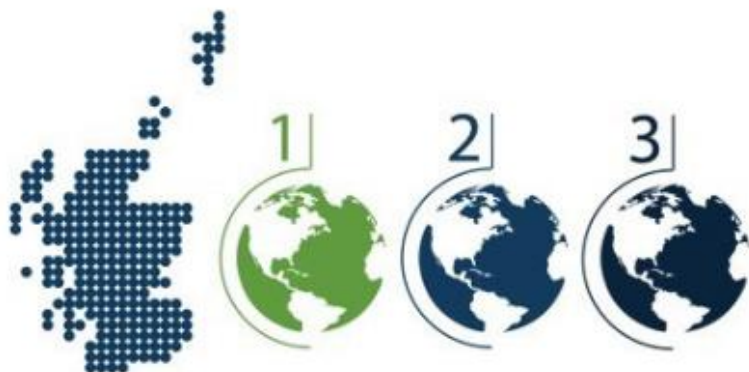


# Non-hazardous landfill environmental monitoring plan

November 2019

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# 1 Non-hazardous landfill environmental monitoring plan

## 1.1 Purpose and scope

The non-hazardous landfill permit requires compliance with an Environmental Monitoring Plan (EMP), which must be compiled by the authorised person and approved by SEPA. The EMP sets out the monitoring required to:

1. demonstrate compliance with the compliance limits set in the permit;
2. fulfil any additional monitoring requirements of the relevant legislation ([The Landfill \(Scotland\) Regulations 2003](#)).

This guidance document sets out in more detail **what elements of monitoring must be detailed in the EMP** to meet the above criteria.

The authorised person should undertake monitoring in excess of what must be detailed in the EMP. The purpose of this is to assess the performance of key infrastructure and to allow the early identification of any risk or unexpected performance that may lead to non-compliance with permit conditions (which do not have a direct compliance limit) or impact the environment. This monitoring includes monitoring to:

- ensure the efficiency and effectiveness of the landfill gas management / extraction system;
- ensure the effectiveness of the leachate collection system;
- ensure the correct operation of the leachate treatment system;
- any monitoring required for Directly Associated Activities.

## 1.2 Interaction of EMP and risk assessments

A requirement of the application process for non-hazardous landfills is for a number of site-specific risk assessments to be undertaken, for example hydrogeological, stability and landfill gas. The findings of these risk assessments underpin the monitoring strategy for the site and must feed into the EMP.

Throughout the lifetime of the landfill these risk assessments should be updated in response to changes as the landfill evolves. Examples of such changes that would necessitate a re-assessment include:

- where ongoing monitoring identifies a significant departure from the findings of the risk assessment.
- where the assumptions made during the original risk assessment are found to be incorrect or superseded (e.g. changes in the leachate, groundwater or landfill gas composition, groundwater level fluctuations and/or changes in flow direction / hydraulic gradient).
- where operational procedures on the landfill alter (e.g. a change in the waste types accepted for disposal, opening of a new cell).

The EMP must be updated to reflect the findings of the revised risk assessment.

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## 2 Landfill gas

Monitoring of landfill gas is essential to ensure that the release of any landfill gas to the environment does not exceed the compliance limits as detailed in the permit.

There will be commonality in the broad principles of landfill gas monitoring, however given the variable and dynamic nature of landfill gas management, the detail will be largely site-specific and influenced by the compliance limits. Factors that should be taken into consideration when determining the site-specific landfill gas monitoring include:

- the age / status of the landfill;
- the waste types landfilled;
- the proximity of sensitive receptors;
- the geological setting of the landfill;
- the topography of the landfill;
- the barriers and capping of the landfill.

### 2.1 Monitoring points

As a minimum, monitoring of landfill gas must be undertaken:

1. at the perimeter of the landfill to monitor compliance with the compliance limits;
2. for each section of the landfill to ensure the correct functioning of the landfill gas management system.

Resources and equipment must be provided to undertake monitoring of landfill gas for each section of the landfill to ensure the landfill gas management system is functioning correctly.

Boreholes must be installed and maintained at the perimeter to effectively monitor the presence, and concentration, of landfill gas to ensure compliance with the permit compliance limits. The design, construction, location and number of boreholes for landfill gas monitoring must comply with the requirements set out in:

- Guidance document [LFTGN03 – Guidance on the management of landfill gas](#).

The EMP must capture the following details:

2.1.1 A plan indicating the locations of all perimeter landfill gas boreholes at the site used for compliance limit monitoring. The plan will form part of the EMP.

2.1.2 Perimeter borehole details including the locations, spacing / distance between boreholes, the borehole unique identifier and the planned maintenance regime.

2.1.3 A brief overview of how the site will meet the requirements of [LFTGN03](#) regarding the design, construction, location and number of perimeter boreholes.

2.1.4 A brief overview of how the site will undertake monitoring for each section of the landfill to ensure the correct functioning of the landfill gas management system.

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## 2.2 Monitoring constituents

Monitoring (as a minimum) must be undertaken to reflect the compliance limits for perimeter boreholes detailed within the site permit. Compliance limits will be determined by SEPA following consideration of the factors set out above and are likely to be included for the following landfill gas constituents:

- methane;
- carbon dioxide

To ensure the correct functioning of the landfill gas management system, monitoring of the following landfill gas constituents must also be undertaken for each section of the landfill:

- atmospheric pressure;
- oxygen;
- hydrogen sulphide;
- hydrogen.

The EMP must capture the following details:

2.2.1 The suite of landfill gas constituents that are to be monitored for perimeter boreholes to ensure compliance with the permit compliance limits.

2.2.2 The suite of landfill gas constituents that are to be monitored for each section of the landfill to ensure the correct functioning of the landfill gas management system.

2.2.3 A brief justification why the selected landfill gas constituents are suitable and representative.

## 2.3 Monitoring frequency

Monitoring must be undertaken at a frequency regular enough to allow the determination of a baseline level and the identification of trends and patterns. It is expected that monitoring is undertaken in line with the frequencies set out in Table 1 as a minimum.

The required frequencies may increase from those set out in Table 1 where the environmental risk posed by the site necessitates more robust monitoring. Similarly, where

the site poses a lower environmental risk (e.g. during aftercare), the frequencies may be relaxed from those set out in Table 1.

**Table 1 Landfill gas minimum monitoring frequency**

Monitoring point	Constituent	Monitoring frequency
Perimeter boreholes	Methane	Monthly and from the same sample event.
	Carbon dioxide	
Each section of the landfill	Oxygen	
	Hydrogen Sulphide	
	Hydrogen	
	Atmospheric Pressure	

The EMP must capture the following details:

2.3.1 The frequency at which landfill gas monitoring will be undertaken in accordance with Table 1.

2.3.2 A brief justification why the selected frequencies for landfill gas monitoring is suitable and representative.

## 2.4 Sample collection, handling and analysis

To ensure validity of the monitoring results, the collection, handling and analysis of landfill gas monitoring samples must comply with the requirements set out in guidance document [LFTGN03 – Guidance on the management of landfill gas](#).

The EMP must capture the following details:

2.4.1 A summary of how the authorised person intends to collect, handle and analyse landfill gas samples in accordance with [LFTGN03 – Guidance on the management of landfill gas](#).



### 3 Leachate and groundwater

Monitoring of leachate and groundwater is essential to:

- confirm that the depth of leachate accumulated at the base of the landfill does not exceed the permitted compliance limit.
- monitor the generation and migration of leachate to groundwater to confirm groundwater or groundwater-dependent receptors are not impacted.
- monitor the composition of leachate to facilitate effective management of treatment and / or disposal.

Factors that should be taken into consideration when determining the site-specific leachate and groundwater monitoring plan include:

- the waste types landfilled;
- the geological setting of the landfill;
- the hydrogeological setting of the landfill;
- the topography of the landfill;
- the liner and leachate collection system of the landfill;
- the proximity to surface water, groundwater and water-dependent receptors.

Where there is a sensitive groundwater dependent receptor (e.g. a groundwater dependent terrestrial ecosystem or an abstraction) in proximity to the landfill, more robust monitoring requirements may be required.

#### 3.1 Monitoring points

As a minimum, monitoring of leachate and groundwater must be undertaken to monitor the generation and migration of leachate and to confirm that groundwater is not adversely impacted.

The design and construction of boreholes for leachate and groundwater monitoring must comply with the requirements set out in:

- BS 5930:2015 'Code of Practice for Ground Investigations';
- BS 10175 'Investigation of potentially contaminated sites'.

The location and number of boreholes for leachate and groundwater monitoring must reflect the results of the site specific hydrogeological risk assessment and comply with the requirements set out in:

- Guidance on [Monitoring of Landfill Leachate, Groundwater and Surface Water \(Version 2, July 2003\)](#).

The EMP must capture the following borehole details:

3.1.1	A plan indicating the locations of all leachate and groundwater boreholes at your site. The plan will form part of the EMP.
3.1.2	Borehole details, including those set out in
3.1.3	Table 2 and the borehole unique identifier.
3.1.4	The planned borehole maintenance regime, including the steps to be implemented to ensure the borehole remains fit for purpose.
3.1.5	A brief overview of how the site will meet the requirements of the above standards and guidance regarding the design, construction, location and number of boreholes.

**Table 2 Borehole details**

Borehole ID	National grid reference	Surveyed reference point (mAOD)	Elevation of borehole base (mAOD)	Response zone elevation (mAOD)	
				Base	Top
LW01					
LW02					
BH01					
BH02					
BH03					

### 3.2 Monitoring constituents

Monitoring (as a minimum) must be undertaken to reflect the site-specific compliance limits detailed within the site permit and the legislative requirements. Compliance limits will be determined by SEPA following consideration of the factors set out above. Compliance limits are likely to be included for the following constituents:

- Leachate level above base of cell (reported as both metres above Ordnance Datum and metres below monitoring datum);
- Groundwater quality (see Appendix 1 for default analytical suite)

Monitoring of the following is also required:

- Groundwater level (reported as both metres above Ordnance Datum and metres below monitoring datum);
- Leachate quality (see Appendix 2 for default analytical suite).

Appendix 1 and Appendix 2 provide default analytical suites that must be undertaken to monitor both groundwater and leachate quality, however these parameters may be altered where justified following an evaluation of site specific factors, e.g.: the risk posed by individual landfills, the leachate collection systems in place and the proximity to sensitive receptors.

The EMP must capture the following details:

3.2.1 The suite of leachate and groundwater constituents that are to be monitored at the landfill.

3.2.2 A brief justification why the selected leachate and groundwater constituents are suitable and representative.

### 3.3 Monitoring frequency

Monitoring must be undertaken at frequency regular enough to allow the determination of a baseline level and the identification of trends and patterns. It is expected that monitoring is undertaken in line with the frequencies set in Table 3 as a minimum.

The required frequencies may increase from those set out in Table 3 where the environmental risk posed by the site necessitates more robust monitoring. Similarly, where

the site poses a lower environmental risk or when stable long-term datasets have been established, the frequencies may be relaxed from those set out in Table 3.

**Table 3 Leachate and Groundwater Monitoring Frequency**

Monitoring parameter	Expected monitoring frequency	Location
<b>1. Leachate Levels</b> i. below monitoring datum (m) ii. above Ordnance Datum (m) iii. Leachate depth above base of cell (m)	Monthly	All leachate boreholes
<b>2. Leachate Quality</b>	See Appendix 2	
<b>3. Groundwater Levels</b> i. below monitoring datum (m) ii. above Ordnance Datum (m)	Monthly	All groundwater boreholes
<b>4. Groundwater Quality</b>	See Appendix 3	

The EMP must capture the following details:

3.3.1 The frequency at which monitoring will be undertaken in accordance with Table 3.

3.3.2 A brief justification why the selected frequencies for leachate and groundwater monitoring are suitable and representative

### 3.4 Sample collection, handling and analysis

To ensure validity of the monitoring results, the collection, handling and analysis of leachate and groundwater monitoring samples must comply with the following standards:

- BS EN ISO 5667 Water Quality Sampling Series;
- BS EN ISO 21413 Manual methods for the measurement of groundwater level in a well.

The EMP must capture the following details:

3.4.1 A summary of how the site intends to collect, handle and analyse leachate and groundwater samples in accordance with BS EN ISO 5667 & 21413.

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## 4 Treated leachate effluent

Where treated leachate effluent is discharged to the water environment, **SEPA will continue to undertake compliance limit monitoring of these discharges**. Compliance limits will be determined by SEPA based on the risk posed by individual landfills and the sensitivity of the receiving environment. These compliance limits are monitored by SEPA to ensure the discharge of treated leachate effluent does not cause pollution of the water environment.

**The operator should also undertake monitoring of the discharge of treated leachate** to ensure the discharge remains compliant with the permit compliance limits and to fulfil the requirements of [The Landfill \(Scotland\) Regulations 2003](#).

This operator monitoring ensures the identification of any risk or unexpected performance that may lead to non-compliance with permit conditions, and the identification of trends or changes in the composition of treated leachate effluent.

Where treated leachate effluent is not discharged to the water environment (i.e. it is discharged to the public sewer or collected and then transported offsite) the monitoring requirements of this section are not applicable.

### 4.1 Monitoring points

As a minimum, monitoring of the treated leachate effluent must be undertaken at the 'end of pipe' at each point where leachate is discharged (i.e. the final effluent that is discharged from the treatment plant prior to the discharge of it to the water environment). A dedicated sampling point must be installed and maintained to monitor the discharge of treated leachate effluent and ensure that representative samples can be obtained.

The EMP must capture the following details:

4.1.1 A plan indicating the locations of all treated leachate effluent discharge points and sampling points at your site. The plan will form part of the EMP.

4.1.2 Discharge and sampling point details, including those set out in Table 4, and the planned maintenance regime.

4.1.3 A brief overview of how the authorised person will ensure representative samples of treated leachate effluent can be obtained.

**Table 4 Treated leachate effluent discharge and sampling point details**

Authorised activity	Receiving watercourse	Discharge location (NGR)	Sampling location (NGR)
Discharge of treated leachate effluent	<<River XXXX>>>	NO.....	NO.....

## 4.2 Monitoring constituents

Monitoring should be undertaken to reflect the site-specific compliance limits for treated leachate effluent as detailed within the permit and to meet the legislative requirements.

Appendix 3 provides a default analytical suite that covers both compliance limits and parameters required to fulfil the legislation, however these parameters may be altered where justified following an evaluation of site-specific factors.

Monitoring of the following is also required:

- Volume of treated leachate effluent discharged.

The EMP must capture the following details:

4.2.1 The suite of treated leachate effluent constituents that are to be monitored at the landfill.

4.2.2 A brief justification why the selected treated leachate effluent constituents are suitable and representative.

### 4.3 Monitoring frequency

Monitoring of the discharge of treated leachate effluent must be undertaken at a frequency regular enough to allow the identification of trends and patterns. It is expected that monitoring is undertaken in line with the frequencies set in Appendix 3.

The required frequencies may increase from those set out in Appendix 3 where the environmental risk posed by the site necessitates more robust monitoring. Similarly, where the site poses a lower environmental risk or when stable long-term datasets have been established, the frequencies may be relaxed from those set out in Appendix 3.

The EMP must capture the following details:

4.3.1 The frequency at which monitoring will be undertaken.

4.3.2 A brief justification why the selected frequencies for treated leachate effluent monitoring is suitable and representative.

### 4.4 Sample collection, handling and analysis

To ensure validity of the monitoring results, the collection, handling and analysis of treated leachate effluent samples must comply with the following standards:

- BS EN ISO 5667 Water Quality Sampling Series.

The EMP must capture the following details:

4.4.1 A summary of how the site intends to collect, handle and analyse treated leachate effluent samples in accordance with BS EN ISO 5667.



## 5 Surface water

Where a surface water flows through a landfill site, or receives flows from groundwater that is overlain by a landfill site, wider monitoring of the surface water is required to ensure:

- the correct functioning of the leachate collection and treatment system;
- that there are no 'breakouts' or 'run-off' from the landfill from unknown discharge points that are impacting surface water;
- migration via a groundwater pathway is not adversely impacting surface water.

Where it is determined that there no surface waters flow through a landfill, or a surface water does not receive flows from groundwater that is overlain by the landfill, the monitoring requirements of this section do not apply.

### 5.1 Monitoring points

As a minimum, monitoring of surface water(s) must be undertaken at two points: one upstream and one downstream.

The upstream monitoring point must be located upstream of the landfill and/or the point at which the surface water receives landfill influenced groundwater flows, i.e. the upstream point must be unaffected by the landfill and representative of 'baseline' levels within the surface water.

The downstream monitoring point must be located downstream of the landfill and/or the point at which the surface water receives landfill influenced groundwater flows, i.e. the downstream point must be able to detect any potential effect of the landfill and representative of 'elevated' levels within the surface water.

If there are multiple discharges from the landfill to the surface water(s), additional monitoring points may be of benefit (downstream of each discharge point) to allow interpretation of the effect of each discharge.

The EMP must capture the following borehole details:

5.1.1 A plan indicating the locations of all surface water monitoring points at your site. The plan will form part of the EMP.

## 5.2 Monitoring constituents

Monitoring of basic indicator parameters (e.g. pH, electrical conductivity, BOD, COD, Chloride, Suspended Solids, etc.) must be undertaken to identify any potential impact. Furthermore, monitoring for additional parameters (e.g. major ions, metals and hazardous substances) should be undertaken based on the site specific risk, characteristics of the leachate, groundwater and treated leachate effluent discharge (if applicable).

The EMP must capture the following details:

5.2.1 The suite of surface water constituents that are to be monitored at the landfill.

5.2.2 A brief justification why the selected surface water constituents are suitable and representative.

## 5.3 Monitoring frequency

Monitoring must be undertaken at frequency regular enough to allow the determination of a baseline level and the identification of trends and patterns. It is expected that monitoring is undertaken in line on a quarterly basis as a minimum throughout the operational phase.

The required frequencies may increase where the environmental risk posed by the site necessitates more robust monitoring. Similarly, where the site poses a lower environmental risk or when stable long-term datasets have been established, the frequencies may be relaxed.

The EMP must capture the following details:

5.3.1 The frequency at which surface water monitoring will be undertaken.

5.3.2 A brief justification why the selected frequency of surface water monitoring is suitable and representative.

## 5.4 Sample collection, handling and analysis

To ensure validity of the monitoring results, the collection, handling and analysis of surface water samples must comply with the following standards:

- BS EN ISO 5667 Water Quality Sampling Series.

The EMP must capture the following details:

5.4.1 A summary of how the site intends to collect, handle and analyse surface water samples in accordance with BS EN ISO 5667.

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## 6 Topography and settling behaviour

Monitoring of the landfill topography and settling behaviour must be undertaken on a yearly basis throughout the operational phase of the landfill, this includes the structure and composition of the landfill by monitoring:

- the surface occupied by waste;
- the volume and composition of waste;
- the methods of depositing waste;
- the time and duration of depositing waste;
- a calculation of the remaining capacity still available at the landfill.

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## 7 Sample analysis accreditation

In order to ensure validity of results, the analysis of all samples must be undertaken by ISO/IEC 17025 or UKAS accredited laboratories.

The EMP must capture the following details:

7.1.1 The accreditation details for each sample type as set out in Table 5.

**Table 5 Sample analysis lab accreditation**

Sample type	Lab name	Lab address	Accreditation (including methodological)
Landfill Gas			
Leachate			
Groundwater			
Surface water			

In addition, adequate control measures must be in place to ensure the suitability of any methods used during sampling. As a minimum, the instrumentation used must be:

- able to measure the ranges expected on the site;
- of a suitable sensitivity;
- regularly calibrated.

The individual undertaking the sampling should be competent in undertaking sampling and UKAS accredited analytical methodologies used.

**Appendix 1: Groundwater quality default analytical suite**

Category	Parameters	Frequency
Basic	<ul style="list-style-type: none"> <li>Field parameters (pH, EC, temperature, DO, Redox Potential)</li> <li>Ammoniacal-N</li> <li>Chloride</li> </ul>	Monthly  (Quarterly where justified* – i.e. if groundwater quality is stable and no adverse impacts observed)
Major ions	<ul style="list-style-type: none"> <li>TON, nitrate, nitrite, sulphate, alkalinity</li> <li>Ca, Mg, K, Na</li> <li>Fe, Mn (total &amp; dissolved)</li> <li>P (as orthophosphate)</li> <li>TDS, TSS, TOC, DOC</li> </ul>	Quarterly
Trace metals/metalloids (total & dissolved)	<ul style="list-style-type: none"> <li>As</li> <li>B</li> <li>Ba</li> <li>Cd</li> <li>Cr</li> <li>Cu</li> <li>Hg</li> <li>Mo</li> <li>Ni</li> <li>Pb</li> <li>Se</li> <li>Zn</li> </ul>	Six monthly  (Annual where justified – i.e. if groundwater quality is stable and no impact from leachate observed based on basic chemistry / major ions)
Common hazardous substances	<ul style="list-style-type: none"> <li>VOC screen</li> <li>SVOC screen</li> <li>Mecoprop</li> </ul> (Plus any additional site-specific indicator substances identified based on leachate quality data)	Six monthly  (Annual where justified – i.e. if groundwater quality is stable and no impact from leachate observed based on basic chemistry / major ions)
Site-specific requirements	If applicable	As appropriate

**Appendix 2: Leachate quality default analytical suite**

Category	Parameters	Frequency
Basic	<ul style="list-style-type: none"> <li>pH, EC, temperature</li> <li>BOD</li> <li>COD</li> <li>Ammoniacal-N</li> <li>Chloride</li> </ul>	Quarterly
Major ions	<ul style="list-style-type: none"> <li>Sulphate, alkalinity</li> <li>Ca, Mg, K, Na</li> <li>Fe, Mn (total &amp; dissolved)</li> <li>TON, P (as orthophosphate)</li> <li>TDS, TSS, TOC, DOC</li> </ul>	Quarterly
Trace metals/metalloids (total & dissolved)	<ul style="list-style-type: none"> <li>As</li> <li>B</li> <li>Ba</li> <li>Cd</li> <li>Cr</li> <li>Cu</li> <li>Hg</li> <li>Mo</li> <li>Ni</li> <li>Pb</li> <li>Se</li> <li>Zn</li> </ul>	Six monthly (Annual where justified – e.g. if cell is capped)
Common hazardous substances	<ul style="list-style-type: none"> <li>VOC screen</li> <li>SVOC screen</li> <li>Herbicide/ pesticide screen</li> <li>Organotin</li> </ul>	Six monthly (Annual where justified – e.g. if cell is capped)
Site-specific requirements	If applicable	As appropriate

**Appendix 3: Treated leachate effluent default analytical suite**

Category	Parameters	Frequency
Basic	pH, EC, alkalinity, temperature, BOD, COD, TSS, Ammoniacal-N, Total Organic Nitrogen, Chloride, Sulphate, Reactive Phosphorus.	Monthly  (Quarterly where justified)
Trace metals/metalloids (total & dissolved) and supporting parameters	TOC, DOC, Ca, Mg, K, Na, Fe, Mn As, Cd, Cr, Cu, Hg, Ni, Pb, Zn	Quarterly  (Six-monthly where justified)
Common hazardous substances	VOC screen SVOC screen Herbicide/ pesticide screen Organotin	Six monthly
Site-specific requirements	If applicable	As appropriate