Geological Survey at the site since 2011. These data are used to characterise the leachate in groundwaters within and below the dump, addressing spatial variability and long term changes.

Burgess field is an unlined historical waste dump located on the floodplain of the River Thames on the eastern side of Port Meadow, in the vicinity of the city of Oxford. The waste dump was closed in 1980 and the area is now a mixed grassland and woodland nature reserve. Subsequent monitoring of the site included a network of seven boreholes installed into the waste dump in 1991; of the seven original sites, only three could be located for the field campaign from 2011 onwards.

Groundwater levels at Burgess field exhibit spatial and temporal variability and have been found to rise above the base of the dump at some borehole locations, producing a saturated zone within the waste material. There is potential interaction of leachate with groundwater under all of the waste material as the dump is unlined.

Uneven settling and the heterogeneous composition of waste is highlighted by spatial and temporal variation in the dissolved gas, groundwater level data and the inorganic chemistry.

Free gas concentrations between 1989 and 1996 show the following:

- CO₂ and O₂ are highly variable and mirror each other at all sites; where one increases in concentration the other is seen to decrease in concentration
- Methane concentrations are variable: there was no methane detected in the southern sites; methane was detected in the northern sites, indicating the occurrence of methanogenisis, apart from the most northerly site where is has not been detected.

Long term trends in inorganic chemistry for the three sites that were sampled during both the 1990s and the 2010s show:

- Spatial variation in the concentrations of Fe, Mn and B is maintained across the two sampling periods;
- Conductivity is generally higher in the current period than during the 1990s, reflecting higher SO₄ and HCO₃ concentrations;
- Dissolved N concentrations vary spatially and temporally but the reduced form of nitrogen (NH₄) is dominant. Concentrations of NH₄ were high during the two periods of study showing a large plume of NH₄ below/within the landfill.

In summary, this points to a heterogeneous waste dump where fill is spatially variable in composition, and breakdown of the material is at different stages. This reflects the long period during which waste was dumped in the area (1930s-1980) and the potentially varied nature of this material, for which there is very limited information. The data collected on Burgess Field shows: it is a source of pollution in the form of NH₄, SO₄, Fe, and Mn; that conditions are anaerobic; and HCO₃ concentrations are buffering the pH so acidic conditions are not occurring.

1 Introduction

Burgess Field is an unlined waste dump located on the floodplain of the River Thames in the city of Oxford (Figure 1). It is situated on the eastern side of Port Meadow, a component of the Oxford Meadows Special Area of Conservation. The site was operational from 1937 to 1980 during which time it accepted all categories of waste (Gooddy et al 2014). The site has been restored to mixed grassland and woodland and is now a nature reserve. Although the dump was capped in 1980, rubbish is visible along the western margin of the waste dump which suggests it is not well sealed.

The waste dump is underlain by a silty clay alluvium, less than 1 m thick and 4 to 5 m of river terrace gravels. As the landfill is unlined, groundwater can flow laterally through the saturated part of the landfill. Precipitation flows through the unsaturated zone of the landfill mixing with leachate before infiltrating the underlying shallow aquifer. Ongoing studies by the British Geological Survey (BGS) are investigating the influence of Burgess Field waste dump on the down-gradient groundwater quality (Macdonald et al 2012; Gooddy et al 2014). In this report, recent data collected from boreholes within the boundary of the waste dump are combined with those collected as part of previous studies, to better characterise the contamination being input to the shallow aquifer from the dump.

The results from the analyses of BGS samples are combined with the historical data to help better understand, within the boundary of the waste dump, the following:

- 1. Spatial variation in water quality;
- 2. Seasonal variation in water quality;
- 3. Long term changes in water quality.



Figure 1 Burgess Field study area

2 Methodology

After the closure and landscaping of Burgess Field, gas and groundwater monitoring boreholes were installed along the boundaries of the waste dump. Records obtained on the waste dump suggest the monitoring network was put in place by Oxfordshire County Council and that subsequent sampling was undertaken by the Environment Agency. Seven gas and groundwater and six groundwater-only monitoring boreholes were completed. The logs of the boreholes are presented in Appendix A. All the holes were drilled through the waste, and into the underlying superficial geology deposits; all but one (G13) were finished within the gravels. It is not known where these boreholes were screened. The original drilling dates and depths are shown in Table 1 and the locations are shown in Figure 2.

Borehole	Grid references	Date of drilling	Depth	Туре
GBH1	449968 207974	21 Nov 1991	4.40 m	Gas &Water
GBH3	449801 208349	13 Nov 1991	5.50 m	Gas &Water
GBH5	449545 208649	14 Nov 1991	5.60 m	Gas &Water
GBH7	449643 208964	18 Nov 1991	5.80 m	Gas &Water
GBH9	449920 208838	19 Nov 1991	5.50 m	Gas &Water
GBH11	450072 208469	20 Nov 1991	5.55 m	Gas &Water
G2	449852 208160	12 Nov 1991	5.30 m	Gas
G4	449682 208514	12 Nov 1991	3.70 m	Gas
G6	449656 208787	13 Nov 1991	3.10 m	Gas
G8	449844 208995	13 Nov 1991	4.80 m	Gas
GI0	450003 208656	14 Nov 1991	5.60 m	Gas
G12	450110 208271	14 Nov 1991	4.70 m	Gas
G13	450152 208074	15 Nov 1991	2.70 m	Gas

Table 1Burgess Field monitoring network.

Historical data obtained for the Burgess Field are summarised in Table 2. The method of collection and analysis was not documented in records received by BGS. It has not been possible to confirm if the data obtained for the sites include all those available. All those data sheets obtained by BGS have been replicated in Appendix B.

BGS staff attempted to find all the monitoring boreholes listed in Table 1, however, only boreholes GBH3, GBH5 and GBH9 were found. Sampling rounds undertaken that included these boreholes are listed in Table 2. Hydrochemical and water level sampling has been carried out at GBH3, GBH5 and GBH9 (seasonally) by BGS since 2011. Groundwater levels were determined prior to sampling using a calibrated waterlevel dip meter.

A WhaleTM Gulper 320 high capacity pump was used to purge the boreholes before sampling with a SolinstTM model 410 peristaltic pump with Pt cured silicon pump tubing and PE downhole tubing where waterlevels allowed. Where waterlevels were beyond the capacity of the peristaltic pump, samples were taken using the Gulper. Inorganic samples were collected in a rinsed plastic beaker and filtered through 0.45 μ m cellulose nitrate filters into clean Nalgene LDPE or HDPE bottles. DOC/Fluorescence samples were collected into a stainless steel cup and filtered through a 0.45 μ m silver filter using a stainless steel filter holder and a glass syringe. A HACH alkalinity titration was performed (using 1.6 N or 0.16 N sulphuric acid cartridges and a bromocresol green indicator) at site where the colour of the sample allowed otherwise HCO₃ was determined at the BGS Keyworth laboratories along with other inorganic parameters.



Figure 2 Burgess Field monitoring network.

3 Results and interpretation

3.1 LANDFILL GAS

The landfill gas survey undertaken in 1989 sampled the subsoil every 15 m along the eastern boundary of Burgess Field and no methane was detected.

From 1991 to 1996 gas samples were taken from the Burgess Field borehole network by contractors on behalf of Oxfordshire County Council. Free gas was sampled from above the groundwater in the boreholes. The following is a summary of the measured methane (CH_4), carbon dioxide (CO_2) and oxygen (O_2) concentrations reported.

During sampling, groundwater level was not always measured and therefore it has not been possible to contrast gas concentrations with groundwater levels within the waste dump. Table 2 summarizes the available free gas data (number of samples, min, max and average concentration) and Figure 3 spatially summarizes the average concentrations of CH_4 , CO_2 and O_2 per site. Averages were calculated as the arithmetic mean, any sample below the detection limit (<DL) were treated as zero but left in the calculation.

Table 2	Maximum, minimum and average values of CH ₄ , CO ₂ and O ₂ (ppm). Sample
concentrat	ions below detection limit are represented by ' <dl', 'n'="" denotes="" number="" of<="" td=""></dl',>
samples.	

Site	n	CH ₄			CO ₂			O ₂		
		min	max	mean	min	max	mean	min	max	mean
GBH1	11	<dl< td=""><td><dl< td=""><td><dl< td=""><td>2000</td><td>89000</td><td>26000</td><td>103000</td><td>210000</td><td>176000</td></dl<></td></dl<></td></dl<>	<dl< td=""><td><dl< td=""><td>2000</td><td>89000</td><td>26000</td><td>103000</td><td>210000</td><td>176000</td></dl<></td></dl<>	<dl< td=""><td>2000</td><td>89000</td><td>26000</td><td>103000</td><td>210000</td><td>176000</td></dl<>	2000	89000	26000	103000	210000	176000
G2	11	<dl< td=""><td><dl< td=""><td><dl< td=""><td>25000</td><td>146000</td><td>95000</td><td>12000</td><td>191000</td><td>97000</td></dl<></td></dl<></td></dl<>	<dl< td=""><td><dl< td=""><td>25000</td><td>146000</td><td>95000</td><td>12000</td><td>191000</td><td>97000</td></dl<></td></dl<>	<dl< td=""><td>25000</td><td>146000</td><td>95000</td><td>12000</td><td>191000</td><td>97000</td></dl<>	25000	146000	95000	12000	191000	97000
GBH3	10	<dl< td=""><td>36000</td><td>8000</td><td>5000</td><td>186000</td><td>51000</td><td><dl< td=""><td>199000</td><td>146000</td></dl<></td></dl<>	36000	8000	5000	186000	51000	<dl< td=""><td>199000</td><td>146000</td></dl<>	199000	146000
G4	11	21000	228000	161000	72000	243000	199000	<dl< td=""><td>142000</td><td>24000</td></dl<>	142000	24000
GBH5	10	<dl< td=""><td>2000</td><td>200</td><td>9000</td><td>43000</td><td>21000</td><td>159000</td><td>199000</td><td>186000</td></dl<>	2000	200	9000	43000	21000	159000	199000	186000
G6	11	<dl< td=""><td>112000</td><td>30000</td><td>6000</td><td>211000</td><td>98000</td><td><dl< td=""><td>203000</td><td>111000</td></dl<></td></dl<>	112000	30000	6000	211000	98000	<dl< td=""><td>203000</td><td>111000</td></dl<>	203000	111000
GBH7	11	2000	331000	143000	9000	304000	199000	<dl< td=""><td>204000</td><td>44000</td></dl<>	204000	44000
G8	8	<dl< td=""><td><dl< td=""><td><dl< td=""><td>16000</td><td>97000</td><td>55000</td><td>108000</td><td>203000</td><td>149000</td></dl<></td></dl<></td></dl<>	<dl< td=""><td><dl< td=""><td>16000</td><td>97000</td><td>55000</td><td>108000</td><td>203000</td><td>149000</td></dl<></td></dl<>	<dl< td=""><td>16000</td><td>97000</td><td>55000</td><td>108000</td><td>203000</td><td>149000</td></dl<>	16000	97000	55000	108000	203000	149000
GBH9	11	<dl< td=""><td>408000</td><td>78000</td><td><dl< td=""><td>346000</td><td>125000</td><td>3000</td><td>209000</td><td>87000</td></dl<></td></dl<>	408000	78000	<dl< td=""><td>346000</td><td>125000</td><td>3000</td><td>209000</td><td>87000</td></dl<>	346000	125000	3000	209000	87000
G10	11	29000	356000	202000	59000	289000	201000	<dl< td=""><td>163000</td><td>42000</td></dl<>	163000	42000
GBH11	11	<dl< td=""><td>66000</td><td>11000</td><td><dl< td=""><td>204000</td><td>63000</td><td>5000</td><td>207000</td><td>139000</td></dl<></td></dl<>	66000	11000	<dl< td=""><td>204000</td><td>63000</td><td>5000</td><td>207000</td><td>139000</td></dl<>	204000	63000	5000	207000	139000
G12	6	<dl< td=""><td><dl< td=""><td><dl< td=""><td>37000</td><td>95000</td><td>59000</td><td>50000</td><td>163000</td><td>123000</td></dl<></td></dl<></td></dl<>	<dl< td=""><td><dl< td=""><td>37000</td><td>95000</td><td>59000</td><td>50000</td><td>163000</td><td>123000</td></dl<></td></dl<>	<dl< td=""><td>37000</td><td>95000</td><td>59000</td><td>50000</td><td>163000</td><td>123000</td></dl<>	37000	95000	59000	50000	163000	123000
G13	5	<dl< td=""><td><dl< td=""><td><dl< td=""><td>30000</td><td>127000</td><td>72000</td><td>91000</td><td>187000</td><td>137000</td></dl<></td></dl<></td></dl<>	<dl< td=""><td><dl< td=""><td>30000</td><td>127000</td><td>72000</td><td>91000</td><td>187000</td><td>137000</td></dl<></td></dl<>	<dl< td=""><td>30000</td><td>127000</td><td>72000</td><td>91000</td><td>187000</td><td>137000</td></dl<>	30000	127000	72000	91000	187000	137000



Figure 3 Summary of arithmetic mean of gas concentrations (ppm) found at each site. CH_4 (purple bar), CO_2 (green bar) and O_2 (brown bar). Refer to Table 2 for relative scale of gas concentrations.

Appendix D shows the temporal variation of all three free gases by site. A summary of observations made on data for each gas type is given in the following sub sections; CO_2 and O_2 have been summarized together as they react in parallel. No annual or seasonal cycle was seen, possibly due to the scarcity of the data. The dominant gas varies with site.

3.1.1 Methane

Concentrations of methane were consistently below the detection limit at GBH1, G2, G8, G12 and G13. While the highest level of methane measured at the site was at GBH9 (408,000 ppm, Nov 1991). Below is a summary per site:

GBH1	concentrations below detection limits
G2	concentrations below detection limits
GBH3	below detection limits during most sampling events. only rising in concentration intermittently. The highest concentration measured was 36,000 ppm in Dec 1993.
G4	elevated concentrations, never falling below 21,000 ppm, with an average of approx. 160,000 ppm
GBH5	only goes above detection limits once, during the study rising to 2000 ppm in June 1993
G6	concentrations often elevated with an average of 30,000 ppm and a maximum concentration of 112,000 ppm - concentrations were also measured below detection limits on 3 occasions
GBH7	overall reduction in concentrations over time but remained high at the end of the study (150,000 ppm 12/1996)
G8	concentrations below detection limits.
GBH9	initially high concentration (408,000 ppm) with an overall trend of decreasing concentrations
G10	average concentrations higher than CO_2 and O_2 for most of the study. From June 1995 concentrations drop significantly although never go below 29,000 ppm
GBH11	on average low, with highest concentration in August 1992 (66,000 ppm) - the only time methane is higher than either of the other gases
G12	concentrations below detection limits.
G13	concentrations below detection limits.

3.1.2 Carbon dioxide and oxygen

Carbon dioxide was detected at every site although concentrations were highly variable; some concentrations were below detection at GBH9 and GBH11 on at least one occasion. The highest detected concentration was 346000 ppm at GBH9.

Oxygen was detected at all of the sites, however, concentrations were below the level of detection on at least one occasion at GBH3, G4, G6, GBH7 and G10. The highest concentration was detected at GBH9. CO_2 and O_2 are seen to mirror each other at all sites; where one increases in concentration the other is seen to decrease in concentration. Below is a summary of CO_2 and O_2 per site:

GBH1	O_2 concentrations are always consistently the highest. There appears to be no annual cycle.
G2	CO_2 and O_2 concentration reverse in dominance over time with both fluctuating about the approximate same mean (95000 ppm)
GBH3	CO_2 and O_2 concentrations again mirror each other around a similar mean however, oxygen is on average higher although it does go below detection on one occasion.
G4	O ₂ is lower on average dipping below detection limits on one occasion.
GBH5	O_2 is substantially higher that CO_2 (as can be seen from table 1).
G6	Average concentrations of CO_2 and O_2 are within the same order of magnitude and maximum concentrations are similar at 21100 ppm and 203000 ppm for CO_2 and O_2 respectively but they are seen to cross over in dominance regularly.

GBH7	CO_2 concentrations are overall higher than O_2 concentrations and there are some changes in dominance during the study period.
G8	O ₂ is higher in concentration throughout the study.
GBH9	CO_2 concentrations are overall higher than O_2 concentrations but CO_2 and O_2 change dominance regularly.
G10	CO_2 concentrations are on average higher than O_2 concentrations during most of the study but from June 1995 this changes coinciding with the reduction in methane concentration (average CO_2 and O_2 201273 ppm, 41636 ppm respectively)
GBH1 1	O_2 is on average higher than CO_2 but this is reversed during the two 1992 samples.
G12	Gas concentrations were only measured on 6 occasions between November 1991 and
	December 1996. Over all O_2 is higher than CO_2 but this is reversed on 2 occasions in 1992.
G13	Similarly, gas concentrations were only measured on 5 occasions between Nov 1991 and June 1993. Concentrations of O_2 are again higher than CO_2 reversing in dominance only once during the study.

3.1.3 Interpretation of gas results

Concentrations of CH₄, CO₂, and O₂ vary significantly spatially and temporally, with no one gas consistently the highest across Burgess Field. Methane was not detected at five of the sites, including the four sites in the south (GBH1, G2, G12 and G13) and G8 in the far north. CH₄ was only measured above detection limit once at GBH5. Methane concentrations are seen to be elevated at G4, GBH7, GBH9 and G10. Where methane has been detected methanogenesis is occurring in the vicinity of the gas sampling port or upflow of the port.

Oxygen and CO_2 are seen to mirror each other but the concentrations can be seen to change in dominance during the study but always as one increases in concentration the other decreases. Oxygen is on average higher than CO_2 at GBH1, GBH3, GBH5, G8, GBH 11, G12 and G13 and CO_2 is on average higher than O_2 at G4, GBH 7, GBH9 and G10. Oxygen and CO_2 have similar means at G2 and G6.

Overall the gas concentrations point to the conclusion that waste is not in a homogenous layer across the site and/or is decomposing at differing rates in different areas.

No conclusions could be drawn between groundwater level and the concentration of free gas due to the small amount of landfill gas and groundwater level data.

3.2 HYDROCHEMISTRY

Below is a summary of the Burgess Field groundwater hydrochemistry and groundwater levels. Local council data from 1991 to 1994 (GBH1, 3, 5, 9 and G11) is presented along with more modern BGS data from 2011 to February 2015 (GBH3, 5, and 9 only). Availability of data is sparse and variable per site. Appendix E provides plots of all anions, cations and N species per site while selected single ion plots for all sites are presented below.

3.2.1 Burgess Field groundwater levels

Groundwater level data are available both from the 1990s and recent monitoring campaigns. However, resurveying of the datums for boreholes used within the recent sampling campaign indicates that the ground level has fallen, most likely due to settlement of the waste dump contents. Groundwater levels from the 1990s campaign are measured relative to the earlier

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datums; groundwater levels from the recent campaign are measured relative to the newly surveyed datums. Sites at which there are a substantial number of measurements during both periods are shown in Figures 4 to 6; the Figures include the base of waste, base of alluvium (where it exists), and the base of the borehole (other groundwater level plots are provided in Appendix C). The figures show a general decrease in groundwater levels in recent years. There is some uncertainty over the measured datums of the 1990s datums which needs to be taken into account when interpreting these results. Groundwater sampled from horizons within the waste dump could potentially have a stronger leachate component than groundwater solely from the gravel aquifer. In some boreholes (e.g.GBH3 and GBH9), the groundwater level rises above the base of the waste dump seasonally. This can cause enhanced decomposition and transport of emissions during periods of very high groundwater levels (Neuhold 2013)



Figure 4 Groundwater levels in monitoring borehole GBH3 in Burgess Field waste dump



Figure 5 Groundwater levels in monitoring borehole GBH5 in Burgess Field waste dump



Figure 6 Groundwater levels in monitoring borehole GBH9 in Burgess Field waste dump

The groundwater flow gradient within/beneath the waste dump is difficult to assess given the limited number of data points, however, those levels available indicate that the flow directions implied by the groundwater contours produced by Macdonald et al (2012) for 2011 (Figure 7) are generally consistent.



Figure 7 Hand-drawn groundwater contours from levels measured 3-7 October 2011 (from Macdonald et al 2012)



Figure 8 Graph showing the depth of groundwater in the piezometer immediately prior to sampling.

3.2.2 Conductivity and Major Ions

Conductivity is a good indicator of total dissolved ions. Conductivity measurements (Figure 9) are included from field measurements on unfiltered samples and laboratory measurements on filtered samples. This may cause some variability within the data as after sampling some dissolved ions will drop out of solution and be filtered out or sit on the bottom of the sample. No seasonal trend can be seen to indicate the influence of recharge diluting the leachate but, as samples are taken from depth within the landfill, mixing will occur to mask this. With the spread and paucity of data, no reliable pattern can be seen between the two sampling campaigns but on average the conductivity at GBH 3 is higher in the recent sampling campaign compared to that undertaken in the 1990s. In February 1993 and December 1994 conductivity dropped at GBH3 which coincided with lower than normal concentrations of Ca, Cl, K, Mg, SO₄, and NH₄. This points to dilution of the leachate at this time.



Figure 9 Conductivity (µS/cm) in boreholes within Burgess Field waste dump

A marked reduction in Cl concentration can be seen in GBH9 and GBH5 between the 1990s data and the more recent data, whereas at GBH3 it appears similar but less varied (figure 10). Chloride concentrations from piezometers within/below the landfill are not particularly high for landfill leachates, and are comparable to the spread of data presented for piezometers in Port Meadow (Stuart 2010) and the more modern Port Meadow data presented in Gooddy et al (2014). This may be due to a lack of initial soluble Cl in the landfill or because it has already dissipated.



Figure 10 Concentration of Cl (mg/l) in boreholes within Burgess Field waste dump.

Concentrations of HCO_3 are high compared with the concentrations at piezometers at Port Meadow not impacted by leachate across the landfill but vary with site and time. Figure 11 highlights the variation of concentrations measured at each site over time and Figure 12 shows the site average concentration to highlight the spatial variation.



Figure 11 Concentration of HCO₃ (mg/l) in boreholes within Burgess Field waste dump.

As it can be seen, HCO_3 values are elevated above background concentrations and, at times, above those in Port Meadow as reported by Stuart (2010). High HCO_3 produced from the breakdown of organic waste will act to buffer the pH to stop the site becoming acidic.



Figure 12 Average concentrations of HCO₃ (mg/l) per site.

Concentrations of SO₄ in the area of the waste dump are high across the site. The high temporal variability within boreholes (especially GBH 3 and 5) is highlighted in Figure 13. The arithmetic average per site has been used to look for spatial variability across Burgess Field (Figure 14). GBH3 and GBH 5 in the east of the area have the highest average SO₄ concentrations but also the greatest variability with time. Sulphate concentrations are in part controlled by the redox couple SO_4^{2-}/S^{2-} ; in the reduced state there is an absence/low concentrations of SO₄ (Stuart and Lapworth 2011). This redox pair has been used by Janowski and Acworth (1997) to define the anaerobic central zone of a landfill leachate plume where S, N, Fe and Mn are seen in their reduced form. We do not have data for S but the concentrations of SO₄ are still elevated at Burgess Field.

Concentrations in GBH9 and 11 are closer to the concentrations reported in Port Meadow by Macdonald et al 2012 while elevated concentrations are seen elsewhere in Burgess Field. This



points to low/incomplete SO_4 reduction in the area. It is possible that the system is not yet in equilibrium due to high SO4 load.

Figure 13 Concentration of SO₄ (mg/l) in boreholes within Burgess Field waste dump.



Figure 14 Average SO₄ concentration per site.

The groundwaters across the site are mostly $HCO_3 - Ca$ (GBH3, GBH7, GBH 9 and GBH 11) to $HCO_3 - Ca/Mg$ (GBH1) dominated waters. GBH5 shows variable dominance during the 1990s and in Feb 1993 SO₄ became the dominant anion.

Due to the paucity of data it is difficult to pick out seasonal or temporal trends within and between the two sampling campaigns in Burgess Field but the trilinear plot for GBH11 (Figure E17) seems to show increasing HCO₃ and Ca dominance with time. GBH1 (Figure E12) and GBH 7 (Figure E15) plots show little variation with time. There is slight variation within GBH3 (Figure E13) but all are Ca- HCO₃ dominated water with the more recent monitoring producing slightly higher SO₄ dominance and concentrations than the samples in the 1990's. Since 2011 GBH 5 (Figure E14) has been Ca-HCO₃ dominant.

3.2.3 Boron



Figure 15 Concentration of Boron (µg/l) in boreholes within Burgess Field waste dump.

Boron (B) concentrations (Figure 15) are variable across the landfill being higher at the western edge than the eastern edge (GBH 9) but again only a few sites were sampled. Overall, B concentrations appear to be stable over the monitoring period at each location. The highest concentrations are seen in GBH5 and GBH1. Boron has been used as a tracer for sewage discharge and landfill leachate in the past, as B concentrations are elevated above the natural background concentrations within the landfill it could be used to trace the leachate plume in Port Meadow.

3.2.4 Redox sensitive ions.

Concentrations of NH₄ and TON (concentrations of NO₃-N + NO₂-N) were measured in the 1990s; since 2011 NH₄, NO₃ and NO₂ concentrations have been measured. The concentrations per site for these ions can be found in graphical form in Appendix E. Gooddy et al (2014) reports the findings of a study to look at N dynamics in the peri-urban environment, conducted in the Port Meadow area (including Burgess Field and the River Thames). They concluded, from N isotopes, N speciation and dissolved nitrous oxide gas, that the dominant source of nitrogen in the floodplain is NH₄ originating from the landfill. Their results show that some nitrification of the NH₄ has occurred along with some denitrification of the resultant nitrate. This is seen in the results presented here as NO₃ concentrations are detectable and occasionally increase over time (eg GBH9, where in Oct 2011 NO₃ was 47.7 mg/l). Concentrations of NH₄ remained high during the two periods of study showing a large plume of NH₄ below/within the landfill.

Concentration of NH_4 are higher than concentrations of TON (NO_3 and NO_2 in the more modern data) at all sites except GBH9 where in Oct 2011 NO_3 (at 47.7 mg/l) is elevated and higher than NH_4 . It returned to its normal low levels during the next sampling round. The increased NO_3 levels within GBH9 during Oct 2011 cannot be explained by being unusually low or high groundwater levels during sampling as the groundwater levels were lower during other summers and are higher most winters; sampling is at the beginning of the recharge period. This may be due to aggressive pumping in GBH9 at this time as there is usually little water in this piezometer. This was, however, the first round of sampling since 1994 so may indicate stagnant water in the locality of the borehole that has allowed nitrification to occur.

Concentrations of NH_4 within the landfill are between 1.1 and 186 mg/l (Figure 16). Average concentrations per site are plotted in Figure 17. The highest average concentrations are seen in the east of the landfill. GBH3s average concentration is a quarter of the average concentration seen at GBH11 but GBH11 shows the greatest variability in concentration over time. The NO₃/

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NH₄ redox pair has also been used in literature to define zones within landfill leachate. The data indicates that the reduced form of N is dominant in the vicinity of the landfill.



Figure 16 Concentrations of NH₄(mg/l) in boreholes within Burgess Field waste dump.



Figure 17 Average NH_4 (mg/l) concentration per site.



Figure 18 Average Fe (μ g/l) concentration per site.

Iron (Fe) is another redox-sensitive ion and dissolved Fe concentrations are very high across the site (Figure 18), as expected of an anaerobic domestic landfill. Dissolved Fe at near neutral pH (pH's about 6.4 to 7.2 across site) can indicate Fe reduction (Christensen et al 2000).

GBH7s average concentration of 58,520 μ g/l is skewed by one concentration of 139,882 μ g/l. As can be seen from Figure 19, this concentration is abnormally high. The lowest average Fe concentrations are seen at the front of the landfill.



Figure 19 Concentration of Fe (µg/l) in boreholes within Burgess Field waste dump.



Figure 20 Average Mn (µg/l) concentration per site.



Figure 21 Concentration of Mn (µg/l) in boreholes within Burgess Field waste dump.

Manganese (Mn) can be found in the dissolved form in anaerobic waters as the reduced form is more soluble; the oxidized form is solid and has a low solubility in groundwaters with near neutral pH. In all piezometers, Mn is to be found in the dissolved (reduced) form. As can be seen in Figure 21, concentrations of Mn are stable and high in GBH5, have increased in GBH 3 and look to have decreased in GBH 9 over time. Higher average concentrations are found at the front of the landfill (Figure 20).

3.2.5 Lithium

Concentrations of lithium (Li) within Burgess Field are elevated above the expected background concentrations when compared with the median Li concentrations in UK aquifers, for example median concentrations of 0.8 to $34 \mu g/l$ in the Chalk (Shand et al 2007), especially in the east of the area. Li can be found naturally in clay minerals, pegmatites and silicate minerals but may also have an anthropogenic source within the landfill. Once in solution Li is much less easily sorbed than other cations and tends to increase in concentration with residence time. The different sampling points within the landfill appear to have distinct Li concentrations and may represent different sources within the landfill of different rates of flushing and residence times within the landfill.



Figure 22 Concentration of Li (µg/l) in boreholes within Burgess Field waste dump.

3.2.6 Phosphate chemistry

During the more recent sampling events, samples from GBH3, 5 and 9 were analysed for total dissolved phosphate (TDP), total phosphate (TP), and soluble reactive phosphate along with the more usual HPO₄. Concentrations are shown graphically in Figures 18 to 20 in Appendix E. Concentrations of phosphate are not seen to be high in any of these forms but the particulate form (TP) of the nutrient is dominant. The general trends in the phosphate chemistry within the 3 boreholes are summarized below:

- GBH3 shows a general reduction in TDP and TP concentration over time showing a general reduction of mobile phosphate in the source with time.
- At GBH 5 a general downward trend in TP is marred by the low concentrations seen during August 2013 when water levels in this piezometer were the lowest ever seen. This could also be showing a general decrease in mobile particulate phosphate with time.
- Phosphate chemistry is variable at GBH9 with no obvious driver.

3.3 INTERPRETATION OF HYDROCHEMISTRY

Variability of groundwater levels prior to sampling and the variability of depth of water within each piezometer over time shows seasonal variation and again hints at uneven settling within the site or a change in drainage pattern over time. Unfortunately the site has only been surveyed once so we are not able to verify this.

The pH is variable spatially and temporally.

Landfill zonation can be defined by redox sensitive ion (Christensen et al 2001) including the NO_3/NH_4 redox pair and Stuart (2010) defines the NO_3 reducing zone at Port Meadow. High concentrations of NH_4 and low TON/NO₃ are indicative of reduction of NO_3 as well as microbial degradation of organic nitrogen (Stuart and Lapworth 2011). A spike in concentration of NO_3 at GBH 9 and reduction in concentration of NH_4 in Oct 2011, as discussed above, is unusual but could indicate a local change in this redox pair as could the variation of NH_4 over time within each piezometer.

Jankowski and Acworth (1997) defines the central zone as an anaerobic zone which has the highest concentrations of S, NH₄, Fe, Mn, HCO₃ and TIC with the pH occurring in a narrow range indicative of pH buffering. However they continue by defining the zone as having an absence of SO₄ and NO₃. Transition zone 1 is defined as being anaerobic with traces of sulphate and NH₄, Fe, Mn, HCO₃, with TIC still elevated above the background but lower than in the Central Zone. An anaerobic central zone within the leachate has been seen at many sites (Christensen et al 2001)

In Burgess Field we have reduced Mn, Fe, N (NH₄), but SO_4 is still elevated in this area as the redox pair hasn't had time to reach an equilibrium due to a high amount of SO_4 in the original material. Or the high concentrations of SO_4 are due to microbial oxidation of iron sulphides in response to water level fluctuations as oxidised water enters the landfill during times of heavy rain. (Jorstad et al 2004). Christensen et al (2000) note that the contaminant plume from a landfill is unlikely to be in internal equilibrium especially as several of the redox processes have very slow kinetics.

4 Conclusions

This report has brought together data on free gases, groundwater chemistry and groundwater levels from the Burgess Field waste dump, Oxford, to assess the nature of leachate in groundwaters that are in the gravel aquifer below the dump and that temporarily saturate waste material within the dump; addressing spatial variability and long term changes. Sampling was

undertaken in the 1990s by environmental consultants and in the 2010s by the British Geological Survey.

Modern lined landfills are designed to prevent groundwater entering the landfill to reduce the risk of associated instability or reduction in effectiveness of engineering controls or environmental protection measures, and manage the risk to the environment. The geological barrier of a modern landfill must also provide sufficient attenuation to prevent a potential risk to soil and groundwater during the life-cycle of the site. This is not the case with Burgess Field; due to the lack of any capping or lining of the base, rainfall is able to infiltrate into the dump, with the resulting leachate free to enter the underlying aquifer. In addition, groundwater levels measured in Burgess field in recent years show that in some locations there is seasonal saturation of the base of the dump, enhancing movement of leachate into the underlying gravel aquifer.

Of the seven groundwater monitoring sites originally constructed within the Burgess Field waste dump in 1991, only three could be located in the 2010s field campaign; these are widely spaced and interpolation/extrapolation from these is not advisable. Therefore it is not possible to identify if saturation of the waste dump due to rising groundwater is focussed in specific areas of the dump. Datums for measuring groundwater levels have changed during the past two decades due to subsidence of the surface of the dump and therefore recent measurements of groundwater levels cannot be compared with those from the 1990s. As a result it is not possible to say if there have been long-term changes in groundwater levels within the dump.

Spatial variation in free gas and water chemistry is seen within the sampled groundwater during each sampling round undertaken. Patterns of spatial and temporal variability are difficult to unravel. Average gas concentrations across the waste dump in the 1990s vary spatially; methane concentrations are low or undetectable in the sample sites in the south and generally higher in the north indicating methanogenisis occurring upflow of, or in the vicinity of the gas sampling ports. There are no free or dissolved gas data for the 2010s making it difficult to assess if these patterns of methanogenisis persist.

Spatial variation is also seen within the dissolved N species, with no consistent pattern although the reduced form of N, NH₄, is dominant across the site.

When looking for long term trends only GBH3, 5 and 9 can be used as no other sites were sampled after the 1990s. Spatial variation can be seen in the concentrations of Fe, Mn and B at these 3 sites. Looking at all of the data, Fe exhibit consistent spatial variation always higher at GBH9 lower at GBH3 in both sets of data. B is always higher at GBH5, intermediate at GBH3 (where data exist) and lower at GBH9. There are no data for Mn for the 1990s but the data since 2011 show concentrations always less than $500\mu g/l$ at GBH9 and greater than $500\mu g/l$ at GBH3 and GBH5.

There is limited evidence of seasonal variation, however; in the 1990s at GBH3 and GBH5, conductivity, Ca, Cl, K, Mg, SO₄, and NH₄ were lower during two successive winter sampling events in comparison to the summer events, suggesting dilution.

A long term change has been seen in conductivity at GBH3 as, on average, conductivity is higher in the later sampling campaign than the 1990s, reflecting a higher concentration of ions such as SO_4 and HCO_3 at these points. These are both products of breakdown, and increasing conductivity may indicate less dilution or higher concentrations of these ions in this area.

In summary, this points to a heterogeneous waste dump where fill is spatially variable in composition, and breakdown of the material is at different stages. This reflects the long period during which waste was dumped in the area (1930s-1980), and potentially varied material, on which there is very limited information. The data collected on Burgess Field shows: it is a source of pollution in the form of NH₄, SO₄, Fe, and Mn; that conditions are anaerobic; and HCO₃ concentrations are buffering the pH so acidic conditions are not occurring.

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Appendix A Logs of gas and water monitoring boreholes within Burgess Field waste dump

To follow are pages copied from the original report on monitoring boreholes within the Burgess Field waste dump, prepared for Oxfordshire County Council by Soiltec Soils and Gas in November 1991



OXFORDSHIRE COUNTY COUNCIL PORT MEADOW LANDFILL SITE

MONITORING BOREHOLES SUMMARY

NOVEMBER, 1991



DRILLING SUMMARY

LANDFILL MONITORING BOREHOLES - PORT MEADOW

Borehole No	Date of Installation	Depth of Installation	Gas/Gas & Water	
GBH1	21 11 91	4.40 m	Gas & Water	
GBH3	13 11 91	5.50 m	Gas & Water	
GBH5	14 11 91	5.60 m	Gas & Water	
GBH7	18 11 91	5.80 m	Gas & Water	
GBH9	19 11 91	5.50 m	Gas & Water	
GBH11	20 11 91	5.55 m	Gas & Water	
G2	12 11 91	5.30 m	Gas	
G4	12 11 91	3.70 m	Gas	
G6	13 11 91	3.10 m	Gas	
G8	13 11 91	4.80 m	Gas	
G10	14 11 91	5.60 m	Gas	
G12	14 11 91	4.70 m	Gas	
G13	15 11 91	2.70 m	Gas	

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Date + Time of S	tart/Finish	13-	11-9	1	·.	•	Vehic	le No	Ē	2.	01	يك_	k/	2_			
DE	SCRIPT	ION OF	STRATA		DEPTH				S	AM	PLE	s					· .
Soft/Firm/ Stiff C	plour	Clayey · Silty	soil	Sand bar	to base		[·	Pene	tration		S.P.	T./C.	Р:Т		mms,		· . REMARK
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ate + Time of Star	e: (0622) 861350 Fax: I/Finish	(0622) 862752	91. "			Vehicl	e No.	E	20	72	ين. رچر	K	7		<i>,</i>
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IOW SAMPLES THU	End of days	drilling		5.50		•						•			
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Date + Time of St	art/Finish 20	-11-9	/			Vehic	le No	E	20	2	SI	1	2_	· · ·	
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Soft/Firm/	our Clayey	SOIL	Sand bands	to base		Γ	Pene	tration		S.P.	т./C.	P,T		mms.	REMARK
Loose/Dense Fine -	Coarse Sandy, etc.	. TYPE	Cobbles etc.	STRATA	Ņo	Туре	From	Ťο	bians	0 to 76	75 to	150 to	225 to	300 375 to to	
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SHOW SAMPLES TH	US : End of day:	s drilling	· · · ·	5.55		· · ·			┝─┤						
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DELAYS/BAD	ACCESS/PITS/HAR	STRATA etc						•		<u> </u>				<u> </u>	-
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- SOILTE Ledian Teleph	EC SOILS AND GAS LIM Farm Ind. Estate, Upper	ITED Street, Leeds, N (0622) 862752	r. Maidstone, Ke	ent ME17 1RZ.		Equip	ment in	Use	TAN	1	515	১ ০				
Date + Time of Sta	art/Finish <u>12</u>	<u>11 91</u>	·			Vehicl	e No	J3	579	LK	(n)					
DES	SCRIPTION OF	STRATA					·····	· S.	AMF	LE	s					
Soft/Firm/ Col	our Clayey	SOIL	Sand bands	to base		<u> </u>	Pene	tration_		S.P.	- Т./С	Р.Т.		mms.		REMARKS
Loose/Dense Fine Med	Coarse Sandy	TYPE	Cobbles etc.	STRATA	No	Туре	From	То	blows	0 10 75	75 ⁻ to	150 to	225 to 300	300 3 to 375 4	375 to	
1 1000	Start of days of	trilling		GL .	· ·						1.1.50	223		3/3		<u>.</u>
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SHOW SAMPLES TH	US : End of days	drilling ulk W Wat	er S Star	JS 30.	tion T		Cone	Penetra	tion	Test						
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SIZE (mm)	FROM (m)	TO (n	n)	OBSER	VATIC)N ^{• •}		DATE		тім	E	DE	РТН	INF	LOW	CASING
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DELAYS/BAD	ACCESS/PITS/HARD	STRATA etc.	·]	;				. •			.			<u> </u>		
Cause	rom (m	10(m) Tim		<u></u>	 ,				+		\rightarrow		•	╁──		· · · · · · · · · · · · · · · · · · ·
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SIGNATURES				FRVATION	S 0 -	Struck	Rate of	flow S		Fin			level	<u>l</u> . Drv		
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WEATHER : Fine Drizzling Raining / Stormy / Snow / Freezing

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SOILS AND GAS				Boreh	ole No.		<u> </u>					•	
Ledian Farm Ind. Estate, Upper Street, Leeds, Nr. Maids Telephone: (0622) 861350 Fax: (0622) 862752	stone, Ken	t ME17 1RZ.		Equip	mènt in	Use	<u>.</u> ()	NOT:	01	50			
Date + Time of Start/Finish <u>1& 11/91</u>				Vehicl	e No. ,_		53	12	LK	<u>, (</u>			
DESCRIPTION OF STRATA		DEPTH				SA	AMF	LE	S		<u> </u>		
Soft/Firm/ Stiff Colour Silty SOIL Sand	bands	to base of		_	Penet	ration	u	S.P.	T./C.P	T	m	ns.	REMARKS
Loose/Dense Fine - Coarse Sandy TYPE Cost Medium etc. TYPE etc.	bbles tc.	STRATA m	No	Туре	From	То	blans	to 75	/5 to 150	to 225 3	to to 100 37	to 5 450	
Start of days drilling		GL.											
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SHOW SAMPLES THUS End of days drilling		3.70									·		
U Undisturbed; D Disturbed; B Bulk; W Water;	S Stand	ard Penetra	tion Te	st; C	Cone	Penetra	tion 1	Fest					<u> </u>
		OBSER			<u></u>	ATER	<u> </u>	TIME	- 1-	DEPI			
250 GL 350	μ	a/0 .				DATE	┢			3.50	<u>, </u>		
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DELAYS/BAD ACCESS/PITS/HARD STRATA etc.			• •		_ .	· ·	1			·`		<u> </u>	
Cause From (m To (m) Time (hr)		-				·					Ţ		
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	STA	NDPIPE/P		ETER		ken (hr)	12	Jepti			UT Sea	ottom	Heading
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SIGNATURES DRIALER A CLIENT	OBSE	RVATIONS	: e.g. 5	Struck,	Rate of	flow, Se	aled	Fina	l stand	ding le	vel, Dr	v	
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SOILTEC SOILS AND GAS LIMITED	. ·	Boreh	ole No.	26	<u>, '</u>					•••	·
Ledian Farm Ind. Estate, Upper Street, Leeds, Nr. Maidstone, Kent ME17 1 Telephone: (0622) 861350 Fax; (0622) 862752	IRZ.	Equip	ment in	Use	<u>DA</u>	<u>ואס</u>	<u>ຄ</u>	15	<u>o</u> .	• •	<u> </u>
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 SOILTEC SOILS AND GAS LIMITE Ledian Farm Ind. Estate, Upper Sti Telephone: (0622) 861350 fax/(0	 D reet, Leeds, Nr. Maidstone, Kent ME17 1RZ. 632) 862752

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Date' + Time of Start/Finish $\frac{1.3}{1.1/21}$

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Soft Ground Daily Record

Town OxFORD

Site Name PORTMEDONS

Borehole No. Cg

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Appendix B Original gas and groundwater analysis result sheets from Burgess Field waste dump monitoring

To follow are pages from a series of reports prepared up to December 1996 that were prepared for Oxfordshire County Council and obtained from the Environment Agency.



Site: Port Meadow

Monitoring Data up to $16^{\rm th}$ December 1996 on CD in Tactical Planning

GAS CHEMISTRY DATA

OXFORDSHIRE COUNTY COUNCIL IN SITU MONITORING RESULTS FOR LANDFILL GAS

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	SITE 1	NAME	Port Mead	OW.		
l	DATE SAN	MPLED	26/11/91	SAMPLE	D BY :D.Ha	awley
1						
· .	BOREHO		% CH4	% CO2	₹02 I	COMMENTS
			I		1 17 10	Atmospherig Pressure -
	GBH1 CO					1017/8 mb
3	62 CDU2	, ,		1 07 90	1 12 50	
<u> </u>	GBR3	l I .		1930	1 12.50	l ISome of these horeholes have
	CRU5	1 "		01 40	18 10	heen drilled through waste
	GBRS				1 10.10	Les it is not surprising
	9 0	1	1 33 10	1 30 40		Ithat this quality of gas is
	68	l .		03 90	1 16.80	being produced GBH1 on the
	Свна	3 	40.80	34.60	00.40	lother hand most probably
1	G10	, 	19.40	20.00	02.30	represents virgin ground.
i	GBH11	1	02.80	07.60	13.00	There is no site lining or
i	G12	i	00.00	05.60	13.90	cap & so gas can vent freely
i	G13	İ	00.00	04.20	16.30	All housing etc. is east of
i		İ	i	Ì	i	the site with a railway line
i		Ì	Ì	Ì	1	& waterway separating the
İ	· ·	ł	1	ĺ	İ.	two.To the north & west of
ł			l .	1	i ·	the site is the meadow with
1		1	1	1	ł	allotments to the south.
- 1			ł		1	ļ
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Oxfordshire County Council in situ monitoring results for Landfill Gas

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		1 7 GH4 1			Comments	•
	грерсп (m) <u>-</u> •					
	ſ			11.40		
	j l		12.80	04,00		
			02.00	18.40 I		1
		20.30	19.40	00.80		
		00.00	00,90	19.80		1
		00.90	07.20	13.70		1
		01.80	08,20	12.10		
		00.00	09.40	13.20		1
I GBH9		14.80	19,00	03.00		۱ ا
I GIO I	, ,	31.50	25,30	01.10		1
I GBH11		00.50	13,70	07.20		1
1 G12		00.00	07.60	12.50		1
613		00.00	12.70	09.10	1	I
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l Atmospher	ric pressu	re - 1010 -	-1013 mb.			1
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Oxfordshire County Council in situ monitoring results for Landfill Gas

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I Site	name	Port Mead				
l Dates	ampled	120/08/92	Sampled	by:D.Hawl	ey	1
l Bor	ehole			T % OP		
lRef	<pre>IDepth(m)_</pre>	1	I	I	. I	· · · · · · · · · · · · · · · · · · ·
I GBH1	L	1 00.00	08.90	1 10.30	168 could not	be found. I
1 G2	1	1 00.00	1 14.60	1 02.50		l
I GBH3 I GA	1	1 00.00	00.60	1 18.80	1	ł
I GBHS	4	1 00.00	04.30	1 18.60	1	•
I G6	1	1 00.70	09.50	1 11.60		
I GBH7	I	1 24.90	1 27.50	1 00.40	1	l.
I GBH9	1	1 29.70	1 27.40	1 02.80	1	L .
	1	1 32.90	28.70	1 00.80		
G 12	I I		09.50	1 07 70	l I	
613	1	1 00.00	08.60	1 11.30	I	
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1	Site name	Port Meade	ow			·
 	Date sampled	15/12/92	Sampled	by:D.Hawle	<u>></u> y	
. I	Borehole	_ % CH4	% CO2	₹02		ĺ
	Ref Depth(m)_	_!	!			!
	GBH1	00.00	00.30	21.00		
H	G2	00.00	09.60	08.70		<u> </u>
H	GBH3	00.00	01.60	18.90		1
	G4	21.70	22.30	02.00		1
· •	GBH5	00.00	01.30	19.90		ł
. 1	_ G6	00.00	01.10	20.30		ļ
ļ	GBH7	30.00	23.80	00.60		1
l l	G8	00.00	03.90	16.40		ļ
	GBH9	00.00	00.60	19.80		I
ł	G10	35.60	25.10	01.50		
.	GBH11	00.00	00.00	20.70		ļ
1	G12	00.00	03.70	16.30		1
	G13	00.00	03.00	18.70		
<u> </u>	` Atmospheric pres	 sure - 1005	 – 1007 mb	l		1
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"Infra-red Gas Analyser Data"

"Code", "Time", "Date", "CH4", "CO2", "O2", "MILLIBAR"

"PORT0001", "09:15", "25/06/93", 000.0,001.3,018.9,1022 "PORT0002", "09:21", "25/06/93", 000.0,005.2,012.8,1021 "PORT0003", "09:25", "25/06/93",000.0,000.5,019.9,1021 "PORT0004", "09:31", "25/06/93",022.8,022.4,000.2,1021 "PORT0005", "09:36", "25/06/93",000.2,004.3,015.9,1020 "PORT0006", "09:44", "25/06/93",005.8,018.5,001.8,1020 "PORT0007", "09:50", "25/06/93",022.3,027.8,000.1,1021 "PORT0008", "09:54", "25/06/93",000.0,009.7,010.8,1020 "PORT0009", "10:00", "25/06/93",018.6,023.1,001.0,1019 "PORT0010", "10:04", "25/06/93",034.0,028.9,000.3,1019 "PORT0011", "10:09", "25/06/93",000.6,004.5,010.8,1019 "PORT0013", "10:16", "25/06/93",000.0,007.6,013.1,1019

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"Infra-red Gas Analyser Data"

"Code", "Time", "Date", "CH4", "CO2", "O2", "MILLIBAR"

"PORT0001", "10:57", "03/12/93", 000.0, 000.2, 020.4, 1013 "PORT0002", "11:01", "03/12/93", 000.0, 013.4, 007.8, 1013 "PORT0003", "11:06", "03/12/93", 003.6, 018.6, 000.0, 1013 "PORT0004", "11:11", "03/12/93", 009.4, 020.0, 001.0, 1013 "PORT0005", "11:16", "03/12/93", 000.0, 001.8, 018.7, 1013 "PORT0006", "11:21", "03/12/93", 011.2, 018.6, 000.0, 1013 "PORT0006", "11:25", "03/12/93", 011.2, 018.6, 000.0, 1013 "PORT0007", "11:25", "03/12/93", 022.2, 022.1, 000.0, 1012 "PORT0008", "11:29", "03/12/93", 000.0, 003.6, 018.0, 1012 "PORT0009", "11:34", "03/12/93", 000.0, 000.0, 020.2, 1013 "PORT0010", "11:39", "03/12/93", 030.3, 022.0, 000.0, 1012 "PORT0011", "11:43", "03/12/93", 000.0, 000.0, 020.1, 1013



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Port Meadow

Borehole	Max CH4	Min CH4	Avg CH4	Max CO2	Min CO2	Avg CO2
G10	35.6	19,4	29.9	28.7	20	24.2
G12	0	0	0.0	9.5	3.7	6.6
G2	0	0	0.0	14.6	9.6	.12.2
G4	21.7	2.1	13.1	22.3	7.2	17.6
G6	11.2	0	2.6	18.6	0.6	7.4
G8	0	0	0.0	9.4	3.6	5.2
GBH1	0	0	0.0	8.9	0.3	4.6
GBH11	6.6	0	2.0	20.4	0	8.3
GBH3	3.6	0	0.9	18.6	0.6	5.5
GBH5	0	0	0.0	4.3	0.9	1.9
GBH7	33.1	1.8	22.4	30.4	8.2	22.4
GBH9	40.8	0	17.1	34.6	0	16.3

* These figures are calculated from the data on computer where borchole type = gas / dual purpose. Data will be missing where the borehole type has not been added to the database.

Infra-red Gas Analyser Data

Code	Date	CH4	CO2	02	MIL	LIBAR
PORT0001	24/06/94	(D	1.2	19.7	1006
PORT0002	24/06/94	(0	2.5	1 9 .1	1005
PORT0004	24/06/94	20.	1	20.1	2.2	1004
PORT0006	24/06/94	(C	2.8	19.4	1004
PORT0007	24/06/94	0.1	2	0.9	20.4	1004
PORT0009	24/06/94	1.5	3	12.2	0.3	1003
PORT0010	24/06/94	27.	7	26	0.2	1002
PORT0011	24/06/94	0.1	1	2.6	16.8	1002

Port Meadow

Gas Analyse	er Data: Mk	I Gas Analy	ser			
Code	Date	CH4	CO2	02	Atmospheric Pressu	re
PORT0001	15/12/94	0	2.9	18.2	1025	
PORT0002	15/12/94	0	6.4	15.1	1024	
PORT0003	15/12/94	0	1.7	18.9	1023	
PORT0004	15/12/94	18.9	24.3	0	1024	
PORT0005	15/12/94	0	2.7	17.9	1024	
PORT0006	15/12/94	4.7	15.6	5.5	1024	
PORT0007	15/12/94	0.9	7.5	11.9	1024	
PORT0009	15/12/94	0	0.6	19.8	1022	
PORT0010	15/12/94	28.2	24.2	0.1	1023	
PORT0011	15/12/94	0.2	3.8	15.8	1023	

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Gas Analyse	er Data: Mk2	2c V2.05 31	/03/95			
Code	Date	CH4	CO2	02	Atmospher	ic Pressure
		%	%	%	mBar	
PORT0001	16/06/95	、 O	1.1	19.1	1004	W
PORT0002	16/06/95	0	14.4	1.2	1003	W
PORT0003	16/06/95	3.4	18.1	0.8	1004	W
PORT0004	16/06/95	18.3	21.6	0.6	1003	W
PORT0005	16/06/95	0	1.3	19.7	1003	W
PORT0006	16/06/95	9.1	21.1	0.7	1003	W
PORT0007	16/06/95	10.5	23.4	0.6	1004	w
PORT0008	16/06/95	0	1.6	20.3	1003	W
PORT0009	16/06/95	0	0.1	20.9	1003	W
PORT0010	16/06/95	3.4	5.9	16.3	1002	W
PORT0011	16/06/95	0.9	6.8	13.9	1002	W

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Sheet1

Port Meadow	· · ·					
Code	Date	CH4	CO2	O2	Atmospheric Pressure	
		%	%	%	mBar	
PORT0001	13/06/96	0	1.8	18.5	1029	W
PORT0002	13/06/96	Ő	- 7.6	16.1	1029	W
PORT0004	13/06/96	15.8	· 21	. 1.5	1028	W
PORT0003	13/06/96	0	1.3	18.8	1028	• • • • • • • •
PORT0005	13/06/96	0	1.5	18.8	1027	W
PORT0006	13/06/96	0.2	6.3	. 15	1028	W
PORT0007	13/06/96	15.5	23.4	1	1027	W
PORT0008	13/06/96	0	5.8	11.7	1026	W
PORT0009	13/06/96	0	10.1	3.6	1027	W
PORT0010	13/06/96	4.5	7.3	11.6	1027	W
PORT0011	13/06/96	0	4.5	14.8	1026	W
PORT0012	13/06/96	0	4.6	15.5	. 1027	W

sc 5/7/96

Code	Date	CH4	CO2	02	Atmospheri	c Pressure		
		%	%	%	mBar			
PORT0001	16/12/96	0	1.9	18.7	1004	W	1	
PORT0002	16/12/96	0	7.7	16.1	1004	Ŵ	1	
PORT0004	16/12/96	15.9	21.1	1.5	1003	W	1	
PORT0003	16/12/96	0	1.4	18.8	1003	W		
PORT0005	16/12/96	· 0	, 1.6	18.8	1002	W	1	
PORT0006	16/12/96	0.2	6.3	15	1003	W		
PORT0007	16/12/96	15.5	23.4	1	1002	W	1	
PORT0008	16/12/96	0	6.3	11.7	1001	W	1	
PORT0009	16/12/96	0	10.2	3.6	1002	W		
PORT0010	16/12/96	4.8	8	11.6	1002	W		
PORT0011	16/12/96	0	4.9	14.9	1001	W		
PORT0012	16/12/96	0	4.6	15.6	1002	W		

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SC 21/1/97

Page 1

GROUNDWATER CHEMISTRY DATA

OXFORDSHIRE COUNTY COUNCIL WATER MONITORING RECORD SHEET

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•	SITE	:Port M	eadow	,		DATE REC	ORDED:26/	11/91
				<u>.</u>	_RECORDED	BY:D.Haw	ley	
	}	BORI	EHOLE		G	ROUNDWATER		_ MISCELLANEOUS
	REF	TOTAL	HEAD OF	(M)	METRES B.C.L.*	DEPTH(M)	SAMPLE	
	GBH1	İ	03.07	•••	01.23	04.30	OCC2	Each groundwater
- 8-	GBH3		01.68		03.47	05.15	OCC2	was pumped until
•	G4	1	-	~ 1			-	the sample taken
•		1	03.02	,	UZ.30	1 05.60	UCCZ	Was representative
-		1						joi the groundwater
		1	02.20		03.34	05.60		IThe samples were
<i>,</i> •	I GO I GBH9		01 14		04 36	05 50		idispatched to
2		1	-		04.76	-		Spencer House the
	GBH11	i	01.87		03.53	05.40	0002	Isame dav.
	G12	i	-		03.24	-	-	This site is
	G13 ~	i	l .		01.58		l. E	llocated on the
		i .	İ		Ì	i ·	i ·	Thames floodplain
	Ì	ĺ			İ	1	ł	with the samples
	ł	ł	l		Ī	Î.	Í	drawn from the
	1	ľ			1	l l	Ì	river gravels.No
		1	١			F		cap or lining was
		1			[1	I	incorporated so
	ł		1					any leachate
	1	1			· ·	1	1	generated is free
	1	l]			1		to disperse.The
						1		dilution afforded
			•					by the groundwater
		1				ļ		is probably quite
						1		substantial
÷.	ļ	!	ļ		ļ	1	!	judging by the
ŀ	ļ		ł		4		4	flow attained when
		!	4		ļ	1		pumping.The
·		1			ł			groundwater most
•	1	1					1	probably flows
	1	1	1		f 1	1	1	towards the Thames
	 i	{ 	r F		1	F	E 3	I lovel a will need
•	· ·	1	1		1	E 1	1	Ito be obtained to
•	1	1 1	1		I I .	1	l f	Loopfirm this same
	τ I	F 1	r f		1		1 \$	horeholes were
		, ,	1		r 1	т 1	1	Arilled through
	1		Í		1		1	refuse but more
	1	1	· ·		ŀ	i	i	will be known on
	i	i	Ì		ł		i	receipt of the
·••	· ·	i	i		İ		i	drilling logs.
	j	i	i		i	i	İ	Contamination of
÷	İ	İ	i		i	i	İ	groundwater would
\sim	İ	l	İ		İ	I	l	not be unexpected.
3	* - BEI	LOW COVE	R LEVEL					

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OCC1 - LIMITED ANALYSIS ,OCC2 - FULL ANALYSIS, OCC3 - SELECTED METALS,OCC4 - TRI - HALO METHANES.

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Spencer House, c/o Gainsborough House, Manor Farm Road, Reading, Berks., RG2 OJN. Tel : 0734 236222. Fax : 0734 756573.

Certificate of Analysis.

Mr D Hawley Oxfordshire County Council Waste Disposal Section Speedwell Street Oxford OX1 1NE

Reference :P26019/C003057 Tag Number : 00094194

Sample Description : BH1 Suite OCC 2 Sample Site : Port Meadow Date Received : 27.11.91 Date of Sample : 26.11.91 Time of Sample : not specified Sampled By : Client

RESULTS.

Determinand	Result	Units
PH VALUE CONDUCTIVITY AT 20C COD AMMONIACAL NITROGEN NITROGEN, TOTAL OXIDISED AS N CHLORIDE AS CL SULPHATE AS SO4 ALKALINITY AS CACO3 CALCIUM, TOTAL SODIUM POTASSIUM MAGNESIUM	$ \begin{array}{r} 6.7\\ 1777\\ 62\\ 51.400\\ 0.900\\ 143\\ 66\\ 752\\ 166\\ 106.0\\ 43.4\\ 34.5\\ \end{array} $	NIL U uSM/c mg/l mg/l mg/l mg/l mg/l mg/l mg/l mg/l

enhim

for The Water Quality Centre Date of Issue: 16 December 1991



Spencer House, c/o Gainsborough House, Manor Farm Road, Reading, Berks., RG2 OJN. Tel : 0734 236222. Fax : 0734 756573.

Certificate of Analysis.

Mr D Hawley Oxfordshire County Council Waste Disposal Section Speedwell Street Oxford OX1 1NE Reference :P26019/C003058 Tag Number :00094195

Sample Description : BH3 Suite OCC 2 Sample Site : Port Meadow Date Received : 27.11.91 Date of Sample : 26.11.91 Time of Sample : not specified Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE CONDUCTIVITY AT 20C COD AMMONIACAL NITROGEN NITROGEN, TOTAL OXIDISED AS N CHLORIDE AS CL SULPHATE AS SO4 ALKALINITY AS CACO3 CALCIUM, TOTAL SODIUM POTASSIUM MAGNESIUM	$\begin{array}{r} 6.5\\ 1506\\ 64\\ 34.900\\ 0.200\\ 56\\ 227\\ 581\\ 220\\ 46.6\\ 48.5\\ 28.4\\ \end{array}$	NIL U uSM/c mg/l mg/l mg/l mg/l mg/l mg/l mg/l mg/l

entim

for The Water Quality Centre Date of Issue: 13 December 1991



Spencer House, c/o Gainsborough House, Manor Farm Road, Reading, Berks., RG2 0JN. Tel : 0734 236222. Fax : 0734 756573.

Certificate of Analysis.

Mr D Hawley Oxfordshire County Council Waste Disposal Section Speedwell Street Oxford OX1 1NE

Reference :P26019/C003059 Tag Number : 00094196

Sample Description : BH5 Suite OCC 2 Sample Site : Port Meadow Date Received : 27.11.91 Date of Sample : 26.11.91 Time of Sample : not specified Sampled By : Client

RESULTS.

Determinand Result Units 6.8 1531 65 PH VALUE CONDUCTIVITY AT 20C NIL U uSM/c mg/l mg/l COD COD AMMONIACAL NITROGEN NITROGEN, TOTAL OXIDISED AS N CHLORIDE AS CL SULPHATE AS SO4 ALKALINITY AS CACO3 CALCIUM TOTAL 43.400 1.300 102 80 572 mg/l mg/l mg/l mg/l mg/l mg/l 162 CALCIUM, TOTAL 85.7 SODIUM POTASSIUM mg/l 30.3 mĝ/l

contin

for The Water Quality Centre Date of Issue: 9 December 1991



Spencer House, c/o Gainsborough House, Manor Farm Road, Reading, Berks., RG2 OJN. Tel : 0734 236222. Fax : 0734 756573.

Certificate of Analysis.

Mr D Hawley Oxfordshire County Council Waste Disposal Section Speedwell Street Oxford OX1 1NE Reference :P26019/C003060 Tag Number :00094197

Sample Description : BH7 Suite OCC 2 Sample Site : Port Meadow Date Received : 27.11.91 Date of Sample : 26.11.91 Time of Sample : not specified Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE CONDUCTIVITY AT 20C COD AMMONIACAL NITROGEN NITROGEN, TOTAL OXIDISED AS N CHLORIDE AS CL SULPHATE AS SO4 ALKALINITY AS CACO3 CALCIUM, TOTAL SODIUM POTASSIUM MAGNESIUM	$\begin{array}{r} 6.8\\ 1189\\ 71\\ 31.700\\ 0.900\\ 87\\ 56\\ 476\\ 136\\ 61.2\\ 30.3\\ 21.6\end{array}$	NIL U uSM/c mg/l mg/l mg/l mg/l mg/l mg/l mg/l mg/l

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for The Water Quality Centre Date of Issue: 10 December 1991


Certificate of Analysis.

Mr D Hawley Oxfordshire County Council Waste Disposal Section Speedwell Street Oxford OX1 1NE Reference :P26019/C003061 Tag Number : 00094198

Sample Description : BH9 Suite OCC 2 Sample Site : Port Meadow Date Received : 27.11.91 Date of Sample : 26.11.91 Time of Sample : not specified Sampled By : Client

RESULTS.

Determinand	Result	Units
PH VALUE CONDUCTIVITY AT 20C COD AMMONIACAL NITROGEN NITROGEN, TOTAL OXIDISED AS N CHLORIDE AS CL SULPHATE AS SO4 ALKALINITY AS CACO3 CALCIUM, TOTAL SODIUM POTASSIUM MAGNESIUM	6.6 1461 91 52.200 1.000 112 586 177 64.3 37.1 19.3	NIL U uSM/c mg/l mg/l mg/l mg/l mg/l mg/l mg/l mg/l

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for The Water Quality Centre Date of Issue: 9 December 1991

The analytical results given in this report were obtained in the laboratories of Tharnes Water Utilities Limited.



Certificate of Analysis.

Mr D Hawley Oxfordshire County Council Waste Disposal Section Speedwell Street Oxford OX1 1NE Reference :P26019/C003062 Tag Number :00094199

Sample Description : BH11 Suite OCC 2 Sample Site : Port Meadow Date Received : 27.11.91 Date of Sample : 26.11.91 Time of Sample : not specified Sampled By : Client

RESULTS.

Determinand	Result	Units
PH VALUE CONDUCTIVITY AT 20C COD AMMONIACAL NITROGEN NITROGEN, TOTAL OXIDISED AS N CHLORIDE AS CL SULPHATE AS SO4 ALKALINITY AS CACO3 CALCIUM, TOTAL SODIUM POTASSIUM MAGNESIUM	6.7 1042 33 9.800 1.000 93 61 379 125 50.8 10.6 6.7	NIL U uSM/c mg/l mg/l mg/l mg/l mg/l mg/l mg/l mg/l

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for The Water Quality Centre Date of Issue: 9 December 1991

The analytical results given in this report were obtained in the laboratories of Thames Water Utilities Limited.

OXFORDSHIRE COUNTY COUNCIL WATER MONITORING RECORD SHEET

ISITE	NAME Por	t Meadow		ISAMPLED B	Y:D.Hawley	
REF	I DEPTH	LHULE I COVER LEVEL IMA.O.D	IG I METRES I_B.C.L	ROUNDWATER 1 LEVEL - 1MA.O.D.	I SAMPLE	I MISCELLANEOUS
I GBH 1 GBH 3 GBH 5 GBH 7 GBH 9 GBH 1 1			01.38 03.60 02.80 03.65 04.47 03.63	1 56-19 1 57-10 1 56-90 1 57-10 1 57-54- 1 57-13- 1	10CC2/3/4 10CC2/3/4 10CC2/3/4 10CC2/3/4 10CC2/3/4 10CC2/3/4 1 1	All boreholes were pumped for 20 mins before the samples were taken. All samples except GBH5 were foul smelling. Borehole covers require levels.
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* - BELOW COVER LEVEL
OCC1 - LIMITED ANALYSIS ,OCC2 - FULL ANALYSIS,
OCC3 - SELECTED METALS,OCC4 - TRI - HALO METHANES.

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PROJECT	:PORT MEADOW (K3)	Poet MEADOW	(K3)
DATE	:22/ 1/1993	:	
	ACSiS Version	1.4i	

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STRING CODING FILE.

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CODE.) RECORD.	: Pt.No.	; E	ASTING. :	NORTHING.	LEVEL.
PBH	;	GBH	-;	*i-		
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	; 5	78	4	49643.410	208964.235	60.751
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	\$7 •	117	f 4	50060.461	208465.200	60.755
CODE.	RECORD.	: Pt.No.	-; E	ASTING, (NORTHING.	LEVEL.
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SUPPLIER : MICHAEL A JENNINOS ASSOCIATES -

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Certificate of Analysis.

Reference:A100340/C007785

Tag Number : 00202666

Page 1 of 6

Mr David Hawley Oxfordshire County Council Waste Management Section Speedwell House Oxon, OX1 1NE

Sample Description : BH1 Suite OCC2/3/4 Sample Site : Port Meadow Date Received : 20.08.92 Date of Sample : not specified Time of Sample : not specified Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE	6.7	NIL U
CONDUCTIVITY AT 20°C	1291	µSM/cm
COD	43.0	mg/l
AMMONIACAL NITROGEN	26.90	mg/1
NITROGEN, TOTAL OXIDISED AS N	0.6	mg/l
CHLORIDE AS Cl	95	mg/l
SULPHATE AS SO.	84.4	mg/1
ALKALINITY AS CaCO,	515	mg/1
CALCIUM, TOTAL	154	mg/1
SODIUM, TOTAL	86.8	mg/1
POTASSIUM, TOTAL	28.7	mg/1
MAGNESIUM, TOTAL	19.9	mg/l
COPPER	<10	$\mu g/1$
NICKEL	<10	$\mu g/1$
CHROMIUM	<10	μg/1
ZINC	<10	$\mu g/1$
CADMIUM	<0.5	$\mu g/1$
MERCURY	<0.10	$\mu g/1$
IRON	3363	$\mu g/l$
BORON, TOTAL	1.674	mg/1
LEAD	<5	μg/1
CHLOROFORM	<1	$\mu g/1$
BROMOFORM	<1	$\mu g/1$
BROMODICHLOROMETHANE	<1	$\mu g/1$
DIBROMOCHLOROMETHANE	<1	μg/1
TRICHLOROETHANE $(1,1,1)$	<1	$\mu g/1$
CARBON TETRACHLORIDE	<0.3	$\mu g/1$
TETRACHLOROETHENE (ALIAS 7792)	<1	$\mu \bar{g}/1$
TRICHLOROETHENE	4	$\mu \bar{g}/l$
T.H.M. TOTAL	<4.0	$\mu \bar{g}/1$
Alexan details of the individual methods of applys	is and performance characte	ristics are availab

Note - details of the individual methods of analysis and performance characteristics are available upon request from our laboratories.

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for The Water Quality Centre Date of Issue: 4 September 1992

> Tests marked *** are not included in the NAMAS Accreditation of our laboratories. The analytical results given in this report were obtained in the laboratories of Thames Water Utilities Limited.



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Certificate of Analysis.

Reference:A100340/C007783

Tag Number : 00202667

Page 2 of 6

Mr David Hawley Oxfordshire County Council Waste Management Section Speedwell House Oxon, OX1 1NE

Sample Description : BH3 Suite OCC2/3/4 Sample Site : Port Meadow Date Received : 20.08.92 Date of Sample : not specified Time of Sample : not specified Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE	6.4	NIL U
CONDUCTIVITY AT 20°C	1496	µSM/cm
COD	62.0	mg/1
AMMONIACAL NITROGEN	23,90	mg/1
NITROGEN, TOTAL OXIDISED AS N	0.1	mg/l
CHLORIDE AS Cl	52	mg/l
SULPHATE AS SO.	219.7	mg/l
ALKALINITY AS CaCO	612	mg/1
CALCIUM. TOTAL	236	mg/l
SODIUM, TOTAL	41.2	mg/l
POTASSIUM. TOTAL	27.7	mg/1
MAGNESIUM, TOTAL	17.7	mg/1
COPPER	<10	$\mu g/1$
NICKEL	<10	$\mu g/1$
CHROMIUM	11	$\mu g/1$
ZINC	<10	$\mu g/1$
CADMIUM	<0.5	$\mu g/1$
MERCURY	<0.10	ug/1
TRON	2521	μg/1
BORON, TOTAL	0.940	mg/1
LEAD	<5	$\mu g/1$
CHLOROFORM	<1	$\mu g/1$
BROMOFORM	<1	$\mu g/1$
BROMODICHLOROMETHANE	<1	$\mu g/1$
DIBROMOCHLOROMETHANE	<1	ug/1
TRICHLOROFTHANE (1 1 1)	<1	$\frac{1}{\mu q} \frac{1}{1}$
CAPBON TETRACHIOPIDE	<03	$\frac{1}{100}$
TETRICICOLORIDE	<0.5	$\frac{\mu_{6}}{\mu_{7}}$
TEIRAGHLOROETHEME (ALIAS //32)		μα/1
IKIURIUKUEIRENE TUUM TOTAI		με/1
1.H.M., IUIAL	<4.U	μβ/1

Note - details of the individual methods of analysis and performance characteristics are available upon request from our laboratories.

iyon for The Water Quality Centre

Date of Issue: 4 September 1992





Certificate of Analysis.

Reference:A100340/C007786 Tag Number : 00202668 Page 3 of 6

Mr David Hawley Oxfordshire County Council Waste Management Section Speedwell House Oxon, OX1 1NE

Sample Description : BH5 Suite OCC2/3/4 Sample Site : Port Meadow Date Received : 20.08.92 Date of Sample : not specified Time of Sample : not specified Sampled By : Client

RESULTS.

Determinand	Result	Units
DH VALUE	6.9	NIL U
CONDUCTIVITY AT 20°C	1601	µSM/cm
COD	81.0	mg/1
AMMONIACAL NITROGEN	65.70	mg/l
NITROGEN, TOTAL OXIDISED AS N	0.4	mg/1
CHLORIDE AS Cl	106	mg/1
SULPHATE AS SO.	123.1	mg/l
ALKALINITY AS CaCO,	615	mg/1
CALCIUM, TOTAL	126	mg/l
SODIUM, TOTAL	103.2	mg/l
POTASSIUM, TOTAL	57.7	mg/l
MAGNESIUM, TOTAL	30.2	mg/l
COPPER	<10	$\mu g/1$
NICKEL	14	$\mu g/1$
CHROMIUM	<10	$\mu g/1$
ZINC	12	μġ/1
CADMIUM	<0.5	μg/1
MERCURY	<0.10	$\mu \overline{g}/1$
IRON	491	$\mu \bar{g}/1$
BORON, TOTAL	1.941	mg/1
LEAD	<5	$\mu g/l$
CHLOROFORM	<1	μg/1
BROMOFORM	<1	μg/1
BROMODICHLOROMETHANE	<1	$\mu g/1$
DIBROMOCHLOROMETHANE	<1	$\mu g/1$
TRICHLOROETHANE (1.1.1)	<1	$\mu g/1$
CARBON TETRACHLORIDE	<0.3	$\mu g/1$
TETRACHLOROETHENE (ALIAS 7792)	<1	$\mu g/1$
TRICHLOROETHENE	<1	$\mu g/1$
T.H.M. TOTAL	<4.0	$\mu g/1$
Nets details of the individual methods of apply	sis and performance characte	rietice are availab

Note - details of the individual methods of analysis and performance characteristics are available upon request from our laboratories.

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for The Water Quality Centre Date of Issue: 4 September 1992



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Certificate of Analysis.

Reference:A100340/C007784 Tag Number : 00202669

Page 4 of 6

Mr David Hawley Oxfordshire County Council Waste Management Section Speedwell House Oxon, OX1 1NE

Sample Description : BH7 Suite OCC2/3/4 Sample Site : Port Meadow Date Received : 20.08.92 Date of Sample : not specified Time of Sample : not specified Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE	6.8	NIL U
CONDUCTIVITY AT 20°C	1217	µSM/cm
COD	76.0	mg/l
AMMONIACAL NITROGEN	40.80	mg/l
NITROGEN, TOTAL OXIDISED AS N	0.2	mg/l
CHLORIDE AS C1	89	mg/l
SULPHATE AS SO.	62.1	mg/l
ALKALINITY AS CaCO,	486	mg/l
CALCIUM, TOTAL	127	mg/l
SODIUM, TOTAL	57.0	mg/1
POTASSIUM, TOTAL	34.8	mg/1
MAGNESIUM, TOTAL	19.1	mg/1
COPPER	<10	$\mu g/1$
NICKEL	<10	$\mu g/1$
CHROMIUM	<10	μg/1
ZINC	<10	$\mu g/1$
CADMIUM	<0.5	$\mu g/1$
MERCURY	<0.10	$\mu g/1$
IRON	12707	$\mu g/1$
BORON, TOTAL	0.606	mg/1
LEAD	<5	µg/1
CHLOROFORM	<1	$\mu \overline{g}/1$
BROMOFORM	<1	$\mu g/1$
BROMODICHLOROMETHANE	<1	$\mu g/1$
DIBROMOCHLOROMETHANE	<1	μg/1
TRICHLOROETHANE (1,1,1)	<1	μg/1
CARBON TETRACHLORIDE	<0.3	$\mu g/1$
TETRACHLOROETHENE (ALIAS 7792)	<1	µg/1
TRICHLOROETHENE	<1	$\mu g/1$
T.H.M. TOTAL	<4.0	$\mu g/1$
Note details of the individual methods of analysis	sie and nerformance characte	arietice are availal

Note - details of the individual methods of analysis and performance characteristics are available upon request from our laboratories.

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for The Water Quality Centre Date of Issue: 4 September 1992





Certificate of Analysis.

Reference:A100340/C007781

Tag Number : 00202670

Page 5 of 6

Mr David Hawley Oxfordshire County Council Waste Management Section Speedwell House Oxon, OX1 1NE

Sample Description : BH9 Suite OCC2/3/4 Sample Site : Port Meadow Date Received : 20.08.92 Date of Sample : not specified Time of Sample : not specified Sampled By : Client

RESULTS.

Determinand	Result	Units
DH VALUE	6.6	NIL U
CONDUCTIVITY AT 20°C	1727	µSM/cm
COD	184.0	mg/l
AMMONIACAL NITROGEN	69.20	mg/l
NITROGEN, TOTAL OXIDISED AS N	0.1	mg/l
CHLORIDE AS C1	118	mg/l
SULPHATE AS SO	65.6	mg/1
ALKALINITY AS CaCO,	` 724	mg/l
CALCIUM, TOTAL	187	mg/l
SODIUM, TOTAL	71.7	mg/1
POTASSIUM, TOTAL	40.1	mg/l
MAGNESIUM, TOTAL	18.6	mg/l
COPPER	<10	$\mu g/1$
NICKEL	<10	$\mu g/1$
CHROMIUM	10	μ <u>g</u> /1
ZINC	<10	μg/1
CADMIUM	<0.5	μg/1
MERCURY	<0.10	$\mu g/1$
IRON	17599	μ <u>g</u> /1
BORON, TOTAL	0.760	mg/l
LEAD	<5	μg/1
CHLOROFORM	<1	$\mu \bar{g}/1$
BROMOFORM	<1	$\mu g/1$
BROMODICHLOROMETHANE	<1	$\mu g/1$
DIBROMOCHLOROMETHANE	<1	$\mu g/1$
TRICHLOROETHANE (1,1,1)	<1	$\mu g/1$
CARBON TETRACHLORIDE	<0.3	$\mu g/1$
TETRACHLOROETHENE (ALIAS 7792)	<1	$\mu g/1$
TRICHLOROETHENE	2	$\mu g/1$
T.H.M. TOTAL	<4.0	μg/1
Alate details of the individual methods of analys	is and performance characte	ristics are availab

Note - details of the individual methods of analysis and performance characteristics are available upon request from our laboratories.

for The Water Quality Centre Date of Issue: 4 September 1992

> Tests marked "*" are not included in the NAMAS Accreditation of our laboratories. The analytical results given in this report were obtained in the laboratories of Thames Water Utilities Limited.



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Certificate of Analysis.

Reference:A100340/C007782 Tag Number : 00202671

Page 6 of 6

Mr David Hawley Oxfordshire County Council Waste Management Section Speedwell House Oxon, OX1 1NE

Sample Description : BH11 Suite OCC2/3/4 Sample Site : Port Meadow Date Received : 20.08.92 Date of Sample : not specified Time of Sample : not specified Sampled By : Client

RESULTS.

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Determinand	Result	Units
DH VALUE	6.7	NIL U
CONDUCTIVITY AT 20°C	1235	µSM/cm
COD	44.0	mg/l
AMMONIACAL NITROGEN	24.90	mg/1
NITROGEN, TOTAL OXIDISED AS N	0.2	mg/1
CHLORIDE AS C1	102	mg/1
SULPHATE AS SO	85.7	mg/l
ALKALINITY AS CaCO,	452	mg/l
CALCIUM. TOTAL	159	mg/l
SODIUM. TOTAL	73.0	mg/1
POTASSIUM. TOTAL	25,6	mg/1
MAGNESIUM. TOTAL	12.2	mg/1
COPPER	<10	ug/1
NICKEL	<10	μg/1
CHROMIUM	<10	μg/1
ZINC	<10	$\mu g/1$
CADMIUM	<0.5	$\mu g/1$
MERCURY	<0.10	$\mu g/1$
IRON	1758	$\mu g/1$
BORON, TOTAL	0.570	mg/1
LEAD	<5	μg/1
CHLOROFORM	<1	$\mu g/1$
BROMOFORM	<1	$\mu g/1$
BROMODICHLOROMETHANE	<1	$\mu g/1$
DIBROMOCHLOROMETHANE	<1	μg/1
TRICHLOROETHANE (1,1,1)	<1	<u>ие/1</u>
CARBON TETRACHLORIDE	<0.3	$\frac{1}{4} \frac{1}{2} \frac{1}{2}$
TETRACHIOROETHENE (ALIAS 7792)	<1	<u>u</u> g/1
TRICHIOROFTHENE	2	μσ/1
	<4 n	₩6/* µr/1
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Note - details of the individual methods of analysis and performance characteristics are available upon request from our laboratories.

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for The Water Quality Centre Date of Issue: 4 September 1992



OXFORDSHIRE COUNTY COUNCIL WATER MONITORING REPORT SHEET

Site name:Port Meadow Date sampled:12/02/93 Sampled by: David Hawley Date of results:24/02/93 Bailed groundwater samples were taken from all boreholes and analysed for the full suite of inorganic determinands. Groundwater levels relative to ordanance datum were also recorded. In all boreholes Ammonia levels are significantly elevated above assumed natural background concentrations and guidelines contained |in the Water Quality Regs. 1989, ranging from 1.3 mg/l at BH3 to 144.3 mg/l at BH11.Levels for Chemical Oxygen Demand are also high |ranging from 169 - 190 mg/l at BH's 7,9 & 11. This site is located on the Thames floodplain and was designed on the dilute and disperse principle, therefore it is not unexpected that there is contamination immediately surrounding the landfill. The principle is that the small volume of leachate produced by the landfill will be afforded adequate dilution by the much larger volume of water present in the aguifer. Leachate will continue to be generated until there is no more biodegradable waste left. Groundwater levels have increase by a maximum of 0.5m since the the previous visit made in August 1992. There is virtually no groundwater gradient but what there is would indicate a flow direction toward the Thames.



Certificate of Analysis.

Mr David Hawley Oxfordshire County Council Waste Management Section Speedwell House Oxon, OX1 1NE Reference:A100638/C012145 Tag Number :00294016 Page 1 of 6

Sample Description : BH1 Suite OCC2 Sample Site : Port Meadow Date Received : 12.02.93 Date of Sample : 12.02.93 Time of Sample : not specified Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE	7.0	NIL U
CONDUCTIVITY AT 20°C	1178	µSM/cm
COD	39.0	mg/l
AMMONIACAL NITROGEN	18.200	mg/l
NITROGEN, TOTAL OXIDISED AS N	<1.0	mg/l
CHLORIDE AS CL	69	mg/l
SULPHATE AS SO.	157.2	mg/1
ALKALINITY AS CaCO,	692	mg/l
CALCIUM	107	mg/l
SODIUM	68.8	mg/1
POTASSIUM	13.8	mg/l
MAGNESIUM	14.7	mg/l

Note - details of the individual methods of analysis and performance characteristics are available upon request from our laboratories.

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for The-Water Quality Centre Date of Issue: 24 February 1993





Certificate of Analysis.

Mr David Hawley Oxfordshire County Council Waste Management Section Speedwell House Oxon, OX1 1NE Reference:A100638/C012141 Tag Number :00294018 Page 2 of 6

Sample Description : BH3 Suite OCC2 Sample Site : Port Meadow Date Received : 12.02.93 Date of Sample : 12.02.93 Time of Sample : not specified Sampled By : Client

RESULTS.

Determinand	Result	Units
DH VALUE	6.7	NIL U
CONDUCTIVITY AT 20°C	783	µSM/cm
COD	21.0	mg/1
AMMONIACAL NITROGEN	1.300	mg/l
NITROGEN, TOTAL OXIDISED AS N	1.1	mg/l
CHLORIDE AS CL	9	mg/1
SULPHATE AS SO	60.0	mg/1
ALKALINITY AS CaCO,	490	mg/l
CALCIUM	147	mg/1
SODIUM	7.8	mg/1
POTASSIUM	5.6	mg/1
MAGNESIUM	6.3	mg/l

Note - details of the individual methods of analysis and performance characteristics are available upon request from our laboratories.

ton.

for The Water Quality Centre Date of Issue: 24 February 1993





Certificate of Analysis.

Mr David Hawley Oxfordshire County Council Waste Management Section Speedwell House Oxon, OX1 1NE Reference:A100638/C012142 Tag Number :00294019 Page 3 of 6

Sample Description : BH5 Suite OCC2 Sample Site : Port Meadow Date Received : 12.02.93 Date of Sample : 12.02.93 Time of Sample : not specified Sampled By : Client

RESULTS.

Determinand	Result	Units
DH VALUE	6.9	NIL U
CONDUCTIVITY AT 20°C	2220	µSM/cm
COD	60.0	mg/1
AMMONTACAL NITROGEN	37.000	mg/l
NITROGEN, TOTAL OXIDISED AS N	31.2	mg/1
CHLORIDE AS CL	93	mg/1
SULPHATE AS SO.	735.5	mg/l
ALKALINITY AS CaCO	552	mg/l
CALCTIM	318	mg/l
SODTIM	65.5	mg/1
POTASSTIM	43.2	mg/l
MAGNESIUM	35.1	mg/1

Note - details of the individual methods of analysis and performance characteristics are available upon request from our laboratories.

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for the Water Quality Centre Date of Issue: 24 February 1993

> NAMAS TESTING



Certificate of Analysis.

Mr David Hawley Oxfordshire County Council Waste Management Section Speedwell House Oxon, OX1 1NE Reference:A100638/C012144 Tag Number :00294020 Page 4 of 6

Sample Description : BH7 Suite OCC2 Sample Site : Port Meadow Date Received : 12.02.93 Date of Sample : 12.02.93 Time of Sample : not specified Sampled By : Client

RESULTS.

Determinand	Result	Units
DH VALUE	6.9	NIL U
CONDUCTIVITY AT 20°C	1907	µSM/cm
COD	190.0	mg/l
AMMONTACAL NITROGEN	75.500	mg/1
NITROGEN, TOTAL OXIDISED AS N	<1.0	mg/1
CHLORIDE AS CL	95	mg/1
SULPHATE AS SO.	70.0	mg/1
ALKALINITY AS CaCO	1001	mg/1
CALCTIM	136	mg/l
SODIUM	56.3	mg/1
POTASSTIM	35.9	mg/l
MAGNESIUM	26.9	mg/l

Note - details of the individual methods of analysis and performance characteristics are available upon request from our laboratories.

JSKyon

for The Water Quality Centre Date of Issue: 24 February 1993

> NAMAS TESTING



Certificate of Analysis.

Mr David Hawley Oxfordshire County Council Waste Management Section Speedwell House Oxon, OX1 1NE Reference:A100638/C012143 Tag Number :00294021 Page 5 of 6

Sample Description : BH9 Suite OCC2 Sample Site : Port Meadow Date Received : 12.02.93 Date of Sample : 12.02.93 Time of Sample : not specified Sampled By : Client

RESULTS.

Determinand	Result	Units
DH VALUE	7.2	NIL U
CONDUCTIVITY AT 20°C	2430	µSM/cm
COD	169.0	mg/1
AMMONIACAL NITROGEN	121.000	mg/l
NITROGEN, TOTAL OXIDISED AS N	<1.0	mg/1
CHLORIDE AS CL	87	mg/1
SULPHATE AS SO.	178.9	mg/1
ALKALINITY AS CaCO	1095	mg/l
CALCIUM	173	mg/l
SODIUM	49.4	mg/l
POTASSIUM	38.9	mg/l
MAGNESIUM	28.3	mg/l

Note - details of the individual methods of analysis and performance characteristics are available upon request from our laboratories.

your

for The Water Quality Centre Date of Issue: 24 February 1993





Certificate of Analysis.

Mr David Hawley Oxfordshire County Council Waste Management Section Speedwell House Oxon, OX1 1NE Reference:A100638/C012146 Tag Number :00294022 Page 6 of 6

Sample Description : BH11 Suite OCC2 Sample Site : Port Meadow Date Received : 12.02.93 Date of Sample : 12.02.93 Time of Sample : not specified Sampled By : Client

RESULTS.

Determinand	Result	Units
DH VALUE	6.8	NIL U
CONDUCTIVITY AT 20°C	2420	µSM/cm
COD	185.0	mg/1
AMMONIACAL NITROGEN	144.300	mg/l
NITROGEN, TOTAL OXIDISED AS N	<1.0	mg/l
CHLORIDE AS CL	95	mg/1
SULPHATE AS SO.	45.3	mg/l
ALKALINITY AS CaCO	1150	mg/l
CALCIUM	168	mg/l
SODIUM	64.2	mg/l
POTASSIUM	56.4	mg/l
MAGNESIUM	23.1	mg/l

Note - details of the individual methods of analysis and performance characteristics are available upon request from our laboratories.

yon

for The Water Quality Centre Date of Issue: 24 February 1993

OXFORDSHIRE COUNTY COUNCIL WATER MONITORING RECORD SHEET

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SITE NA DATE SA	ME:Port Meado MPLED:12/02/9	рж ЭЗ		SAMPLED BY	C:D.HAWLEY	
HONITO	MONITORING POINT		GROUNDWATER/LEACHATE			
REF NO.	COVER LEVEL	DEPTH B.C.L.	LEVEL m.A.O.D.	ANALYSIS Suite	OBSERVATIONS	
E BH3 BH5 BH7 BH9 BH11	58.37 60.62 59.78 60.75 62.01 60.76	01.07 03.23 02.48 03.35 04.00 03.33	57.30 57.39 57.30 57.40 58.01 57.43	0CC2 0CC2 0CC2 0CC2 0CC2 0CC2		
			· ·			
				·	 	

KEY OCC1 - BASIC INORGANIC SUITE, OCC2 - FULL INORGANIC SUITE OCC3 - SELECTED METALS, OCC4 - VOLATILE ORGANICS B.C.L.- BELOW COVER LEVEL A.O.D. - ABOVE ORDNANCE DATUM

.

OXFORDSHIRE COUNTY COUNCIL WATER MONITORING RECORD SHEET

MONITO	RING POINT	GROUNI	WATER/LEAC	CHATE	<u> </u>	
REF No.	COVER LEVEL	DEPTH B.C.L.	LEVEL	ANALYSIS Suite	OBSERVATIONS	
BH1 BH3 BH5 BH7 BH9 BH11	58.37 60.62 59.78 60.75 62.01 60.76	01.32 03.54 02.73 03.60 04.45 03.62	57.05 57.08 57.05 57.15 57.56 57.14	OCC2/3/4 OCC2/3/4 OCC2/3/4 OCC2/3/4 OCC2/3/4 OCC2/3/4	All boreholes pumped for 10 mins. and then sampled. All samples taken clearly contaminated.	
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OCC1 - BASIC INORGANIC SUITE, OCC2 - FULL INORGANIC SUITE OCC3 - SELECTED METALS, OCC4 - VOLATILE ORGANICS B.C.L.- BELOW COVER LEVEL A.O.D. - ABOVE ORDNANCE DATUM

### THE WATER QUALITY CENTRE analysis



Mr D Hawley Oxfordshire County Council Waste Management Section Speedwell House Speedwell Street Oxford OX1 1NE [part of Thames Water Laboratories]

Spencer House Manor Farm Road Reading Berks RG2 0JN Tel 0734 236222 Fax 0734 756573

Certificate of analysis

Reference : A100947/C015626 Tag No : 00334359 Date Received : 11.06.93 Page 1 of 6

Sample Description : BH1, Suite OCC2/3/4 Sample Site : Port Meadow Sampled By : Client

Date of Sample : 11.06.93 Time of Sample : not specified

	<b>2 2</b>	
pH Value, NIL/U	6.9	
Conductivity at 20°C, µS/cm	1702	
COD, mg/l	58.0 -	
Ammoniacal Nitrogen, mg/l	50.900 -	· •
Nitrogen, Total Oxidised as N, mg/l	<1.0	1
Chloride as Cl, mg/l	122 -	/
Sulphate as SO ₄ , mg/l	81.6	<i>i</i> , , , , , , , , , , , , , , , , , , ,
Alkalinity as CaCO ₃ , mg/l	822 -	
Calcium, mg/l	128	
Sodium; mg/l	93.8	
Potassium, mg/l	38.6	
Magnesium, mg/l	29.9	
Copper, μg/l	<10	
Nickel, µg/l	· 7	
Chromium, µg/l	<5	
Zinc, µg/l	<30	
Cadmium, µg/l	<0.5	
Mercury, µg/l	< 0.05	
lron, µg/l	1541	
Boron, mg/l	2.196	
Lead, µg/l	<5	
Chloroform, µg/l	<2.5	
Bromoform, $\mu g/l$	<2.5	
Bromodichloromethane, $\mu$ g/l	<2.5	
Dibromochloromethane, $\mu g/l$	<2.5	•
Trichloroethane (1,1,1), µg/l	<1	
Carbon Tetrachloride, µg/l	<0.3	
Tetrachloroethene, µg/l	<1.0	
Trichloroethene, $\mu g/l$	5.0 -	
T.H.M Total, µg/l	0	
$\sim$		

for The Water Quality-Centre Date of Issue: 23 June 1993

NOTES :

1. Details of the individual methods of enalysis and performance characteristics are evailable upon request.

2. Tests marked "*" are not included in the NAMAS Accreditation for our laboratories.

3. The analytical results given in this report were obtained in the Spencer House, Reading Laboratories of Themes Water Utilities Limited.



The Water Quality Centre is part of Thames Water Utilities Limited Registered in England and Wates No 2366681 Registered Office Nugent House Vastern Road Reading RG1 8DB Part of Thames Water PK Group

### THE WATER QUALITY CENTRE | analysis

6.6 1252 69.1 1 16.000 -< 1.0 41 134.2 706 -188 33.2 16.8 14.0 <10 5 < 5 <30 < 0.5 < 0.05 8567

> 0.688 <5 <2.5 <2.5 <2.5 <1.5 <0.3 <1.0 <2.5 0



Mr D Hawley Oxfordshire County Council Waste Management Section Speedwell House Speedwell Street Oxford OX1 1NE

Sample Site : Port Meadow

Sampled By : Client

Sample Description : BH3, Suite OCC2/3/4

' [part of Thames Water Laboratories] Spencer House Manor Farm Road

Manor Farm Road Reading Berks RG2 0JN Tel 0734 236222 Fax 0734 756573

Certificate of analysis

Reference : A100947/C015627 Tag No : 00334360 Date Received : 11.06.93 Page 2 of 6

Date of Sample : 11.06.93 Time of Sample : not specified

pH Value, NIL/U
Conductivity at 20°C, µS/cm
COD, mg/l
Ammoniacal Nitrogen, mg/l
Nitrogen, Total Oxidised as N, mg/l
Chloride as CI, mg/l
Sulphate as SO4, mg/l
Alkalinity as CaCO ₃ , mg/l
Calcium, mg/l
Sodium, mg/l
Potassium, mg/l
Magnesium, mg/l
Copper, µg/l
Nickel, µg/l
Chromium, µg/l
Zinc, µg/l
Cadmium, µg/l
Mercury, µg/l
fron, $\mu g/l$
Boron, mg/l
Lead, µg/l
Chloroform, µg/l
Bromoform, µg/l
Bromodichloromethane, $\mu g/l$
Dibromochloromethane, µg/l
Trichloroethane $(1,1,1), \mu g/l$
Carbon Tetrachloride, µg/l
Tetrachloroethene, µg/l
Trichloroethene, $\mu g/l$
T.H.M Total, µg/l
$\sim$

for The Water Quality Centre

Date of Issue: 23 June 1993

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#### THE WATER QUALITY CENTRE

7.0 1902 77.0 -66.100 -7.2 107 -269.3 586 143 97.5 50.7 36.8 <10 10 <5 < 30 < 0.5 < 0.05 145 1.969 < 5 <2.5 <2.5 < 2.5 <2.5 <1 . < 0.3 <1.0 <2.5 0

Mr D Hawley **Oxfordshire County Council** Waste Management Section Speedwell House Speedwell Street Oxford OX1 1NE

Sample Description : BH5, Suite OCC2/3/4 Sample Site : Port Meadow Sampled By : Client

Spencer House . Manor Farm Road Reading Berks RG2-0JN Tel 0734 236222 -Fax 0734 756573

analysis

Certificate of analysis

[part of Thames Water Laboratories]

Reference : A100947/C015624 Tag No : 00334361 Date Received : 11.06.93 Page 3 of 6

Date of Sample : 11.06.93 Time of Sample : not specified

pH Value, NIL/U
Conductivity at 20°C, µS/cm
COD, mg/l
Ammoniacal Nitrogen, mg/l
Nitrogen, Total Oxidised as N, mg/l
Chloride as Cl, mg/l
Sulphate as SO,, mg/l
Alkalinity as CaCO ₃ , mg/l
Calcium, mg/l
Sodium, mg/l
Potassium, mg/l
Magnesium, mg/l
Copper, µg/l
Nickel, µg/l
Chromium, µg/l
Zinc, µg/l
Cadmium, µg/l
Mercury, µg/l
Iron, µg/l
Boron, mg/l
Lead, µg/l
Chloroform, µg/l
Bromoform, µg/l
Bromodichloromethane, µg/l
Dibromochloromethane, µg/l
Trichloroethane (1,1,1), µg/l
Carbon Tetrachloride, µg/l
Tetrachioroethene, µg/l
Trichloroethene, µg/l
T.H.M Total, µg/l

for The Water Quality Centre

Date of Issue: 23 June 1993

NOTES :

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3. The analytical results given in this report were obtained in the Spencer House, Reading Laboratories of Thames Water Utilities Limited.







6.9 1399 96.0 -43.500~ <1.0 100 -62.6 534 136 65.0 30.7 24.1 <10 <5 <5 < 30 < 0.5 < 0.05

> 0.679 <5 <2.5 <2.5 <2.5 <1^{\\} <0.3 <1.0 <2.5 0



Mr D Hawley Oxfordshire County Council Waste Management Section Speedwell House Speedwell Street Oxford OX1 1NE analysis

[part of Thames Water Laboratories]

Spencer House Manor Farm Road Reading Berks RG2 0JN Tel 0734 236222 Fax 0734 756573

Certificate of analysis

Reference : A100947/C015623 Tag No : 00334362 Date Received : 11.06.93 Page 4 of 6

Sample Description : BH7, Suite OCC2/3/4 Sample Site : Port Meadow Sampled By : Client

Date of Sample : 11.06.93 Time of Sample : not specified

pH Value, NIL/U	6
Conductivity at 20°C, µS/cm	1399
COD, ma/l	96
Ammoniacal Nitrogen, mg/l	43
Nitrogen, Total Oxidised as N, mg/l	<1
Chloride as Cl, mg/l	100
Sulphate as SO,, mg/l	62
Alkalinity as CaCO ₃ , mg/l	534
Calcium, mg/l	136
Sodium, mg/l	65
Potassium, mg/l	30
Magnesium, mg/l	24
Copper, µg/l	<10
Nickel, µg/l	<5
Chromium, µg/I	<5
Zinc, µg/l	< 30
Cadmium, µg/l	<0
Mercury, µg/l	<0
lron, µg/l	13982
Boron, mg/l	0
Lead, µg/l	<5
Chloroform, µg/l	<2
Bromoform, µg/l	<2
Bromodichloromethane, µg/l	<2
Dibromochloromethane, µg/k	<2
Trichloroethane (1,1,1), µg/l	<1
Carbon Tetrachloride, µg/l	<0
Tetrachloroethene, $\mu g/l$	<1.
Trichloroethene, µg/l	<2.
T.H.M Total, μg/l	0

for The Water Quality Centre

Date of Issue: 23 June 1993

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Thames Water Utilities Limited.



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### THE WATER QUALITY CENTRE | analysis

6.8 1791 144.0 -74.300 -<1.0 121 ~ 75.5 741 -164 65.6 35.0 21.9 <10 5 <5 < 30 < 0.5 < 0.05 24460

> 0.745 7 <2.5 <2.5 <2.5 <1 <0.3 <1.0 <2.5 0



Mr D Hawley Oxfordshire County Council Waste Management Section Speedwell House Speedwell Street Oxford OX1 1NE Spencer House Manor Farm Road Reading Berks RG2 0JN Tel 0734 236222 Fax 0734 756573

Certificate of analysis

[part of Thames Water Laboratories]

Reference : A100947/C015622 Tag No : 00334363 Date Received : 11.06.93 Page 5 of 6

Sample Description : BH9, Suite OCC2/3/4 Sample Site : Port Meadow Sampled By : Client

Date of Sample : 11.06.93 Time of Sample : not specified

pH Value, NIL/U
Conductivity at 20°C, µS/cm
COD, mg/i
Ammoniacal Nitrogen, mg/l
Nitrogen, Total Oxidised as N, mg/l
Chloride as CI, mg/l
Sulphate as SO ₄ , mg/l
Alkalinity as CaCO ₃ , mg/l
Calcium, mg/l
Sodium, mg/l
Potassium, mg/l
Magnesium, mg/l
Copper, µg/l
Nickel, µg/l
Chromium, µg/l
Zinc, µg/l
Cadmium, µg/l
Mercury, µg/l
lron, µg/l
Boron, mg/l
Lead, $\mu$ g/l
Chloroform, µg/l
Bromoform, µg/l
Bromodichloromethane, µg/l
Dibromochloromethane, µg/l
Trichloroethane (1,1,1), µg/l
Carbon Tetrachloride, µg/l
Tetrachloroethene, µg/l
Trichloroethene, µg/l
T.H.M Total, μg/l

for The Water Quality Centre

Date of Issue: 23 June 1993

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### THE WATER QUALITY CENTRE | analysis



Mr D Hawley Oxfordshire County Council Waste Management Section Speedwell House Speedwell Street Oxford OX1 1NE Certificate of analysis Reference : A100947/C015625

Spencer House Manor Farm Road

Reading Berks RG2 0JN Tel 0734 236222 Fax 0734 756573

Tag No : 00334364 Date Received : 11.06.93 Page 6 of 6

Sample Description : BH11, Suite OCC2/3/4 Sample Site : Port Meadow Sampled By : Client

Date of Sample : 11.06.93 Time of Sample : not specified

pH Value, NIL/U	6.8
Conductivity at 20°C, µS/cm	2070
COD, mg/l	115.0 -
Ammoniacal Nitrogen, mg/l	94.100 -
Nitrogen, Total Oxidised as N, mg/l	<1.0
Chloride as CI, mg/i	126 🦯
Sulphate as SO ₄ , mg/l	73.5
Alkalinity as CaCO ₃ , mg/l	876 ~
Calcium, mg/l	166
Sodium, mg/l	80.6 \
Potassium, mg/l	45.2
Magnesium, mg/l	21.0
Copper, µg/l	<10
Nickel, µg/l	´<5
Chromium, µg/l	5
Zinc, µg/l	<30
Cadmium, µg/l	<0.5
Mercury, µg/l	<0.05
lron, µg/l	23700
Boron, mg/l	1.169
Lead, µg/l	<5
Chloroform, µg/l	<2.5
Bromoform, µg/l	<2.5
Bromodichloromethane, µg/l	<2.5
Dibromochloromethane, $\mu$ g/l	<2.5
Trichloroethane (1,1,1), µg/l	<1
Carbon Tetrachloride, µg/l	<0.3
Tetrachloroethene, µg/l	<1.0
Trichloroethene, $\mu g/l$	<2.5
T.H.M Total, µg/l	0

for The Water Quality Centre

Date of Issue: 23 June 1993

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analysis [part of Thames Water Laboratories]

### OXFORDSHIRE COUNTY COUNCIL WATER MONITORING REPORT SHEET

Site Name:Port Meadow Sampled by: D. Hawley Date sampled:11/06/93 Date of results:28/06/93 All boreholes were pumped for 10 mins. prior to sampling. **INORGANICS (OCC2)** All samples taken show contamination by landfill leachate. The greatest contamination is evident in boreholes 9 & 11 located on the eastern boundary of the site. BH11 BH9 Estimated background conc. Conductivity 1791 2070 <1000 us/cm Chemical Oxygen Demand mg/l 115 < 50 144 Ammonia mg/l 74.3 94.1 <1 Chloride mg/l 121 126 <50 Sodium 80.6 mg/l 65.6 <20 Potašsium mg/l 35 45.2 <10 Magnesium mg/l 21.9 21 <10 SELECTED METALS (OCC3) Only Iron is present at levels exceeding guidelines (Water Quality Regs. 1989). Level of Iron in BH9 (mg/l) : 24.460 Guideline level : 00.300 ORGANICS (OCC4) Only in the sample taken from borehole 1 , was a parameter included in the OCC4 analytical suite , to be found. This reproduces the result obtained from the previous visit for which organics were sampled. 20/08/92 11/06/93 Guideline Level BH1 1989 Water Quality Regs Trichloroethene (ug/l) 2 5 30 Recommendations A second line of boreholes (west of the established boreholes) to be located on the Thames floodplain to ascertain the level of dilution afforded by the gravel aquifer. **INORGANICS (OCC2)** ORGANICS (OCC4) METALS (OCC3) T.H.M (TOTAL) COPPER рH CONDUCTIVITY CHLOROPORM NICKEL CHEMICAL OXYGEN DEMAND BROMOFORM CHROMIUM AMMONIA BROMODICHLOROMETHANE ZINC DIBROMOCHLOROMETHANE CHLORIDE. CADHIUM **TRICHLOROETHANE** NITRATE MERCURY SULPHATE. CARBON TETRACHLORIDE IRON

TETRACHLOROETHENE

TRICHLOROETHENB

BORON

LEAD

ALKALINITY

CALCIUN

SODIUN POTASSIUN MAGNESIUN

# Oxfordshire County Council

	Memorandum From: P. PEARCE TO: FILE	
	My Reference Internal Tel: Date 3¢/μ / ι	ie3
	NOTE FOR FILE	
	On 26/11/1993.	
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# Test report

TEST REPORT NUMBER TH/000422/94

PAGE_____OF____1

3

LAB. SAMPLE NUMBER 102308/

ARGUS LANDFILL MONITORING LTD Vulcan House Vulcan Road Solihull B91 2JY

Sample date : 17/06/94 Description : PORT MEADOW BH11

Sample received : 20/06/94

Page: 4

Analytical Results

Determinand	Result	Units
pH	6.7	
D.O. concentration	1.9	mg/l
Conductivity- Electrical 25deg	2630	uS/cm
C.O.D. (Total)	111	mg/l
Ammoniacal Nitrogen as N	114	mg/l
Nitrogen, Total Oxidised as N	Less than 0.3	mg/l
Chloride as Cl	121	mg/l
Sulphate as SO4	. 13	mg/1
Alkalinity as CaCO3	1230	mg/l
Potassium as K	75.0	mg/l
Magnesium as Mg	34	mg/l
Calcium as Ca	209	mg/l
Copper, Total as Cu	30	ug/l
Nickel, Total as Ni	17	ug/l
Chromium, Total as Cr	9	ug/l
Zinc, Total as Zn	50	ug/l
Cadmium, Total as Cd	Less than 1.0	ug/l
Manganese as Mn	340	ug/l
Iron as Fe	27400	ug/l
Lead, Total as Pb	Less than 10	ug/l
Boron as B	1470	ug/1

Analyst Comments :

b 7.

INORGANIC ANALYSIS CARRIED OUT AT BIRMINGHAM LABORATORY.

SIGNED_

BEVERLEY GALE

Unless otherwise stated Severn Trent Laboratories was not responsible for sampling. Details of the method(s) used and performance characteristics are available on request. Tests marked "Not NAMAS accredited" in this report are not included in the NAMAS Accreditation Standard for our laboratory. Opinions and interpretations expressed herein are outside the scope of NAMAS accreditation.

NAME_





TORRINGTON AVENUE COVENTRY

CV4 9GU TELEPHONE: 0203 692692

TELEFAX: 0203 421423



TEST REPORT NUMBER TH/000422/94

PAGE _____1 OF ____1

LAB. SAMPLE NUMBER _____ 102307/ 2

ARGUS LANDFILL MONITORING LTD Vulcan House Vulcan Road Solihull B91 2JY



Sample received : 20/06/94

Page: 3

evern Tre

COVENTRY LABORATOR

TORRINGTON AVENUE COVENTRY

CV4 9GU TELEPHONE: 0203 692692

TELEFAX: 0203 421423

## Analytical Results

Determinand Result Units pН 6.9 D.O. concentration 1.4 mg/l Conductivity- Electrical 25deg uS/cm 1770 C.O.D. (Total) mg/l 67 Ammoniacal Nitrogen as N 53.5 mg/l Nitrogen, Total Oxidised as N Less than 0.3 mg/lChloride as Cl 92 mg/lSulphate as SO4 47 mg/l Alkalinity as CaCO3 866 mg/l Potassium as K 42.3 mg/l Magnesium as Mg 33 mg/l Calcium as Ca 177 mg/l Copper, Total as Cu 30 ug/l Nickel, Total as Ni 13 ug/l Chromium, Total as Cr 9 ug/l Zinc. Total as Zn 80 ug/l Cadmium, Total as Cd Less than 1.0 ug/l Manganese as Mn 200 ug/l Iron as Fe 18900 ug/l Lead, Total as Pb 50 ug/l Boron as B 800 ug/l

Analyst Comments :

ANALYSIS CARRIED OUT AT BIRMINGHAM LABORATORY.

SIGNED ____

BEVERLEY GALE

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NAME



Test report	
TEST REPORT NUMBER   TH/000422/94     PAGE   OF     I   I     LAB. SAMPLE NUMBER   102306/	NAMAN TESTING No. 1314

ARGUS LANDFILL MONITORING LTD Vulcan House Vulcan Road Solihull B91 2JY

Sample date : 17/06/94 Description : PORT MEADOW BH1

Sample received : 20/06/94

Page: 2

Severn Trent

COVENTRY LABORATORY TORRINGTON AVENUE COVENTRY CV4 9GU TELEPHONE: 0203 692692 TELEFAX: 0203 421423

aborator

### **Analytical Results**

Determinand	Result	Units		
рH	6.7			
D.O. concentration	1.7	mg/l		
Conductivity- Electrical 25deg	1890	uS/cm		
C.O.D. (Total)	34	mg/l		
Ammoniacal Nitrogen as N	53.6	mg/l		
Nitrogen, Total Oxidised as N	Less than 0.3	mg/l		
Chloride as Cl	143	mg/l		
Sulphate as SO4	85	mg/l		
Alkalinity as CaCO3	886	mg/l		
Potassium as K	50.3	mg/l		
Magnesium as Mg	39	mg/l		
Calcium as Ca	173	mg/l		
Copper, Total as Cu	40	ug/l		
Nickel, Total as Ni	22	ug/l		
Chromium, Total as Cr	6	ug/l		
Zinc, Total as Zn	130	ug/l		
Cadmium, Total as Cd	Less than 1.0	ug/l		
Manganese as Mn	3200	ug/l		
Iron as Fe	2400	ug/l		
Lead, Total as Pb	Less than 10	ug/l		
Boron as B	2490	ug/l		
		-		

Analyst Comments :

ANALYSIS CARRIED OUT AT BIRMINGHAM LABORATORY.

SIGNED.

inter NAME

_DATE

Unless otherwise stated Severn Trent Laboratories was not responsible for BADAR Betals & the Acheb (s) used and performance (herein a characteristics are available on request. Tests marked "Not NAMAS accredited" in this report are not included in the NAMAS Accreditation Standard for our laboratory. Opinions and interpretations expressed herein are outside the scope of NAMAS accreditation.

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	-	 		

Ground Water Monitoring

Port Meadow Site: Eyres Lane

2

Operatives:

Graham White and Carl Branch

Number of well volumes to purge:

Sample Route: R13

Borehole ref Date Borehole Liquid Depth Electrical Dissolved Dissolved pН Temp Smell Comments Depth Cond Oxygen Oxygen (⁰C) (mg/l) (dd:mm:yy) (m) (m) (µS/cm) (%)

GBH 1	17/06/94	4.32	1.54	1592	1.1	7.1	12.6		Murky Brown
GBH73	17/06/94	6.1	3.7	1494	1.2	6.95	12.9	Yes	Cloudy grey Leachate odour
BH 5	17/06/94	5.4	2.7	2060	 1.6	6.83	13.9	Yes	Cloudy grey Leachate odour
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					 ······································				
,									
								$\bigcirc$	

Compiled By: Carl Rench

Checked by:



# Ground Water Monitoring

Port Meadow

2

Operatives:

C. Branch and G. White

Number of well volumes to purge:

à

Sample Route:

R13

. .

Borehole ref	Date	Borehole	Liquid Depth	Liquid Depth	Electrical	Dissolved	Dissolved	pН	Temp	Smell	Comments
1		Depth	[		Cond	Oxygen	Oxygen				
	(dd:mm:yy)	(m)	(m)	AOD (m)	(µS/cm)	(%)	(mg/l)		(°C)		
GBH 1	09/12/94	4.35	1.13	57.24	1350		3.2	7.58	11.5	No	Clear
GBH 3	09/12/94	5.09	2.89	57.43	640		2.1	8.12	10.5	Yes	Clear, slight leachate odour
GBH 5	09/12/94	5.60	2.39	57,39	1990		1.5	7.29	13.6	No	Clear
GBH 7	09/12/94	5.80	3.26	57.49	1640		1.4	7.24	13.1	Yes	Clear, leachate odour
GBH 9	09/12/94	5.24	3.84	58.17	1610		1.2	7.14	12.9	Yes	Cloudy, leachate odour
GBH 11	09/12/94	5.35	3.30	57.46	1730		1.2	7.25	12.7	Yes	Cloudy, leachate odour. Loose cover

Checked by:

Page 1

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2	20
PAGE	OF
LAB. SAMPLE NUMBER	132250

Sample Dated :08-Dec-1994Sample Received :09-Dec-1994Analysis Commenced:09-Dec-1994

Sample Description : PORT MEADOW GBH 1





Lab	Determinand name	Result	Units
B	pH	6.7	
W	D.O. concentration	1.5	mg/l
В	Conductivity- Electrical 25deg	1690	uS/cm
W	C.O.D. (Total)	40	mg/l
В	Ammoniacal Nitrogen as N	37.0	mg/l
В	Nitrogen, Total Oxidised as N	5.8	mg/l
В	Chloride as Cl	93	mg/l
В	Sulphate as SO4	98	mg/l
В	Alkalinity as CaCO3	557	mg/l
В	Potassium as K	38.9	mg/l
В	Magnesium as Mg	32	mg/l
В	Calcium as Ca	163	mg/l
В	Copper, Total as Cu	20	ug/l
В	Nickel, Total as Ni	10	ug/l
В	Chromium, Total as Cr	<5	ug/l
В	Zinc, Total as Zn	40	ug/l
В	Cadmium, Total as Cd	< 1.0	ug/l
В	Manganese as Mn	2000	ug/l
В	Iron as Fe	800	ug/l
В	Lead, Total as Pb	< 10	ug/l
В	Boron as B	1700	ug/l



TECT DEDART NUMBER	TH/	5802/94
3		20
PAGE	0	F
LAB. SAMPLE NUMBER		132251

Sample Dated :08-Dec-1994Sample Received :09-Dec-1994Analysis Commenced:09-Dec-1994

Sample Description : PORT MEADOW GBH 3





Lab	Determinand name	Result	Units
B	pH	6.4	
W	D.O. concentration	1.3	mg/l
В	Conductivity- Electrical 25deg	708	uS/cm
W	C.O.D. (Total)	31	mg/l
В	Ammoniacal Nitrogen as N	0.9	mg/l
В	Nitrogen, Total Oxidised as N	< 0.3	mg/l
В	Chloride as Cl	8	mg/l
В	Sulphate as SO4	59	mg/l
В	Alkalinity as CaCO3	246	mg/l
В	Potassium as K	6.3	mg/l
В	Magnesium as Mg	6	mg/l
В	Calcium as Ca	132	mg/l
В	Copper, Total as Cu	< 20	ug/l
В	Nickel, Total as Ni	<7	ug/l
В	Chromium, Total as Cr	< 5	ug/l
В	Zinc, Total as Zn	40	ug/l
В	Cadmium, Total as Cd	< 1.0	ug/l
В	Manganese as Mn	100	ug/l
В	Iron as Fe	1000	ug/l
В	Lead, Total as Pb	< 10	ug/l
В	Boron as B	< 100	ug/l



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LAB SAMPLE NUMBER		132252

Sample Dated :08-Dec-1994Sample Received :09-Dec-1994Analysis Commenced:09-Dec-1994

Sample Description : PORT MEADOW GBH 5





Lab	Determinand name	Result	Units
B	pH	6.7	
W	D.O. concentration	0.7	mg/l
В	Conductivity- Electrical 25deg	2680	uS/cm
W	C.O.D. (Total)	48	mg/l
В	Ammoniacal Nitrogen as N	68.6	mg/l
В	Nitrogen, Total Oxidised as N	3.2	mg/l
В	Chloride as Cl	89	mg/l
В	Sulphate as SO4	439	mg/l
В	Alkalinity as CaCO3	638	mg/l
В	Potassium as K	64.8	mg/l
В	Magnesium as Mg	56	mg/l
В	Calcium as Ca	215	mg/l
В	Copper, Total as Cu	20	ug/l
В	Nickel, Total as Ni	21	ug/l
В	Chromium, Total as Cr	<5	ug/l
В	Zinc, Total as Zn	30	ug/l
В	Cadmium, Total as Cd	4.3	ug/l
В	Manganese as Mn	1000	ug/l
В	Iron as Fe	300	ug/l
В	Lead, Total as Pb	< 10	ug/l
В	Boron as B	2300	ug/l



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LAB. SAMPLE NUMBER		132253

Sample Dated :08-Dec-1994Sample Received :09-Dec-1994Analysis Commenced:09-Dec-1994

Sample Description : PORT MEADOW GBH 7





Lab	Determinand name	Result	Units
В	pH	6.5	
W	D.O. concentration	< 0.5	mg/l
В	Conductivity- Electrical 25deg	2200	uŠ/cm
W	C.O.D. (Total)	78	mg/l
В	Ammoniacal Nitrogen as N	53.2	mg/l
В	Nitrogen, Total Oxidised as N	< 0.3	mg/l
В	Chloride as Cl	72	mg/l
В	Sulphate as SO4	64	mg/l
В	Alkalinity as CaCO3	770	mg/l
В	Potassium as K	35.5	mg/l
В	Magnesium as Mg	31	mg/l
В	Calcium as Ca	230	mg/l
В	Copper, Total as Cu	30	ug/l
В	Nickel, Total as Ni	10	ug/l
В	Chromium, Total as Cr	< 5	ug/l
В	Zinc, Total as Zn	50	ug/l
В	Cadmium, Total as Cd	< 1.0	ug/l
В	Manganese as Mn	300	ug/l
В	Iron as Fe	23000	ug/l
В	Lead, Total as Pb	. 12	ug/l
В	Boron as B	800	ug/l


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LAB. SAMPLE NUMBER		132254

ARGUS Landfill Monitoring Ltd

Sample Dated :08-Dec-1994Sample Received :09-Dec-1994Analysis Commenced:09-Dec-1994

Sample Description : PORT MEADOW GBH 9

Lab	Determinand name	Result	Units		
B	pH	6.6			
W	D.O. concentration	< 0.5	mg/l		
В	Conductivity- Electrical 25deg	2160	uŠ/cm		
W	C.O.D. (Total)	87	mg/l		
В	Ammoniacal Nitrogen as N	46.5	mg/l		
В	Nitrogen, Total Oxidised as N	< 0.3	mg/l		
В	Chloride as Cl	83	mg/l		
В	Sulphate as SO4	135	mg/l		
В	Alkalinity as CaCO3	698	mg/l		
В	Potassium as K	33.6	mg/l		
В	Magnesium as Mg	28	mg/l		
В	Calcium as Ca	250	mg/l		
В	Copper, Total as Cu	30	ug/l		
В	Nickel, Total as Ni	40	ug/l		
В	Chromium, Total as Cr	40	ug/l		
В	Zinc, Total as Zn	90	ug/l		
В	Cadmium, Total as Cd	< 1.0	ug/l		
В	Manganese as Mn	600	ug/l		
В	Iron as Fe	23000	ug/l		
В	Lead, Total as Pb	13	ug/l		
В	Boron as B	700	ug/l		







Test report

TEST REPORT NUMBER		TH/	5802/	'94
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LAB. SAMPLE NUMBER_			13225	5

ARGUS Landfill Monitoring Ltd

Sample Dated :08-Dec-1994Sample Received :09-Dec-1994Analysis Commenced:09-Dec-1994

Sample Description : PORT MEADOW GBH 11

Lab	Determinand name	Result	Units		
B	pH	6.5			
W	D.O. concentration	< 0.5	mg/l		
В	Conductivity- Electrical 25deg	2230	uS/cm		
W	C.O.D. (Total)	101	mg/l		
В	Ammoniacal Nitrogen as N	70.8	mg/l		
В	Nitrögen, Total Oxidised as N	< 0.3	mg/l		
В	Chloride as Cl	83	mg/l		
В	Sulphate as SO4	54	mg/l		
В	Alkalinity as CaCO3	755	mg/l		
В	Potassium as K	42.6	mg/l		
В	Magnesium as Mg	21	mg/l		
В	Calcium as Ca	210	mg/l		
В	Copper, Total as Cu	< 20	ug/l		
В	Nickel, Total as Ni	22	ug/l		
В	Chromium, Total as Cr	<5	ug/l		
В	Zinc, Total as Zn	40	ug/l		
В	Cadmium, Total as Cd	< 1.0	ug/l		
В	Manganese as Mn	300	ug/l		
В	Iron as Fe	21000	ug/l		
В	Lead, Total as Pb	< 10	ug/l		
В	Boron as B	900	ug/l		







## Appendix C Plots of groundwater levels in monitoring boreholes in Burgess Field waste dump



Figure C1 Groundwater levels in monitoring borehole GBH1 in Burgess Field waste dump



Figure C2 Groundwater levels in monitoring borehole GBH3 in Burgess Field waste dump



Figure C3 Groundwater levels in monitoring borehole GBH5 in Burgess Field waste dump



Figure C4 Groundwater levels in monitoring borehole GBH7 in Burgess Field waste dump



Figure C5 Groundwater levels in monitoring borehole GBH9 in Burgess Field waste dump



Figure C6 Groundwater levels in monitoring borehole GBH11 in Burgess Field waste dump

Appendix D Burgess field Landfill Gas concentration with time graphs



Figure D1 GBH1 landfill gas concentrations time series.



G2

Figure D2 G2 landfill gas concentrations time series.





Figure D3 GBH3 landfill gas concentrations time series.



Figure D4 G4 landfill gas concentrations time series.

250000 CH4 • 0 CO2 02 • 200000 T 150000 bpm 100000 50000 0 0 O 0 O 0 0 ----01/94 01/95 01/96 01/91 01/92 01/93 01/97 Date

Figure D5 GBH5 landfill gas concentrations time series.



Figure D6 G6 landfill gas concentrations time series.



Figure D7 GBH7 landfill gas concentrations time series.

G8



Figure D8 G8 landfill gas concentrations time series.



Figure D9 GBH9 landfill gas concentrations time series.

G 10



Figure D10 G10 landfill gas concentrations time series.



Figure D11

G 12



Figure D12 G12 landfill gas concentrations time series.



Figure D13 G13 landfill gas concentrations time series.

## Appendix E Hydrochemistry with time for Burgess field



Figure E1 GBH1Major elements time series.



Figure E2 GBH1 Dissolved N time series.



Figure E3 GBH3 major elements time series



Figure E4 GBH3 Dissolved N time series



Figure E5 GBH5 major elements time series



Figure E6 GBH5 dissolved N time series



Figure E7 GBH7 major elements time series



Figure E8 GBH7 dissolved N time series



Figure E9 GBH9 major elements time series



Figure E10

**GBH9** dissolved N time series





**GBH11 major elements time series** 



Figure E12 GBH1 Trilinear plot. December 1994 data is incomplete and not plotted.



Figure E13 GBH3 Trilinear plot. December 1994 data is incomplete and not plotted.



Figure E14 GBH5 Trilinear plot. December 1994 data is incomplete and not plotted.

GBH7



Note: Light green is Feb 1993 with very high bicarbonate.

Figure E15 GBH7 Trilinear plot. December 1994 data is incomplete and not plotted.



Figure E16 GBH9 Trilinear plot. December 1994 data is incomplete and not plotted.







Figure E18 GBH3 phosphate chemistry time series





Figure E19 GBH5 phosphate chemistry time series



Figure E20 GBH9 phosphate chemistry time series

Site	Ca	Mg	Na	К	HCO ₃	Cl	SO4	NO2	NO3	TON	NH4	рН	SEC
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l		μS/cm
GBH1													
n	5	5	4	5	5	5	5			5	5	6	6
min	107	14.7	68.8	13.8	628	69	66			<dl< td=""><td>30.3</td><td>6.7</td><td>1178</td></dl<>	30.3	6.7	1178
max	166	34.5	106	43.4	1003	143	157.2			5.8	66.3	7.6	1777
median	154	29.9	90.3	38.6	844	95	84.4			0.6	47.7	6.8	1520
average	143.6	26.2	88.9	32.7	814	104.4	97.44			1.7	48.9	6.9	1498
GBH3													
n	8	8	7	8	8	8	10	5	5	5	10	8	9
min	132	6	7.8	5.6	300	8	59		<dl< td=""><td>0.1</td><td>1.2</td><td>6.4</td><td>640</td></dl<>	0.1	1.2	6.4	640
max	440.2	28.4	54.2	48.5	1053	60.5	429.9	<dl< td=""><td>5.59</td><td>1.1</td><td>45.0</td><td>8.1</td><td>2110</td></dl<>	5.59	1.1	45.0	8.1	2110
median	228	20.0	41.2	30.6	728	46.5	240.4		0.15	0.2	23.5	6.6	1496
average	256.2	18.7	38.5	27.0	728	40.1	232.4		1.32	0.4	22.9	6.8	1389
GBH5													
n	10	10	9	10	10	10	10	5	5	5	10	9	9
min	126	30.2	52.9	43.2	429	29.4	80		2.55	0.4	9.6	6.7	1438
max	318	60.9	103.2	64.8	863	107	735.5	<dl< td=""><td>16.2</td><td>31.2</td><td>88.5</td><td>7.5</td><td>2680</td></dl<>	16.2	31.2	88.5	7.5	2680
median	194.2	42.2	58.4	52.6	764	71.5	285.5		5.85	3.2	69.1	6.9	1902
average	193.8	42.6	69.8	53.6	741	70.3	310.3		6.89	8.66	63.6	7.0	1904
GBH7													
n	5	5	4	5	5	5	5			3	5	5	5
min	127	19.1	56.3	30.3	581	72	56			<dl< td=""><td>40.9</td><td>6.8</td><td>1189</td></dl<>	40.9	6.8	1189
max	230	31	65	35.9	1221	100	70			0.9	97.4	7.2	1907
median	136	24.1	59.1	34.8	651	89	62.6			0.2	56.1	6.9	1399
average	153	24.5	59.9	33.4	797	88.6	62.9			0.4	63.1	6.9	1470
0													
GBH9													
n	10	10	9	10	10	10	10	5	5	3	10	11	9
min	164	15.7	43.4	20.3	388	48.5	20.2	<dl< td=""><td>0.41</td><td>0.1</td><td>9.6</td><td>6.6</td><td>1403</td></dl<>	0.41	0.1	9.6	6.6	1403
max	259.5	29.2	71.7	40.1	1373	121.0	178.9	0.17	47.75	1	156.1	7.2	2430
median	183.4	20.6	50.2	34.3	879	74.8	67.4	0.05	0.84	0.15	67.7	6.8	1610
average	196.9	21.7	55.5	31.1	903	79.6	74.4	0.08	10.38	0.42	73.0	6.9	1735
G11	_	_		_	_	_	_			-	_	-	-
n	5	5	4	5	5	5	5			3	5	6	6
min	125	6.7	50.8	10.6	462	83	45.3			<dl< td=""><td>12.6</td><td>6.5</td><td>1042</td></dl<>	12.6	6.5	1042
max	210	23.1	80.6	56.4	1403	126	85.7			1	186.1	7.3	2420
median	166	21	68.6	42.6	921	95	61			0.2	91.3	6.8	1900
average	165.6	16.8	67.2	36.1	881	99.8	63.9			0.45	88.7	6.8	1788

## Table E1.Selected Burgess field data.

Site	TDP	TP	SRP	$HPO_4$	Al	As	В	Ва	Br	Cd	Со	Cr	Cs	Cu	F
	μg/l	μg/l	μg/l	mg/l	μg/l	μg/l	μg/l	μg/l	μg/l	μg/l	μg/l	μg/l	μg/l	μg/l	μg/l
GBH1															
n							3			3					
min							1600								
max							2100			<dl< th=""><th></th><th></th><th></th><th></th><th></th></dl<>					
median							1700								
average							1800								
GBH3															
n	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
min	28.0	36.0	3		2	1.6	<dl< td=""><td>119.5</td><td>0.25</td><td>0.02</td><td>4.17</td><td>0.32</td><td>0.02</td><td><dl< td=""><td>0.14</td></dl<></td></dl<>	119.5	0.25	0.02	4.17	0.32	0.02	<dl< td=""><td>0.14</td></dl<>	0.14
max	105	244.1	15	<dl< td=""><td>4</td><td>5.9</td><td>1615</td><td>140.6</td><td>0.47</td><td>0.09</td><td>5.11</td><td>0.53</td><td>0.02</td><td>5</td><td>0.18</td></dl<>	4	5.9	1615	140.6	0.47	0.09	5.11	0.53	0.02	5	0.18
median	42.6	67.2	9		4	5.0	1019	135	0.39	0.05	4.39	0.40	0.02	2	0.15
average	59.5	114	8		3.2	3.9	1009	133.8	0.37	0.05	4.48	0.41	0.02	2.4	0.16
GBH5															
n	5	5	4	5	5	5	8	5	5	8	5	5	5	5	5
min	16.1	68.3	1		1	2.1	1699	83.5	0.22	<dl< td=""><td>7.62</td><td>0.24</td><td><dl< td=""><td><dl< td=""><td>0.16</td></dl<></td></dl<></td></dl<>	7.62	0.24	<dl< td=""><td><dl< td=""><td>0.16</td></dl<></td></dl<>	<dl< td=""><td>0.16</td></dl<>	0.16
max	37.0	311.4	3	<dl< td=""><td>5</td><td>5.2</td><td>2300</td><td>121.8</td><td>0.40</td><td>4.30</td><td>11.61</td><td>0.31</td><td>0.02</td><td>1.7</td><td>0.20</td></dl<>	5	5.2	2300	121.8	0.40	4.30	11.61	0.31	0.02	1.7	0.20
median	30.9	147.0	2		2	3.6	1903	93.7	0.27	0.04	10.69	0.28	0.01	0.4	0.17
average	26.7	165.2	2		2.4	3.4	1962	99.28	0.30	0.61	10.13	0.27	0.01	0.6	0.17
GBH7															
n							3			3					
min							600			<b>.</b>					
max							800			<dl< td=""><td></td><td></td><td></td><td></td><td></td></dl<>					
median							600								
average							667								
GBH9															
n	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
min	29.1	59.7	1	0.0	3	13.2	543	149.5	0.40	<dl< td=""><td>2.08</td><td>0.57</td><td>0.04</td><td><dl< td=""><td>0.05</td></dl<></td></dl<>	2.08	0.57	0.04	<dl< td=""><td>0.05</td></dl<>	0.05
max	73.4	307.0	- 11	0.5	7	22.3	922	335	0.70	0.02	4.43	1.31	0.19	5.1	0.13
median	45.7	88.0	2	0.1	3	18.5	700	162.4	0.47	0.02	2.70	0.92	0.07	0.9	0.12
average	46.8	152.8	3.6	0.1	4.2	17.5	685	219.9	0.51	0.02	2.97	0.89	0.10	1.6	0.11
G11															
n															
min															
max															
median															
average															

	Fe														
Site	total	Li	Mn	Мо	Ni	Pb	Rb	Sb	Se	Si	Sn	Sr	U	V	Zn
	μg/l	μg/l	μg/l	μg/l	μg/l	μg/l	μg/l	μg/l	μg/l	μg/l	μg/l	μg/l	μg/l	μg/l	μg/l
GBH1															
n	3		1												
min	800		2000												
max	3363		2000												
median	1541														
average	1901														
uveruge	1501														
GBH3															
n	8	5	6	5	5	5	5	5	5	5	5	5	5	5	5
min	1000	65.0	100	0 69	<di< td=""><td>0.02</td><td>15 13</td><td>0.20</td><td>0 10</td><td>7 43</td><td>0 13</td><td>1111</td><td>1 34</td><td><di< td=""><td>4.0</td></di<></td></di<>	0.02	15 13	0.20	0 10	7 43	0 13	1111	1 34	<di< td=""><td>4.0</td></di<>	4.0
may	8567	98.0	1260	0.82	27.7	0.02	18 76	0.46	0.10	9.13	0.10	1210	3 25	0.20	03.8
modian	2001	90.0	1200	0.02	10.7	0.11	10.70	0.40	0.25	9.21	0.20	1201	2.25	0.20	55.0
meulan	2901	82.0	772	0.70	19.7	0.05	17.62	0.54	0.20	0.10	0.10	1101	2.29	0.20	52.2
average	3475	80.4	/51	0.74	21.4	0.05	17.02	0.32	0.17	8.34	0.17	1191	2.23	0.16	55.4
GBH5	0	-	c	-	-	-	-	-	-	-	-	-	-	-	-
n	8	5	0	5	5	5	5	5	5	5	5	5	5	5	5
min	145	108.0	807	0.21	13.2	<dl< td=""><td>8.81</td><td>0.09</td><td><dl< td=""><td>7.42</td><td>0.15</td><td>745</td><td>0.69</td><td></td><td>1.3</td></dl<></td></dl<>	8.81	0.09	<dl< td=""><td>7.42</td><td>0.15</td><td>745</td><td>0.69</td><td></td><td>1.3</td></dl<>	7.42	0.15	745	0.69		1.3
max	14901	144.0	1000	0.43	16.3	0.10	10.29	0.11	0.40	13.9	0.26	993	0.86	<dl< td=""><td>8.3</td></dl<>	8.3
median	4006	131.0	914	0.30	14.8	0.03	9.43	0.10	0.25	7.94	0.18	876	0.83		6.6
average	5161	128.6	904	0.30	14.6	0.05	9.54	0.10	0.25	9.06	0.19	869	0.80		5.1
GBH7															
n															
min															
max															
median															
average															
GBH9															
n	8	5	6	5	5	5	5	5	5	5	5	5	5	5	5
min	10097	23.0	238	0.68	6.1	0.06	13.25	0.16	<dl< td=""><td>6.69</td><td>0.36</td><td>688</td><td>0.10</td><td><dl< td=""><td>6.0</td></dl<></td></dl<>	6.69	0.36	688	0.10	<dl< td=""><td>6.0</td></dl<>	6.0
max	24508	47.0	600	0.80	17.1	0.24	24.67	0.35	0.40	8.02	0.98	902	0.25	0.30	51.5
median	18995	27.0	309	0.77	7.1	0.08	15.31	0.19	0.30	7.36	0.46	795	0.15	0.20	12.0
average	18529	31.4	358	0.76	8.8	0.13	17.66	0.22	0.31	7.41	0.57	777	0.16	0.22	19.6
G11															
n	3		1												
min	1758		300												
max	23700		300												
median	21000														
average	15486														

Note: Data below the detection limit have been replaced with half detection limit concentrations for the calculations. Data from 1992 to 1994 for Cr, Cu, Ni, Pb and Zn have been deleted from the dataset due to high detection limits. Ag, Be, W, Ce, Ti, Zr excluded as below or near DL.