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THORPE MARSH LANDFILL (EPR/CP3091SC/V002) ENVIRONMENTAL MONITORING PLAN

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THORPE MARSH LANDFILL (EPR/CP3091SC/V002)
ENVIRONMENTAL MONITORING PLAN

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1. INTRODUCTION

1.1 Background

As part of our ongoing support to Thorpe Marsh Green Energy Hub Limited ("TMGEHL" or herein "the "Client"), Ramboll UK Limited ("Ramboll") have produced an Environmental Monitoring Plan (EMP) for Thorpe Marsh Landfill (the "site"). The landfill is to be redeveloped into a Battery Energy Storage System (BESS).

This EMP includes monitoring requirements for both the existing landfill and the proposed new landfill cell.

1.2 Objectives

This EMP has been designed to support the site's environmental permit (reference EPR/CP3091SC) variation application, provide information on the environmental condition of the site over the permit lifetime and to enable compliance with future permit conditions. The site also has a discharge consent (reference WRA 7038) for surface water run-off into a tributary of Ea Beck.

This report has been produced in accordance with:

- Environmental Permit Waste Management Licence No. WD20D53 dated 1977 and subsequent variations;
- Thorpe Marsh – Waste Management Licence Working Plan, H J Banks & Co Ltd, revision 1 dated 9th March 2001;
- Guidance on the management of landfill gas, Environment Agency, reference LFTGN03 dated 24th June 2014;
- Guidance on Monitoring of Landfill Leachate, Groundwater and Surface Water, Environment Agency, reference LFTGN02 dated 24th June 2014;
- Thorpe Marsh Tip, Environmental Monitoring Plan, Egniol Consulting Ltd, reference ECL.7991.R03.001 Rev D, dated February 2022;
- Thorpe Marsh Landfill (EPR/CP3091SC/V002), Conceptual Site Model, 1620016237-012-RAM-RP-SS-001 dated June 2024; and
- Thorpe Marsh Landfill (EPR/CP3091SC/V002), Hydrogeological Risk Assessment, 1620016237-012-RAM-RP-SS-001 dated June 2024

There is no requirement for monitoring of leachate levels or leachate composition, therefore this has not been included in this report.

1.3 Constraints and Limitations

This report has been prepared by Ramboll exclusively for the intended use by the Client in accordance with the agreement (proposal dated 18th August 2023) between Ramboll and the Client defining, among others, the purpose, the scope and the terms and conditions for the services, namely for this aspect on-going advice in terms of environmental permitting and the associated requirements. No other warranty, expressed or implied, is made as to the professional advice included in this report or in respect of any matters outside the agreed scope of the services or the purpose for which the report and the associated agreed scope were intended or any other services provided by Ramboll.

In preparation of the report and performance of other services, Ramboll has relied upon publicly available information, information provided by the Client and information provided by third parties.

Ramboll's services are not intended as legal advice, nor an exhaustive review of site conditions and/or compliance. This report and accompanying documents are initial and intended solely for the use and benefit of the Client for this purpose only and may not be used by or disclosed to, in whole or in part, any other person without the express written consent of Ramboll. Ramboll neither owes nor accepts

any duty to any third party, unless formally agreed by Ramboll through that party entering into, at Ramboll's sole discretion, a written reliance agreement.

Unless stated otherwise, the geological information provided is for general environmental interpretation and should not be used for other geotechnical and / or design purposes.

2. MONITORING WELL NETWORK

The construction of the new landfill cell will require decommissioning of all monitoring wells within the proposed new cell boundary. As this EMP includes monitoring during the operational landfill phase, these wells will be decommissioned and replaced (where necessary) prior to the excavation and re-deposition of PFA. Monitoring wells requiring decommissioning are summarised below and shown on Figure X, Appendix 1:

- GEL wells (2024): RBH116, RBH119, RBH124*, RBH125, RBH126, RBH129, RBH131, RBH132, RBH141A*, RBH143 and RBH145*.
- Egniol wells: BH1, BH5 and BH6, and MW1D, MW2, MW5S*, MW5D*

Wells marked with an asterisk are located close to the new cell boundary or the edges of the attenuation ponds, so further assessment is required as to whether they can be retained during landfill operations.

All borehole/monitoring well decommissioning shall be undertaken in line with the EA's guidance on decommissioning redundant boreholes and wells[1] and details of the decommissioning process for each monitoring well will be recorded using the decommissioning field sheet in Appendix 2. Borehole Logs are presented as Appendix 3.

The monitoring wells to be retained as part of the EMP network will require protection during landfilling activities. Protection will typically comprise a concrete inspection chamber ring placed encompassing the well, together with signage denoting the monitoring well's presence, thereby protecting it from impacts from plant or excavation activities.

Any damage to the monitoring well network on-site caused by landfilling activities must be reported within 24 hrs. This is to ensure that the full monitoring well network is available to meet the objectives of the gas and groundwater monitoring programme.

The site will be an operational BESS during the aftercare phase of the landfill; however, access will be maintained at all times to allow monitoring of the well network and repairs, where necessary.

[1] Good Practice for Decommissioning Boreholes and Wells; Environment Agency, October 2012

3. MONITORING WELL CONDITION SURVEY

Each monitoring visit should include a monitoring well condition survey to include:

- Access issues, vegetation cover and whether the well is easily visible and identifiable;
- Surrounding ground condition / sunken ground or cover; and
- Cover, bolts and seals;
- End cap / gas taps;
- Surface water ingress in cover or well;
- Silting up of the base of the borehole, especially where this may extend above the screened section of the well; and
- Obstructions or blockages in the well pipe.

All monitoring wells should be labelled and locked when not in use.

Where damage to monitoring wells has been noted, this should be repaired prior to the next monitoring visit.

4. LANDFILL GAS MONITORING PLAN

4.1 Ground Gas Monitoring Wells

The existing environmental permit for the dilute and disperse landfill requires monitoring of landfill gas from in-waste monitoring wells and at the site's perimeter.

However, the site does not currently have a landfill gas management system and one is not proposed as part of this permit variation. Only PFA will be relocated under the proposed permit variation; PFA is not degradable and therefore cannot produce landfill gas. Small volumes of untreated domestic and commercial waste exist in the southeast of the site, however given the anticipated volume and the length of time since deposition, the potential for landfill gas generation is low. Therefore, the existing ground gas monitoring programme remains unchanged, with the exception of the decommissioning and re-installation of some monitoring wells which are currently located within the proposed new landfill cell.

Ground gas monitoring wells are summarised below in Table 4-1 and locations presented on Figure 2, Appendix 1.

Table 4-1. Summary of Groundwater Monitoring Wells

Monitoring Well ID	X	Y	Screened Strata	Well Screen (m bgl)	Installed By
BH1*	459582.1	409640.7	PFA	1.0 – 15.0	Egniol (2021)
BH2	459580.5	409326.3		1.0 – 15.0	Egniol (2021)
BH3	459350.7	409123.5		1.0 – 15.0	Egniol (2021)
BH4	459206.0	409167.9		1.0 – 15.0	Egniol (2021)
BH5*	459182.4	409392.4		1.0 – 15.0	Egniol (2021)
BH6*	459205.1	409572.7		1.0 – 15.0	Egniol (2021)
MW1D*	459720.6	409826.8	Drift	5.0 – 10.0	Egniol (2021)
MW2*	459713.7	409521.5		8.0 – 18.0	Egniol (2021)
MW3	459485.9	409071.9		8.5 – 13.0	Egniol (2021)
MW4D	459689.3	409303.6		11.2 – 15.0	Egniol (2021)
MW5DA	459389.8	409077.9		13.7 – 16.7	Egniol (2021)
MW6D	459098.6	409208.5		10.0 – 15.0	Egniol (2021)
MW7DA	459094.3	409668.9		9.0 – 14.5	Egniol (2021)

*Monitoring well to be replaced as existing well within proposed new landfill cell.

New monitoring wells will be installed with long response sections which screen the full thickness of the waste at each location. These wells will also be used to monitor groundwater levels within the waste.

Detailed ground gas monitoring field procedures are included in Appendix 4.

4.2 Landfill Gas Control Limits and Monitoring Programme

The proposed monitoring regime is presented in Table 4-2 below. There is an existing permit condition for the current landfill for ground gas monitoring at least once per year. In addition, Control Limits are specified in the permit for methane (1 % v/v) and carbon dioxide (1.5 % v/v).

Table 4-2: Landfill Gas Monitoring Requirements

Monitoring Point	Monitoring Frequency	Parameters	Control Limit
In-waste wells: BH1-BH6 and RBH141(MG) Perimeter wells installed in the drift:	Landfill operation: Every two months for the first 6 months, then quarterly (anticipated to be up	Methane, % v/v	1
		Carbon Dioxide, % v/v	1.5
		Oxygen, % v/v	n/a
		Gas Flow, l/sec	n/a

MW1-MW8 and RBH141A Note: BH1, BH5 and BH6 are located within the proposed new landfill cell so will be decommissioned prior to PFA movements and will be reinstalled once deposition is complete.	to 24 months duration in total). Aftercare: Quarterly for the first year, then annually	Differential and atmospheric Pressure, mbar	n/a
		Total Volatile Organic Compounds at RBH141(MG) only, ppm	n/a

The monitoring results will be reviewed after each monitoring survey and assessed for compliance with control limits. In the event of a borehole recording methane or carbon dioxide in excess of the control limits, subsequent investigations will take place to determine whether the concentrations are within normal ranges for the borehole. Other factors such as atmospheric pressure change will also be assessed.

The landfill gas monitoring results will be reported to the Environment Agency annually.

5. GROUNDWATER MONITORING PLAN

5.1 Groundwater Monitoring Wells

Hemingbrough Glaciolacustrine Formation was recorded below the waste within all boreholes across the site area and is classified as Unproductive Strata. The thickness of the glaciolacustrine deposits ranged between 4.50 m (in the east of the site, off the bund) and to 67.5 m (in the south-east of the site). Immediately east of the site is alluvium, which is classified as a Secondary A Aquifer.

The drift deposits are underlain by bedrock of the Chester Formation, a Principal Aquifer. The site is also located within a Source Protection Zone III (Outer Catchment) associated with nine abstraction wells to the south-east and south of the site all of which are greater than 2km from the site. Probable weathered sandstone was encountered from depths of between 10.50 m bgl / -2.06 m AOD (in the north-east of the site) and 71.50 m bgl / -60.1 m AOD (in the south-east). The depth to bedrock (and the deeper drift deposits) within the south-east of the site indicates the presence of an infilled glacial channel known as the Barnaby Dunn Station Channel by the BGS[2]. This could act as a preferential pathway for groundwater, however, based on the available evidence and as the channel and surrounding geology comprises low permeability glaciolacustrine deposits, this does not appear to be having a significant effect on groundwater on-site.

In general, the proposed groundwater monitoring well network is as presented in the previous EMP for the existing landfill. The PFA to be excavated and re-deposited as part of the landfill cell is will not have an impact on existing groundwater quality and therefore no addition monitoring locations are proposed, with the exception of RBH141A(D), which is located down inferred hydraulic gradient of the commercial waste impacted with solvents identified during the 2024 investigation.

The majority of wells are screened within the drift deposits (Unproductive strata), with a further three monitoring wells within the deeper Principal bedrock aquifer.

Groundwater monitoring wells to be dipped (monitored) and sampled are summarised below in Table 5-1 and locations presented on Figure 1, Appendix 1.

Table 5-1. Summary of Groundwater Monitoring Wells

Monitoring Well ID			Screened Strata	Well Screen (m bgl)	Installed By
MW1D*	459720.6	409826.8	Drift	5.0 – 10.0	Egniol (2021)
MW2*	459713.7	409521.5		8.0 – 18.0	Egniol (2021)
MW3	459485.9	409071.9		8.5 – 13.0	Egniol (2021)
MW4D	459689.3	409303.6		11.2 – 15.0	Egniol (2021)
MW5DA	459389.8	409077.9		13.7 – 16.7	Egniol (2021)
MW6D	459098.6	409208.5		10.0 – 15.0	Egniol (2021)
MW7DA	459094.3	409668.9		9.0 – 14.5	Egniol (2021)
RBH141A(D)	459698.5	409375.2		12.0 – 38.0	GEL (2024)
MW4S	459680.7	409299.3	Sandstone	78.0 – 83.0	Egniol (2021)
MW5S	459364.2	409061.5		36.0 – 45.0	Egniol (2021)
MW7S	459097.0	409672.6		45.0 – 50.0	Egniol (2021)

*Monitoring well to be replaced as existing well within proposed new landfill cell.

Borehole logs for all monitoring wells are included in Appendix 2, however logs are not available for MW2 and MW3 which were installed prior to 1994. Detailed groundwater sampling field procedures are included in Appendix 5.

[2] PRICE, S.J, BANKS, V, COOPER, A.H, WILDMAN, G,KESSLER, H, BURKE, H.F, TERRINGTON, R, BRIDGE, D & SHEPLEY, M. 2006.3-D hydrogeological characterisation of the superficial deposits between Doncaster and Retford. British Geological Survey Internal Report, CR/06/027. 30pp.

New drift groundwater monitoring wells will have short response sections approximately 3-5 m in length, fully within the drift deposits, with a sufficient bentonite seal at the top to prevent the creation of a preferential groundwater pathway from the PFA.

5.2 Groundwater Control Limits

The proposed groundwater monitoring control limits are summarised in Table 5-2 below. This incorporates monitoring required for the current landfill, although there are no corresponding compliance limits in the existing permit for groundwater. Therefore, control limits have been included for analytes indicative of PFA in the new landfill cell only.

Table 5-2. Groundwater Control Limits

Monitoring Point	Parameters	Maximum Concentration (2021-24)	Control Limit
MW1D, MW2, MW3, MW4D, MW5DA, MW6D, MW7DA and RBH141A(D)	Arsenic	399 µg/l	600 µg/l
	Cadmium	25 µg/l	38 µg/l
	Lead	1.70 µg/l	10 µg/l**
	Mercury	3.16 µg/l	4.74 µg/l
	Sulphate as SO4	6,930 mg/l	10,395 µg/l
	Vanadium	220 µg/l	330 µg/l

**Drinking Water Standards

Control limits have been taken from the maximum recorded concentration in groundwater between 2021 and 2024 plus 50% or the Drinking Water Standard (DWS) or EQS, whichever is highest, due to the existing elevated background concentrations reported in groundwater. Control limits have been applied to groundwater in the drift deposit only, as conservative protection of groundwater quality in the deeper sandstone aquifer.

5.3 Groundwater Monitoring Programme

The proposed groundwater monitoring regime is summarised in Table 5-3 below.

Table 5-3. Groundwater Monitoring Requirements

Monitoring Point	Monitoring Frequency	Parameters
MW1D, MW2, MW3, MW4D, MW5DA, MW6D, MW7DA and RBH141A(D) MW4S, MW5S and MW7S	Landfill operation: Every two months for the first 6 months, then quarterly (anticipated to be up to 24 months duration in total). Aftercare: Quarterly for the first year, then annually.	pH Electrical conductivity Metals (arsenic, boron, cadmium, calcium, chromium (III and VI), copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, sodium and zinc Total Sulphate Ammoniacal nitrogen Chloride Volatile Organic Compounds (RBH141A(D) only)

Groundwater samples obtained from RBH141A(D) will be analysed for volatile organic compounds (VOC) as this monitoring well is located down inferred hydraulic gradient of commercial waste impacted with solvents.

The groundwater purging and sampling methodology utilised should aim to minimise the amount of entrained sediment and the potential loss of volatiles.

The monitoring results will be reviewed after each monitoring survey and assessed for compliance with control limits. In the event of a groundwater sample recording concentrations in excess of the control limits, subsequent monitoring and/or investigations will be undertaken, as required.

The groundwater monitoring results will be reported to the Environment Agency annually.

6. SURFACE WATER MONITORING PLAN

There are four surface water drains which run parallel to the landfill's south-western, south-eastern and eastern boundaries. The third drain from the site is Thorpe Marsh Drain, also known as the Ea Beck. Detailed surface water sampling field procedures are included in Appendix 4.

6.1 Surface Water Sample Locations

The proposed surface water sampling locations have been chosen based on the following:

- The proposed new landfill cell design includes the creation of several large attenuation ponds. These ponds will collect surface water run-off only and will be sampled via the discharge point (DP1) only. Discharge at DP1 is regulated by discharge consent WRA7038, which requires facilities to be provided to enable sampling;
- The area where surface water discharges under consent to a tributary of Ea Beck (DP1) and upstream and downstream of this point;
- The 2024 CSM (see Section 1.2, above) indicated that the inner two toe drains are in potential hydraulic continuity with groundwater beneath the landfill. Therefore, proposed sample locations include down inferred hydraulic gradient of the landfill and a further sample location to the northeast of the landfill from both drains;
- Collection of upstream and downstream samples from Ea Beck (Thorpe Marsh Drain) as surface water run-off from the toe drain is pumped to Ea Beck; and
- Upstream and downstream locations on Thorpemere pond, which discharges to the south to the pumping station.

A description of the proposed monitoring locations is summarised in Table 6-1 below and presented on Figure 2, attached. Sample locations DP1 and SS1-5 are as per the previous EMP.

Table 6-1. Surface Water Sample Locations

Sampling Location	X	Y	Description
Inner Toe Drain			
DP1	459148.5	409060.7	Landfill discharge point to toe drain
SS1	459115.4	409077.1	West of DP1
SS2	459563.4	409148.9	Midstream and down hydraulic gradient of the landfill based on groundwater flow direction to south-east
SS4	459183.4	409042.0	East of DP1
SS12	459783.0	409476.0	North-east of landfill (possibly upstream assuming flow to south-west)
Outer Toe Drain			
SS7	459105.1	409065.8	Upstream of landfill
SS9	459565.3	409138.1	Midstream and down hydraulic gradient based on groundwater flow direction to south-east
SS13	459875.3	409849.4	North-east of landfill (possibly upstream assuming flow to south-west)
Ea Beck (Surface Water Pumped to Ea Beck via Pumping Station between SS3 and SS10)			
SS3	458874.3	409110.0	Upstream on Thorpe Marsh Drain / Ea Beck
SS10	459541.2	409016.1	Midstream and down hydraulic gradient based on groundwater flow direction to south-east
Thorpemere Pond			
SS5	458961.5	409247.4	Southern discharge from Thorpemere Pond to pumping station
SS16	458937.8	409536.8	Northern boundary (upstream) of Thorpemere pond

Previously surface water monitoring was undertaken at Discharge Point 2 (DP2) located to the northeast of the landfill. However, the associated discharge consent (reference WRA7037) is for surface water run-off from the former coal stock yard, which is located outside of the environmental permit boundary. Therefore, this discharge consent will not be monitored as part of this EMP.

6.2 Surface Water Control Limits

The proposed surface water control limits are presented below in Table 6-2. This incorporates monitoring required for the current landfill, although there are no corresponding control limits in the existing permit for surface water (with the exception of the discharge point).

Table 6-2. Surface Water Control Limits

Monitoring Point	Parameters	Maximum Concentration (2021-24)	Control Limit
DP1	Suspended Solids	n/a	50 mg/l
	pH	n/a	<6 and >10
	Total TPH	n/a	10 mg/l
SS1, SS2, SS4, SS12 SS7, SS9, SS13 SS3, SS10, SS14 SS5 and SS16	Arsenic	20 µg/l	50 µg/l*
	Cadmium	0.61 µg/l	0.92 µg/l
	Lead	0.30 µg/l	0.45 µg/l
	Mercury	0.21 µg/l	0.32 µg/l
	Sulphate as SO4	1,890 mg/l	2,835 µg/l
	Vanadium	21 µg/l	32 µg/l

TPH = Total Petroleum Hydrocarbons

* Freshwater Environmental Quality Standard (Annual Average)

The remaining analytes are those which were identified in soil leachate results as exceeding their corresponding generic assessment criteria GAC or minimum reporting value (MRV).

Compliance limits have been taken from the maximum recorded concentration in surface water between 2021 and 2024 plus 50%, or the Environmental Quality Standard (EQS), whichever is highest. The EQS has not been used where this is below recent surface water concentrations as these are considered representative of background conditions in surface water adjacent to a historical dilute and disperse landfill.

6.3 Surface Water Monitoring Programme

The proposed surface water monitoring regime is summarised in Table 5-3 below.

Table 6-3. Surface Water Monitoring Requirements

Monitoring Point	Monitoring Frequency	Parameters
DP1	Landfill operation: Every two months for the first 6 months, then quarterly (anticipated to be up to 24 months duration in total).	Suspended Solids and Total TPH (DP1 only) pH, Electrical conductivity

SS1, SS2, SS4, SS12 SS7, SS9, SS13 SS3, SS10, SS14 SS5 and SS16	Aftercare: Quarterly for the first year, then annually.	Arsenic, boron, cadmium, calcium, chromium (III and VI), copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, sodium and zinc Total Sulphate Ammoniacal nitrogen Chloride

The monitoring results will be reviewed after each monitoring survey and assessed for compliance with control limits. In the event of a surface water sample recording concentrations in excess of the control limits, subsequent monitoring and/or investigations will be undertaken, as required.

The surface water monitoring results will be reported to the Environment Agency annually.

7. QUALITY ASSURANCE AND QUALITY CONTROL

Quality control samples should make up at least 10% of the total number of samples analysed, as directed in Table 6-1, below.

Table 6-1. Quality Assurance and quality control sampling frequencies

Type of Sample	No. of Primary Samples	No. of Duplicate Samples per Round	No. of Trip Blank Samples per Round	Laboratory Analysis
Groundwater - Drift	8	1 (MW2 / MW4D / MW5D)	1	pH, Electrical conductivity Arsenic, boron, cadmium, calcium, chromium (III and VI), copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, sodium and zinc Total Sulphate Ammoniacal nitrogen Chloride Volatile Organic Compounds (Groundwater trip blank only).
Groundwater - Sandstone	3			
Surface Water	13	1 (SS4 or SS2 as elevated concentrations expected)	1	

8. REPORTING

All monitoring data will be stored electronically and compared against control limits and historical concentrations after completion of each monitoring event.

All field record sheets, monitoring data and laboratory analytical result will be held electronically for the duration of the environmental permit.

All monitoring data collected for permit compliance will be submitted to the Environment Agency annually.

APPENDIX 1 – FIGURES

APPENDIX 2 – MONITORING WELL DECCOMMISSIONG RECORD SHEET

APPENDIX 3 – BOREHOLE LOGS

APPENDIX 4 – GROUND GAS MONITORING FIELD PROCEDURE

Ground gas Sampling Methodology

Well Condition Survey

Prior to monitoring, the condition of each well will be assessed to identify potential factors that may compromise or affect the quality of the monitoring works (e.g. missing cover / cap / gas tap and gas tap closed, not blocked, monitoring well cover effectively cemented in place (sealed) etc).

Methodology

Before starting gas monitoring, turn on the gas analyser, run clean air through the instrument and zero methane. This must be done away from any potential sources of gas.

Record background gas concentrations, atmospheric pressure and weather conditions.

Monitoring equipment should either be left on between wells, or otherwise purged with clean air between wells to ensure the methane and carbon dioxide are zeroed before monitoring subsequent wells.

Attach the outlet tube to the flow socket (if internal) or flow pod (if external) and attach the inlet tube to the gas tap on the well using the flexible tubing. Ensure the flow is reading zero before opening the gas tap. Record the peak flow rate (in litres per hour) over a minimum period of 1 minute, noting the range of flow rates detected. Negative flow rates should also be recorded.

Close the gas tap and switch the outlet tube to the gas socket. Open the gas tap and start the pump. Record the peak methane, carbon dioxide, carbon monoxide and hydrogen sulphide concentrations, together with the 'peak' oxygen concentration (the lowest oxygen concentration), and the balance (reported as nitrogen). The steady state concentrations can only be known once the peak concentration has passed. If the steady state concentrations is not reached after ten minutes, the final concentration should be recorded with a note that this reading has not stabilised.

Note: In the unlikely event that water is pulled up the tubing detach the inlet tubing and switch off the pump. Record the gas concentrations and make a note that water was pulled up. Replace the filter and remove water from tubing.

Remove the gas analyser.

Purge the gas analyser in clean air until methane and carbon dioxide levels return to zero, should this not happen naturally after five minutes of purging, then manually zero the methane and carbon dioxide concentrations.

The depth to groundwater level and depth to the well base should then be recorded using a dip meter.

After Sampling

The gas tap should be free of debris and in the closed position when replaced on the monitoring well. The cover then should be closed and secured.

Field Records

The following field data will be recorded at each location:

- Name of person completing the monitoring;
- Field equipment used and calibration;
- Weather conditions;
- Monitoring well condition;
- Peak and steady concentrations for flow and each ground gas. A note should be made if the ground gas concentrations do not stabilise within ten minutes of monitoring.
- Description of datum point used to record water level at each sampling location; and

- Depth to groundwater (if present) and depth to base of well.

APPENDIX 5 – GROUNDWATER MONITORING FIELD PROCEDURE

Groundwater Sampling Methodology

Well Condition Survey

Prior to sampling, the condition of each well will be assessed to identify potential factors that may compromise or affect the quality of the groundwater sample to be collected (e.g. missing cover / cap, cracked seal, surface spill etc).

Groundwater Gauging

The depth to water and depth to base of the monitoring well will be assessed using an electronic interface probe or dip meter. The reference point for measurements will be noted, including the distance between the reference point and ground level at each location.

The depth to the well base will be compared against previous readings to see if the well has silted up or is blocked. If significant silting up has occurred, then further well development may be required.

Groundwater Sampling

Groundwater samples should be obtained following purging if low flow (micro purge) methods are used. However, this methodology also includes the use of no purge methods.

Low flow purging

This method involves purging a relatively low volume of water (e.g. 1 well volume) at a low rate, while monitoring wellhead parameters to assess their stability, then sampling using the same equipment while pumping at a similar or lower flow rate. It is important that the groundwater level is stable and does not continuously decline (otherwise the sample should be considered a grab sample, or purging should default to dewatering and waiting for the well to recover).

A low flow pump (typically peristaltic or bladder pump) will be used in order to minimize disturbance of the water in the borehole column. The pump intake depth will be set by lowering it slowly into the well to a position midway within the saturated part of the screened interval. It is important to avoid unnecessary turbulence/mixing, which could mobilise sediment particles from the well screen or from the bottom of the well.

Wellhead parameters such as electrical conductivity, pH, temperature, turbidity and dissolved oxygen should be monitored during purging using a flow-through cell. The water will then be discharged into a bucket and disposed to ground. Purging should be continued until:

1. At least one well volume of water has been removed; *and*
2. The parameter values are approximately stable (see below).

The groundwater level will be monitored during purging to check that it is stable. If the groundwater level continues to fall during purging, the purge rate will be reduced. If groundwater level continues to fall, the well is not suitable for low flow purging and the sample that is obtained will be considered a 'grab' sample. In this scenario, the well should be fully dewatered and a sample obtained once groundwater has sufficiently recovered.

The depth to groundwater should be recorded prior to the collection of groundwater samples.

<u>Field Parameter Stabilisation</u>

Purging will continue until the differences between successive sets of field parameters, taken at intervals of at least 5 minutes or 0.5 well volumes, are within the following criteria:

- pH: ± 0.1
- Electrical Conductivity: ± 3%
- Redox: ± 10 mV
- DO: ± 10%
- Temperature: 0.2ºC
- Turbidity: ± 10%

No Purge Methods

No purging is required. Grab samples collected.

Groundwater Sampling

If the sample is being collected using a 'no purge' sampling method, the manufacturer's recommended methodology should be used for deploying the equipment and collecting the sample.

If the well has been purged, sampling should be conducted as soon as practicable following purging, and at a lower flow rate than used in purging. Prior to collecting the sample, the flow-through cell should be disconnected, and the sample collected directly from the tubing used for purging.

A fresh pair of nitrile gloves should be used at each borehole to prevent cross-contamination.

Samples should be collected with minimal turbulence and aeration into appropriately prepared bottles or vials supplied by the laboratory and should be free of air bubbles. Sample bottles will be labelled using a unique identifier. Bottles containing samples for analysis of volatile compounds should be filled to the top including a convex meniscus before the cap is put on, in order to avoid the presence of air bubbles in the sample bottle.

All samples should be filtered in the field to remove sediment. Samples will be filtered using a filtration unit fitted with a dedicated, sample-specific, high capacity 0.45 micron filter and transferred to a plastic sample bottle with appropriate preservative, as supplied by the laboratory.

Samples should be sent to a United Kingdom Accreditation Service (UKAS) approved laboratory in containers suitable for the analysis required to prevent the reporting of deviating analysis. Samples should be transported in chilled cooler boxes under chain of custody procedures.

All samples will be transferred by same-day or overnight courier where possible to the laboratory (generally within 24 hours of sampling if volatile chemicals are being tested for).

QA/QC Samples

QA/QC samples must be kept with the primary samples while on site and during transport to the laboratory.

Field duplicate will be collected in the same manner and at the same time as the primary samples.

Water for trip blanks will be supplied by the laboratory. These will be transported to site in a cool box, kept with the samples and then transported back to the laboratory with the samples.

After Sampling

Following sample collection, the monitoring well end cap / gas tap and cover will be replaced, secured, and the area around the well left tidy. Gas taps (if present) should be closed.

Equipment Decontamination

Decontamination of non-dedicated, non-single use equipment should be undertaken between monitoring wells and upon completion of monitoring.

Field Records

The following field data will be recorded at each location:

- Name of person completing the monitoring;
- Weather conditions;
- Depth to resting water level and base of well from both the well cover and ground level. A single groundwater dipping round should be undertaken prior to starting works, with monitoring wells further dipped immediately before and after purging;
- Details of measuring point (i.e. ground level or cover level) and distance between cover level and ground level;

- Field equipment used and calibration;
- Purging and sampling methodology including purge volumes and field parameter stabilisation (for low flow or micro purging methods);
- Confirmation of which samples were filtered on site;
- Record of number and type of sample container filled at each location.
- Sample observations including colour and turbidity;
- Visual and olfactory evidence of contamination including odours, sheens and globules of product (if present);
- Details of groundwater purging including volumes purged, whether the monitoring well became dry during purging and if a further grab sample was obtained. The groundwater level should be dipped immediately before collection of a grab sample to understand recharge rates;
- Field water quality parameters including temperature, dissolved oxygen, electrical conductivity, redox and pH; and
- Records to be provided in AGS4 format, where possible.

APPENDIX 6 – SURFACE WATER MONITORING FIELD PROCEDURE

Surface Water Sampling Condition Survey

Prior to sampling, the condition of each surface water sample location point should be assed for extent of vegetation cover and health and safety risks which may affect access. The project manager should be notified within 24 hours where access issues are noted and access issued should be rectified as soon as reasonably practicable.

Sampling Methodology

Samples of surface water will be collected using a telescopic extension rod with a detachable stainless steel sampling scoop. The use of the telescopic extension rod will facilitate the collection of surface water samples whilst maintaining a safe distance from the water body and associated embankments.

Subsurface samples shall be taken from approximately 30cm depth, with care taken to reduce floating films or organic material in the sample, or entrainment of bottom sediment.

Samples will be collected from the fastest flowing part of the water course where possible, avoiding stagnant parts. Where possible, field staff are to stand downstream of the sample point with collection in the flow of water to prevent disturbing water upstream of the sample location.

Samples collected from ponds or lakes should be obtained as far as possible from the banks as is safe to collect.

Equipment Decontamination

Decontamination of non-dedicated, non-single use equipment should be undertaken between monitoring wells and upon completion of monitoring. This will be undertaken to prevent cross-contamination of both samples and water bodies.

Field Records

The following field data will be recorded at each location:

- Name of person completing the monitoring;
- Description of location;
- Sketch plan or photograph of the monitoring point (if necessary);
- Grid co-ordinates of location using handheld GPS;
- Description of datum point used to record water level at each sampling location;
- Elevation of datum point (normally as m AOD);
- Flow (l/s);
- Groundwater elevation (m aOD);
- Field equipment used and calibration;
- Collection of water quality parameters including temperature, dissolved oxygen, electrical conductivity, redox and pH;
- Description of sample including colour and turbidity;
- Visual and olfactory evidence of contamination including odours, sheens and globules of product;
- Record of number and type of sample container filled at each location; and
- Confirmation of which samples were filtered in the field.