Best Available Techniques Assessment

Meece 1 Landfill

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[1] Introduction

[1.1] Report Objectives

Ayesa (ByrneLooby Partners (UK) Limited) have been commissioned by Biffa Waste Services Limited to produce a Best Available Techniques (BAT) Assessment to support a Permit variation application to enable the discharge of a treated leachate effluent to surface water from the Meece 1 Landfill (the Site) Environmental Permit Ref. EPR/BV4967IW.

Meece 1 Landfill is operated by Biffa under Environmental Permit ref. EPR/BV4967IW along with a hazardous Soils Treatment Facility (STF) which has been developed within the eastern part of the permitted area. The site is operated by Biffa, which is hereafter referred to as the Operator.

The site is located at Swynnerton, Cold Meece, Stone, Staffordshire, ST15 0QN. Landfilling at the site commenced prior to 1996 with the site to date developed as twelve cells (Phase 0 to Phase 7 and 13A). Meece 1 was mothballed in 2008 following the completion of Phase 7. The eastern part of the site (Phases 8, 11, 12, 13B and 14) therefore remains as available permitted void space and is undeveloped.

A Permit variation application for the Meece 1 Landfill was submitted by ByrneLooby Partners (UK) Limited (ByrneLooby) in December 2022 which sought to allow Biffa to discharge trade effluent associated with the permitted operations to sewer. The proposals were supported by an environmental risk assessment (H1 assessment)[1] which considered the impact of the consented discharge on the River Sow following treatment at the Eccleshall and Sturbridge WwTW.

The application documents were then updated and re-submitted in December 2023 to update the Permit in accordance with the recommendations set out within the Hydrogeological Risk Assessment produced in June 2023 by Swan Environmental Limited.

Proposed Changes

The application is queued with the Environment Agency and has not yet been duly made. Whilst the application has been queued, further consideration has been given by Biffa to long-term leachate management options for the site to increase capacity for leachate removal and disposal. Biffa are therefore seeking a further amendment to the Permit to enable the operation of a Reverse Osmosis (RO) Leachate Treatment Plant (LTP) at the Meece 1 landfill. This will provide two routes for disposal:

(1) up to 100m^3/day of untreated leachate and other trade effluent directly to the sewer (where the TEDC limits are met)

(2) up to 150m^3/day of treated leachate via the RO plant to the Meece Brook

This report has been produced to assess the proposed Reverse Osmosis (RO) Plant with respect to the Best Available Techniques (BAT) and the conclusions set out within relevant BAT reference (BREF) documents.

[1] ByrneLooby (2022) Surface Water Risk Assessment, Meece 1 Landfill, Report 14-K6094-ENV-R002

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[1.2] Best Available Techniques (BAT)

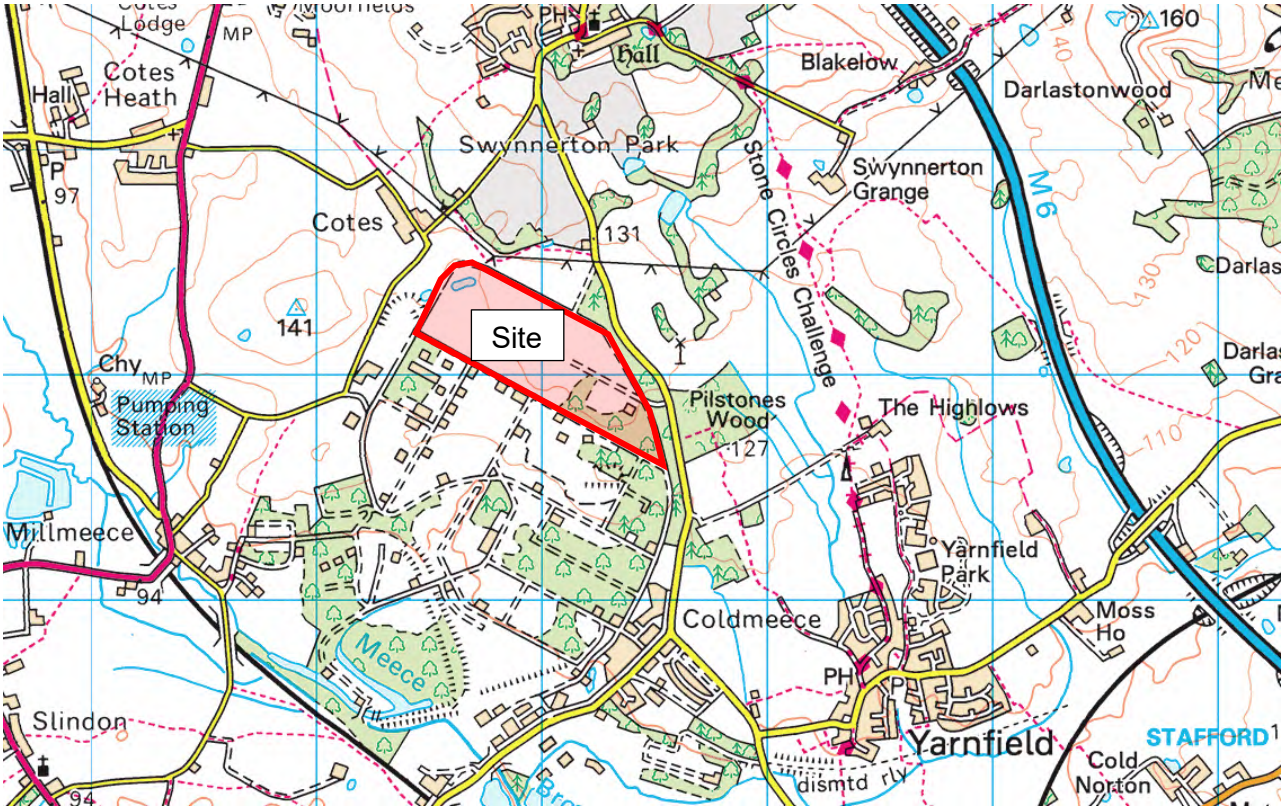
The Industrial Emissions Directive (Directive 2010/75/EU)[2] states that permit conditions should be set on the basis of BAT. However, as noted in Paragraph 16 of Directive 2010/75/EU, the essence of BAT is that the techniques selected to protect the environment should achieve an appropriate balance between environmental benefit and costs. Indicative BAT standards for Waste Treatment were most recently laid out within the European Commission's 2018 Best Available Techniques Reference (BREF) Document[3].

The relevant BAT conclusions for a wastewater treatment plant are set out within Chapter 6.1 (General BAT conclusions) and Chapter 6.5 (BAT conclusions for the treatment of water-based liquid waste) of the BREF Document for Waste Treatment and have therefore been considered within this assessment.

[1.3] Site Location and Development

Meece 1 Landfill is located at National Grid Reference (NGR) SJ 384960 334104 and is situated in a predominantly rural area comprising small villages, wooded areas and agricultural fields. The site is bound to the south by the Swynnerton Training area, a former Ministry of Defence site, and to the east by Swynnerton Road. To the north of the site are agricultural fields and ~300m to the west lies the village of Cotes. The site location and surrounding features are illustrated on Figure 1.

Figure 1 – Site Location and Surrounding Features



[2] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions
[3] A. Pinasseau et al. (2018) Best Available Techniques (BAT) Reference Document for Waste Treatment https://eippcb.jrc.ec.europa.eu/sites/default/files/2019-11/JRC113018_WT_Bref.pdf

Meece Landfill was developed on part of the old Ministry of Defence site which housed a munition depot. Historically Meece Landfill was operated as a co-disposal site from 1986 until 2004 when it was split into two areas, Meece 1 and Meece 2. Meece 1 continued to receive the non-hazardous component of the waste streams. Meece 2 is authorised under a separate Permit (Reference EPR/BW0096IJ) for the receipt of hazardous wastes. Meece 2 authorises the disposal of Air Pollution Control (APC) residues from an Energy from Waste (EfW) plant. However, to date landfilling in this part of the site has not commenced and the landfill site is currently mothballed.

A hazardous soils treatment facility (STF) is operated on the eastern part of the landfill complex (*i.e.* across the undeveloped Phase 11 and 12 footprints) and this activity is authorised under Environmental Permit ref. EPR/BV4967IW, *i.e.* the Meece 1 non-hazardous landfill Permit. A separate Permit (Ref. EPR/EB360FM) has also been issued for an Aggregate Treatment Recycling Facility (ATRF) at the site which processes street cleaning residues.

The RO plant comprises a series of water separation membrane tubes housed within a shipping container and is intended to be placed at National Grid Reference SJ 85070 34353 on the Northern boundary of the Meece landfill site (Figure 2). The proposed location of the RO plant is currently outside of the Permitted area. Therefore, a change to the Permit boundary will be required as part of the Permit variation application.

Figure 2 – Proposed RO Plant Location

[2] Process Description

[2.1] Proposed Activity

A Reverse Osmosis (RO) plant with a design capacity of 150 tonnes per day (150m^3/day) to treat excess waters which cannot otherwise be managed is proposed. The RO plant would accept a combination of landfill leachate from the Meece 1 landfill and other trade effluent from the permitted activities on site including contaminated surface water.

Site derived surface water is currently collected within the existing surface water drainage system prior to being discharged via sewer with an agreed Trade Effluent Discharge Consent (TEDC) (ref. 009226V) in place with Severn Trent Water. The proposed RO plant will provide additional capacity on site for the abstraction and disposal of wastewaters generated at the facility.

It is expected that when operating at full capacity the RO plant would produce some 50m^3/day of concentrate which would be managed off-site, with the remaining 100m^3/day discharged through the existing surface management system at discharge location 88902104 'Meece Avenue' demarcated on the site's Monitoring Plan appended to this report as drawing ref. M4180107-2022. Meece Landfill still benefits from the surface waste management system that was installed at the wider ROF Swynnerton munitions factory site. Therefore the discharge from site enters the part of the drainage system that is located within the MOD land and it is understood that this discharges into the nearest 'Main' River (Meece Brook) . Discharge location 88902104 is the point at which the treated discharge along with surface water collected in the site's surface water drainage system will leave the site.

The flow from the LTP will therefore be 'buffered' by the surface water drainage system, which extends to areas to the north of the site, prior to being discharged to the Meece Brook. The combined surface water and treated effluent mixture will be discharged to the Meece Brook via a culvert which passes through the Swynnerton Training Area to the south of the site. The culvert is understood to outfall at NGR SJ 84478 33093, with the ultimate discharge point to the Meece Brook at NGR SJ 84388 32477 (Figure 3).

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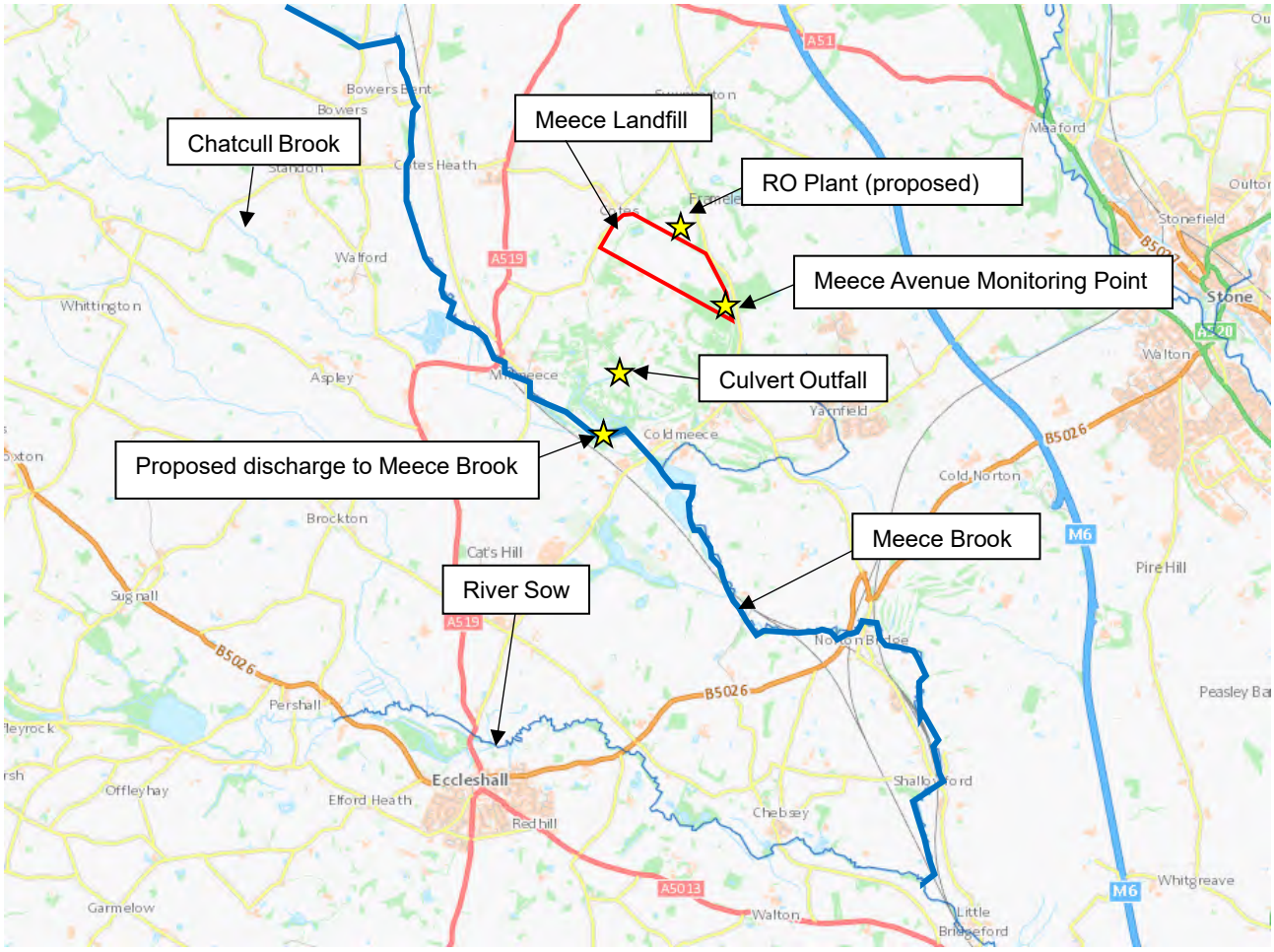
Figure 3 – Nearby surface watercourses and proposed discharge route



[2.2] Treatment Technique

RO treatment aims to extract clean water from the aqueous solution of organic and inorganic contaminants that constitute the landfill leachate. The RO process is capable of separating even small sodium and chloride ions from solution, hence its use in potable water purification applications. The process is therefore the most effective mechanism for guaranteeing a high-quality effluent. However, due to high energy costs and the production of a concentrated waste stream, RO systems are typically only employed when a drinking water supply is required from a saline source or where off-site tankering is unsustainable and there are no other alternative options available.

RO treatment utilises a high-pressure system to force the leachate through a combination of an ultrafiltration membrane to remove biosolids, small particulates and colloids and then a chemically charged membrane which is designed to reject dissolved ions.

The liquid is forced through the pores of the membrane to produce an effluent (the permeate). Any rejected liquor (the retentate) which does not pass through the membrane and contains the rejected dissolved constituents is re-circulated back into the system for re-processing. The process gradually results in a concentrated liquor which is disposed of on a batch basis via off-site tankering.

Reverse Osmosis membranes are designed to reject a specific particle/ ionic size range using the mechanism of electro-static rejection in the order of 0.0001 – 0.003µm and is an ideal process for removing:

- Monovalent ions;
- Metal ions;
- Acids;
- soluble salts;
- hydrocarbons;
- solvents;
- natural resins;
- residual paint; and
- other low molecular weight species and for selective separations.

For some leachates, up to 95% of the influent volume can theoretically be 'purified' to a standard suitable for a surface water discharge. All leachate constituents are then concentrated into the remaining 5% of the leachate volume which is disposed of by off-site tankering. However, if there is the possibility of extensive biofouling of the membrane which results in reduced efficiency of the process, then rejectate volumes can be up to 40% of the influent volume.

RO plants as a physical process are often an effective alternative to biological treatment systems due to their treatment reliability and being less prone to process instabilities caused by feed quality variations. They can also meet more stringent discharge quality limits for substance not treated biologically and are therefore often selected when the discharge is directly to a surface water system as opposed to the public sewer system.

[2.3] RO Plant Design

The proposed RO plant is based on a reverse osmosis process that 'cleans' the leachate primarily and then 'polishes' the permeate further in subsequent stages. A typical arrangement for a 2-stage RO plant is illustrated in Figure 4 nb a three or possibly four stage plant will be used at Meece. Following the final stage, the permeate will be processed through a carbon dioxide stripping tower to achieve a more neutral pH. Specification details for the RO plant are provided in Appendix A.

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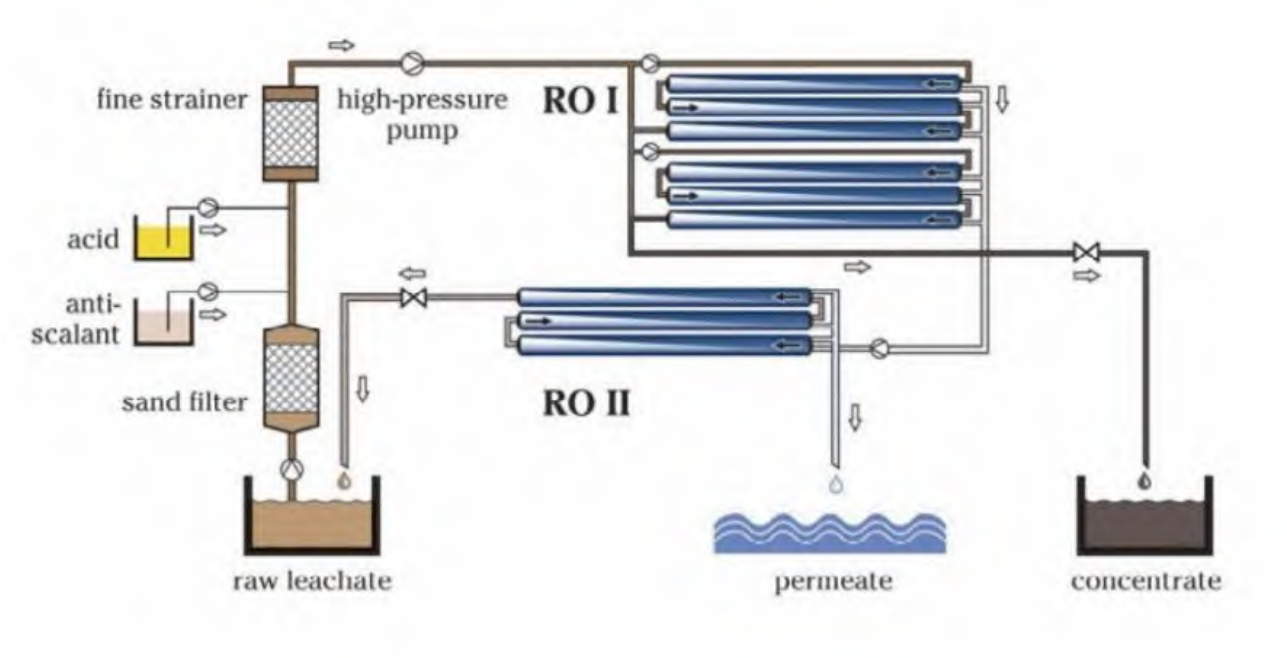
Figure 4 – Typical Reverse Osmosis process for leachate treatment



The plant will use an artificial, semi-permeable membrane of thin film composite that has been optimised with very high physical and chemical durability for use with landfill leachate. The membrane modules are mounted within pressure tubes on racks, complete with interconnecting pipework and recirculation/transfer pumps. The recirculation pump maintains a leachate feed of sufficiently high velocity to effectively 'overflow' and fully saturate the membrane surface at a velocity that inhibits precipitation and preventing concentration polarisation and fouling that would impact on efficiency.

The outputs from the RO treatment process include:

- a permeate (treated effluent) which will be discharged to the site's surface water management system and ultimately to the environment at Meece Brook; and
- a rejectate or concentrate that is collected and in this case intended to be transported by tanker to a suitably licenced facility for off-site treatment/disposal.

[2.3.1] Influent Quality

The RO plant will primarily receive landfill leachate from the Meece 1 landfill. However, surface water collected in the ATRF lagoon may also be directed to the RO plant (where necessary). The ATRF lagoon collects rainfall and runoff from around the site weighbridge and the recycled water from the ATRF process. As noted above, the ATRF is a separately permitted activity. The landfill leachate quality is summarised in Table 1 to Table 4, whilst a summary of the ATRF lagoon water quality is provided in Table 5. The raw data is provided in Appendix B.

The leachate at Meece Landfill is generally consistent with expectations for a non-hazardous leachate, *i.e.* an ammoniacal-N rich sodium-chloride bicarbonate solution with significant potassium and insignificant sulphate (Table 1). Total oxidised nitrogen and nitrate are typically negligible in the leachate and reported below the limit of detection at <0.7mg/l.

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Table 1 – Meece Landfill Leachate Matrix Summary (March 2020 to January 2024)

Location		pH	EC	NH_4-N	COD	BOD	Ca	Mg	Na	K	Cl	SO_4	Alk
			µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
In-waste wells	Avg	7.3	16,433	830	1,558	157	487	104	1,756	874	4,187	150	3,452
	95th %ile	8.0	44,400	3,530	6,221	505	1,500	155	5,270	2,570	15,200	487	13,800
	Max	8.1	80,600	5,250	1,120	3,580	7,800	933	12,300	6,880	27,700	1,720	15,400
Leachate Tank 1	Avg	7.8		2,200	3,800						8,030	56	
	95th %ile	8.0		2,504	4,657						9,583	101	
	Max	8.0		2,570	4,850						9,760	105	
Leachate Tank 2	Avg	7.2		247	869						1,545		
	95th %ile	7.2		372	1,419						2,288		
	Max	7.2		386	1,480						2,370	57	

There is a limited priority metal inventory within the leachate (Table 2). Mercury is consistently reported below the limit of detection and has not been identified as present within the leachate. Mercury is therefore environmentally insignificant, and no further assessment of this substance is required. Arsenic is also low and often below the 50µg/l EQS. Hence there is unlikely to be any environmental significance to the arsenic following discharge to the environment after treatment of the landfill leachate.

The non-hazardous metal content is consistent with expectations for a landfill leachate and primarily comprises of chromium, nickel, and zinc. However, the percentile distribution demonstrates significant outliers (*e.g.* for copper and zinc) which will be in a colloidal or particulate type form which can be removed by an UF membrane. These are not expected to pass through to the RO membranes.

Table 2 – Meece Landfill Leachate Priority Metals (March 2020 to January 2024)

Location		Hg (total)	Pb (total)	As (total)	Cd (total)	Cr (total)	Cu (total)	Ni (total)	Zn (total)	Fe (total)	Mn (total)
		µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	mg/l
In-waste wells	Avg	<0.2	10	13	1	92	111	96	284	13	2
	95th %ile	<0.2	59	45	6	560	447	315	870	38	7
	Max	<0.2	60	150	7	651	6,690	904	6,900	362	16

Note no heavy metal data collected for holding tanks

The recent organics screens (Table 3) have identified a limited number of substance present above the limit of detection. The most abundant substances are the BTEX substances (i.e. benzene, toluene, ethylbenzene and xylene) and substituted BTEX which are reported on average at 2 – 13µg/l. These are degradation by-products and are continuously released into both the landfill gas and the leachate whilst the organic content of the waste stabilises.

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Table 3 – Meece Landfill Organic Substances (March 2020 to January 2024)

Description		Ave	95th	Max
BTEX and substituted BTEX				
Benzene	µg/l	2	4	5
Toluene	µg/l	7	20	22
m and p-xylene	µg/l	13	30	36
o-Xylene	µg/l	3	12	19
Ethylbenzene	µg/l	8	19	23
1,2,4-Trimethylbenzene	µg/l	8	22	32
iso-propylbenzene	µg/l			2
n-propylbenzene	µg/l	2	3	3
p-isopropyltoluene	µg/l	8	20	23
Polyaromatic Hydrocarbons				
Naphthalene	µg/l	7	11	11
Phenolic Substances				
Phenol *	µg/l			8
2-methylphenol *	µg/l	11	24	28
3 & 4-methylphenol *	µg/l	8	29	46
2,4-dimethylphenol	µg/l	9	21	79
4-chlorophenol	µg/l			1.4
2,4,6-trichlorophenol	µg/l			1.1
Chlorinated Substances				
Dichloromethane	µg/l			5
Chloroethene	µg/l	3	6	7
Chlorobenzene	µg/l	6	13	15
1,4-Dichlorobenzene	µg/l	2	3	4
1,2,3-trichlorobenzene	µg/l	0.03	0.05	0.05
Herbicides and Pesticides				
Mecoprop	µg/l	14	36	47
Dichlorprop	µg/l	0.8	1.4	1.4
2,3,6-TBA	µg/l			0.3
Other				
2,6-Dichlorobenzonitrile	µg/l	0.02	0.05	0.06
MTBE	µg/l	1.3	1.5	1.5

*Data for LW22 removed – see text for justification. No data collected for holding tanks

Some phenolic substances have also been identified within the leachate. Phenolic substances are hydrolysis products from putrescible waste that are rapidly released under acetogenic conditions. These are only present at significant concentrations up until a methanogenic microbial population can develop within fresh wastes. Consequently, as the methanogenic microbial population in the waste mass develops these substances are degraded as rapidly as they form and provide a feedstock for the methanogens. Therefore, there is a limited to negligible permanent presence within

the leachate. Acetogenic leachate can be recirculated into the more mature waste cells to optimise landfill gas to energy recovery.

Phenolic substances are generally identified within the Meece landfill leachate at low concentrations (1 – 79µg/l) which is consistent with the establishment of methanogenic conditions across the majority of the site. Higher values (2 – 5mg/l) are reported for LW22 in Phase 6 which contains the younger wastes where methanogenic conditions are not fully established. However, in accordance with the above, the concentrations reported at LW22 are unlikely to be sustained and are unrepresentative of the expected leachate quality for the wider Meece landfill or that to be processed through the RO plant.

The only other organic substance identified within the leachate at a significant concentration is the non-hazardous acid herbicide mecoprop which is reported at up to 47µg/l and on average is below the 18µg/l annual average EQS. Mecoprop is also permanently below its 187µg/l 95th percentile concentration EQS.

The organic substances screens have also identified several other substances at lower concentrations which are on average below the 10µg/l leachate screening threshold including naphthalene, several chlorinated solvents, 2,6-dichlorobenzonitrile, MTBE, dichlorprop and 2,3,6-TBA.

In addition to the organics, the annual screens have identified several inorganic substances which are present within the leachate and these are summarised in Table 4.

Table 4 – Meece Landfill Other Substances (March 2020 to January 2024)

Location		Sb	Mo	Se	B (total)	CN (free)
		mg/l	mg/l	mg/l	mg/l	mg/l
	EQS	**0.005**	**0.070**	**0.010**	**2**	**0.001**
In-waste wells	Avg	0.041	0.027	0.001	3.1	0.030
	Max	0.310	0.152	0.002	12.8	0.140

No data collected for holding tanks
In absence of EQS, DWS used for Se and WHO health standard used for Mo

The ATRF lagoon water is tested for a reduced suite of substance which are summarised in Table 5. The ATRF lagoon water contains lower ammonium, COD and chloride. Sulphate is of a similar concentration to that found within the Meece Landfill leachate. Hence, any input from the ATRF is expected to generally dilute the overall influent to the RO plant.

Table 5 – Meece Landfill ATRF Drainage Lagoon Matrix Substances Summary (September 2020 - August 2023)

	pH	NH_4-N	COD	Cl	SO_4	Sus. Solids
		mg/l	mg/l	mg/l	mg/l	mg/l
Ave	7.5	44	553	1,699	107	312
95th %ile	8.0	79	1,189	4,120	298	536
Max	8.0	96	1,370	4,380	414	680

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[2.3.2] Effluent Quality Expectations

The proposed RO plant is not in operation and therefore site specific treated effluent quality is not available. However, the RO plant manufacturer has advised that a 99% concentration reduction in the COD, BOD and ammonium is expected.

RO plants are routinely used at other landfill sites across the UK to treat landfill leachate. In accordance with the Best Available Techniques (BAT) Reference Document for Waste Treatment[3], reverse osmosis treatment is considered to be BAT. Performance data for RO leachate treatment plants demonstrates that concentrations of 1 – 9mg/l ammoniacal-N and 1 – 15mg/l of BOD[4] are usually achieved. A summary of the expected permeate (effluent) concentration based on existing plants is provided below:

- pH – 6.5 – 8.5
- Ammoniacal-N – 1 to 9mg/l
- BOD – 1 – 15mg/l
- Calcium, magnesium, sodium, potassium, chloride and sulphate – 10mg/l
- Lead, arsenic, cadmium, chromium, copper, nickel, zinc, iron and manganese – 1 – 5µg/l
- Phenols – 1 - 5mg/l

The final effluent quality will be dependent on the treatment objectives required by the risk assessment. The RO plant will be designed to meet the desired effluent quality.

[2.3.3] Discharge Objectives and Proposed Plant Performance

The RO plant will be designed to process up to 150m^3/day of landfill leachate.

The surface water risk assessment has demonstrated that under low flow conditions there are a limited number of substances which could pose a risk to the Meece Brook. Permit limits have therefore been recommended for these substances as set out in Table 6. The proposed limits are significantly more conservative than those set out within Table 6.1 of the BREF document[2] which sets out BAT-associated emission levels (BAT-AELs) for direct discharges to a receiving waterbody.

The permit limits will be applied to the effluent discharge point at NGR SJ 85075 34335 prior to discharge into the surface water management system.

[4] Environment Agency (2007) Sector Guidance Note IPPC S5.03. Guidance for the Treatment of Landfill Leachate (withdrawn)

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Table 6 – Comparison of Proposed Permit Limits and BAT-EALs

Substance	Proposed Permit Limit under low flow conditions	BAT-EALs
	mg/l	mg/l
Ammoniacal-N	4.8	10 - 60
BOD	39	None set
Chloride	1,965	None set
Chromium	0.037	0.010 – 0.150
Iron	7.8	None set
Free Cyanide	0.008	0.020 – 1
Orthophosphate	1.0	1 – 3
Suspended Solids	60	5 – 60
Visible Oil and Grease	None visible	None set

[2.3.4] Control Systems

The RO plant is designed to operate continuously and is therefore fully automatic. The process control system will be operated by the interface software program *SIEMENS S 7*. The process control system is programmed with operational targets and limits to maintain process efficiency. The operational limits are shown in **Error! Reference source not found.**.

The interface software program will provide operation, remote monitoring, and data logging capabilities. The data recording function allows for automated control including the starting/stopping the operation of pumps, valves, sliders, fittings etc.

A visualisation program WinCC flexible by SIEMENS and host computer (Siemens Microbox-PC), including touch panel will be available to view the collected process data and system information.

The plant is equipped with:

- Conductivity control system comprising a sensor, sensor cable and transmitter;
- pH control system comprising a sensor, sensor cable and transmitter; and
- Automated level control system within the tanks comprising of a radar sensor.

The system is built with telemetric capability that provides an element of remote monitoring and control as appropriate. The probes are connected to automatic shut-off valves which will restrict the discharge in the event of a breach.

RO plant minimum and maximum control levels can be set for the influent and permeate for conductivity, pH and temperature. Similarly, a minimum and maximum level set point can be set for the tanks.

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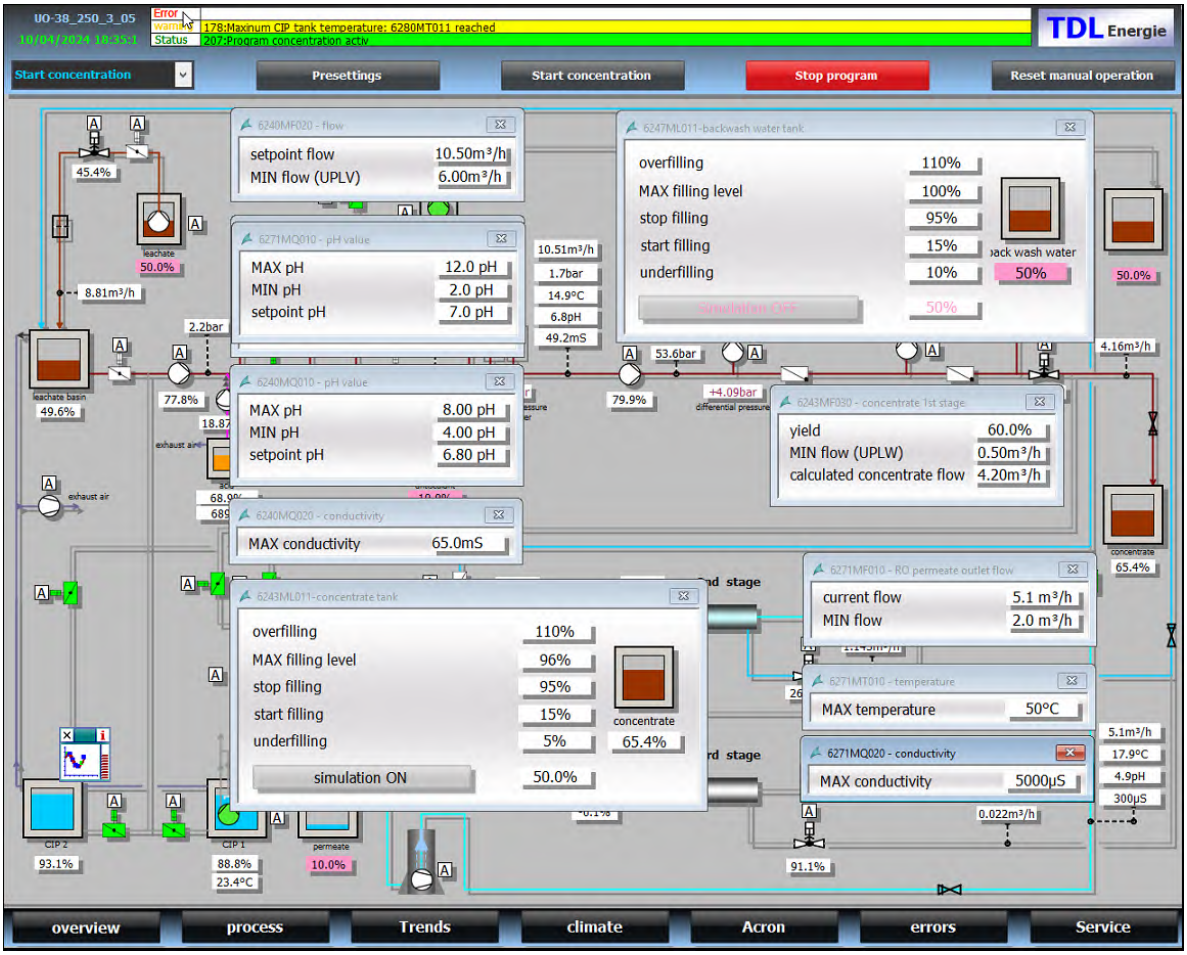
Figure 5 – Screenshot of RO Plant interface showing control levels (example)



The plant will automatically shut-down in the event that the minimum or maximum control levels set for the influent and permeate are breached. The automated level sensor system controls inputs to the tanks and prevents overfilling in accordance with minimum or maximum control levels.

The minimum and maximum control levels will be set based on the process requirements and treatment objectives. The control levels will be determined prior to the operation of the plant during the commissioning phase. These will then be reviewed regularly throughout the operation of the RO treatment plant.

The RO plant controls system includes an Automatic Feed Shut Off (AFSO) system that will protect against non-compliant conditions such as:

- Tank overflow
- Power failure
- Ineffective plant operation (detected through conductivity measurements)

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[3] Techniques for Pollution Control

The RO treatment plant is being developed to the north of Phases 2 and 3 of the restored landfill (Figure 2). Details of the proposed system are provided in Section [2] above. The RO plant is being developed upon a new impermeable concrete hardstanding area which will limit the potential for contaminant migration in the event of an uncontained spillage. Details of the drainage arrangements and hardstanding areas is provided on Drawing M4032800 and M4032900.

The new RO plant area is being developed upon an existing concrete pad most likely associated with the former WWII Munitions factory, and not atop of areas of landfilled waste. Albeit, site-derived borehole logs do indicate that made ground is present around the perimeter of the site most likely associated with the former WWII Munitions factory. Hence, made ground may also be present in this area.

The proposed site of for the RO plant and surrounding area are underlain by the Mercia Mudstone of an approximate thickness of 130m locally[5]. The Mercia Mudstone is described as '*a hard, red-brown, thinly laminated, silty or sandy clay with occasional fragments of gravel and sandstone. Regular bands of very weak fine sandy siltstone are present'.* The Mercia Mudstone confines groundwater in the underlying Sherwood Sandstone aquifer but is itself characterised as a Secondary B aquifer with groundwater flow primarily via fractures and within the more permeable horizons. Groundwater within the Mercia Mudstone exists as isolated systems which may be confined by the overlying less permeable mudstone. The less permeable mudstone will similarly limit the potential for contaminant migration in the event of an uncontained spillage.

[3.1] Management Systems

Reference has been made to Chapter 6.1 (General BAT Conclusions) of the BREF document, BAT conclusion 1[3].

Biffa operate the site in accordance with a site management system which has been certified by an independent UKAS accredited body as compliing with the requirements of ISO14001. The site is operated in accordance with an Environmental Management system (EMS) which meets the requirements of the Environment Agency's guidance on "*Develop a management system: environmental permits*"[6]. The management system provides an overview of management responsibility and management techniques employed at the site and this has been updated to include the LTP.

Routine management of the RO plant will be carried out in accordance with the EMS and operational manual provided by the manufacturer.

It is considered that the facility complies with BAT 1.

[5] Swan Environmental Ltd (2023) Meece 1 Landfill – Hydrogeological Risk Assessment Review
[6] https://www.gov.uk/guidance/develop-a-management-system-environmental-permit

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[3.2] Leachate Acceptance, Handling and Storage

Reference has been made to Chapter 6.1 (General BAT Conclusions) of the BREF document, BAT conclusions 2 to 5. Reference has also been made to Chapter 6.5 (BAT conclusions for the treatment of water-based liquid waste) of the BREF document, BAT conclusion 52.

[3.2.1] Pre-Acceptance Procedures and Waste Characterisation

The RO plant will treat leachate generated on-site only and as such pre-acceptance and acceptance procedures are not discussed further. The proposed inputs to the plant are well characterised through routine monitoring which is carried out in accordance with the site's Environmental Permit. Monitoring is carried out for a range of determinands including BOD and COD.

The influent to the LTP and outputs (permeate and concentrate) will be routinely monitored as detailed in Section 3.3 below. Automated process control systems are also in place to maintain process efficiency.

It is considered that the facility complies with BAT 2, 3 and 52.

[3.2.2] Leachate Storage

General Storage

All RO plant infrastructure arrangements for storage have been designed taking into consideration the requirements of relevant guidance[7] and process requirements.

Leachate and concentrate will be stored within fully enclosed bunded vessels (secondary contained tanks) designed to meet CIRIA C736 containment Class 2. Leachate and concentrate storage tanks are equipped with suitable abatement systems e.g. level sensors, remote telemetry communication systems and alarms.

Leachate, concentrate and reagent storage tanks and supporting structures, pipes, hoses and connections have been designed to be resistant to the leachate or mix of substances being stored. All connections have been sized in accordance with the plant specification and are capable of being closed through use of relevant valves operated from the RO control system.

All tanks will be positioned upon the impermeable concrete hardstanding area which will be designed to contain any potential leaks or spillages. The hardstanding area will be sufficiently bunded using kerbing and this bunded area will have a capacity equivalent to at least 110% of the largest vessel or 25% of the total tankage volume (whichever is greatest). Details of the proposed kerbing and drainage features are illustrated on Drawing M4032800.

The off-take points from the tanks are to be positioned within the bunded hardstanding area to contain any leaks or spills. Drip trays will be used to catch spillages during the connection and dis-connection of pipe work.

Pipework will be routed above ground within containment areas. Pipework has been designed taking into consideration material characteristics and loading.

[7] Biffa Waste Services Limited *et al.* (2017) Landfill Industry Code of Practice (ICoP). The Establishment of Appropriate Containment Standards for Leachate Storage and Treatment Plant

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Reagent Storage

All reagents will be stored within the bunded hardstanding area which has been designed to contain any leaks or spills. Sulphuric acid will be stored within a fully enclosed bunded vessel (self-contained tank). Other reagents may be stored in drums or bags, as considered appropriate.

Verification of stored quantities on site will be undertaken via weekly manual stock checks and will be recorded.

Security

All containers, vessels, tanks and drums will be fit for purpose and stored securely. Access to the LTP facility will limited as follows:

- The LTP area will be designated as “restricted access” as necessary
- The LTP area will be enclosed by 1.8m high weld-mesh fencing and dedicated access gates
- Access to the LTP area will be via a secure entrance which will require authorisation by reporting to site offices.
- Tanker access to the LTP area will be via the internal haul road
- The RO plant (treatment system) will be enclosed within a lockable ISO container.

Monitoring and Maintenance

Integrity testing and monitoring of the tanks will be carried out as follows:

- maintenance of the tanks will be undertaken in accordance with the manufacturer’s recommendations;
- each tank is equipped with level detection systems, actuators and alarms which are monitored continuously. The monitoring system has telemetric capability and incorporates a visual/audible alarm and a fail-safe mechanism that shuts plant down in a controlled manner within a few minutes;
- each tank will be visually inspected (externally) for leaks once per week, and each inspection will be recorded;
- each tank will be assessed at least annually for potential sludge/sediment build up to ensure that plant efficiency and integrity are maintained;
- the treatment vessels and associated equipment (pipework, valves and level alarms) will be serviced no less frequently than annually or in accordance with the manufacturers recommendations; and

All maintenance and inspection activities are to be undertaken by relevant competent personnel or appointed external specialist contractors. In the event of a fault being identified, remedial work will be undertaken as soon as reasonably practicable taking into consideration the hazard properties of the material present, and the site operational requirements at the time, to ensure that work can be done both safely and efficiently.

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The results of all such work are recorded, confirming that plant equipment continues to remain fit for purpose and where necessary will identify remedial work including plant replacement that has been undertaken.

It is considered that the facility complies with BAT 4.

[3.2.3] Waste Handling and Transfer

Handling and transfer activities will be supervised at all times by suitably trained staff.

Appropriate training will be provided to personnel on the safe handling, use and disposal of any process chemicals. Spill kits will be provided in areas of chemical handling and storage and personnel will be trained in their use.

Loading

Loading areas for concentrate to be removed to an off-site treatment facility have been designed to capture and contain any small releases that may occur. The controls in place at the site are as follows:

- allocated loading points for different aqueous materials are clearly labelled for the material type;
- discharge from tanks will only be permitted providing all pipe connections and hoses are of the correct specification and are in good condition. In the event of any incident occurring during discharge then the discharge operation will be ceased immediately;
- off-take points from the tanks are positioned within the bunded hardstanding area to contain any leaks or spills;
- drip trays are available to catch spillages during the connection and dis-connection of pipe work; and
- operating procedures for the RO plant are incorporated into the site's management system which details the plant loading/discharge requirements.

Records are to be maintained of any waste sent off-site (Duty of Care).

It is considered that the management of above actions are compliant with BAT 5.

[3.3] Monitoring

Reference has been made to Chapter 6.1 (General BAT Conclusions) of the BREF document, BAT conclusions 6 to 21 and 20.

[3.3.1] Process Monitoring

The RO plant control systems are set out within Section [2]. Conductivity will be monitored at various stages in the treatment process to maintain process efficiency. Results of the monitoring will be continually assessed and used to adjust the production processes.

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Conductivity will be monitored by a probe located in the discharge pumping chamber which will be connected to shut-off valves prior to the outfall to the surface water management system. The discharge will be automatically stopped if concentrations exceed the discharge control limits.

The above process controls are compliant with BAT 6.

As the influent is a landfill leachate, characterisation of this will continue through the routine monitoring programme as set out within the Environmental Permit.

[3.3.2] Emissions Monitoring

Reference has been made to Chapter 6.1 (General BAT Conclusions) of the BREF document, BAT conclusions 7 to 10 and 12.

Emissions to Water

There are no point source emissions to groundwater.

The LTP will discharge to surface water via the site's surface water collection system. Monitoring of the most suitable parameters will be agreed with the Agency and will be stipulated within the Permit.

A risk assessment has been produced in support of the proposed LTP (as Report Ref. K6094-ENV-R003). This report characterises the influent, process efficiencies and expected effluent. The RO plant at Meece will be designed to achieve the BAT-AELs detailed in Table 6.1 of the BREF document. Emission limits have been proposed in accordance with the BAT-AELs and quantitative risk assessment.

As noted above, RO plants are often an effective alternative to biological treatment systems due to their treatment reliability and being less prone to process instabilities caused by feed quality variations. Hence, significant changes in the process efficiency are not expected. The LTP is fully automated, and a conductivity probe will be used to continuously monitor the discharge quality. It is proposed to monitor for a wider suite of determinands on a monthly basis as set out within the risk assessment (Report Ref. K6094-ENV-R003).

BAT is to monitor emissions to water in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality. Consequently, there are several different methods which could be used to monitor for the above substances (e.g. BS EN 18-99-1 and SCA blue book 130 for BOD) depending on the laboratory used. All water sampling will be carried out at a UKAS accredited laboratory and in accordance with EN standards or a suitable alternative.

Emissions to Air

BAT 8 is to monitor channelled emissions to air. There is one proposed channelled emission source from the carbon dioxide stripping tower which is to be used after the RO process to adjust the pH prior to discharge to surface water. This pH correction (from acidic to neutral) is often carried out by dosing with caustic soda. However, this process introduces additional sodium ions and involves the handling of a corrosive chemical. The proposed stripping tower will reduce the risk of spillages whilst maintaining the overall requirement to adjust the pH to within an acceptable range *i.e.* >6 and <9.

BAT 8 does not specify a requirement to monitor for carbon dioxide which may be released by the carbon dioxide stripping tower. Other potentially volatile substances listed are not expected to be

present within the permeate in significant concentrations following processing through the RO membrane. Hence, monitoring in accordance with BAT 8 in not considered necessary. Potential emissions from the carbon dioxide stripping tower are considered within the accompanying Environmental Risk Assessment (Report Ref. K694-ENV-R004).

BAT 9 is to monitor diffuse emissions of organic compounds to air from the regeneration of spent solvents, the decontamination of equipment containing POPs with solvents, and the physico-chemical treatment of solvents for the recovery of their calorific value. BAT 9 is therefore not considered applicable.

BAT 10 and BAT 12 are only applicable to cases where an odour nuisance at sensitive receptors is expected and/or has been substantiated.

The potential for fugitive air emissions to occur at the site is considered low due to the nature of the activity and it is considered unlikely that odour associated with the LTP could reach nearby receptors. A complaints procedure is in place to record any nuisance emissions. There have been no odour complaints at the site which already stores leachate in tanks and transfers to tankers for offsite disposal. Hence, no further controls or monitoring are therefore considered necessary.

BAT 10 (odour monitoring) and BAT 12 (provision of an odour management plan) is not considered applicable as significant odour emissions are not expected.

Consumption of Water, Energy and Raw Materials

The site's Environmental Permit sets out requirements to:

- maintain records of raw materials and water used in the activities;
- review and record at least every four years whether there are suitable alternative materials that could reduce environmental impact or opportunities to improve the efficiency of raw material and water use; and
- report energy usage on an annual basis.

The consumption of water, energy, raw materials and the LTP throughput will be monitored on at least an annual basis.

It is considered that the above measures are compliant with BAT 11.

[3.4] Emission Control

[3.4.1] Water emissions

Reference has been made to Chapter 6.1 of the BREF document, BAT conclusion 19.

Point Source Emissions to Surface water, Groundwater and Sewer

There are no point source emissions to groundwater from the LTP.

Point source emissions to surface water and/or sewer will be carried out as part of the wastewater treatment activity. Monitoring of the discharge will be carried out to confirm that the discharge quality and quantity meets either the limits set out within the Environmental Permit (for surface water) or Trade Effluent Discharge Consent (for sewer).

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Conductivity will be monitored by a probe located in the discharge pumping chamber. The discharge will be automatically stopped if concentrations exceed the process control limits.

Fugitive Emissions to Surface Water and Groundwater

The LTP will be located upon an impermeable concrete hardstanding to contain any potential leaks or spillages. The hardstanding area will be sufficiently bunded using kerbing and this bunded area will have a capacity equivalent to at least 110% of the largest vessel or 25% of the total tankage volume (whichever is greatest). All fill points will be located within the bunded area and no pipework will penetrate the bund wall.

The hardstanding areas will be regularly inspected on a weekly basis to ensure the integrity of the containment system is maintained. Rainwater falling on the treatment and storage areas will collect within the bunded hardstanding area. The hardstanding areas will be inspected to ensure that bunds filled by rainwater are regularly emptied.

Leachate and concentrate storage tanks are all secondary contained and equipped with suitable abatement systems e.g. level sensors, remote telemetry communication systems and alarms. The LTP will automatically shutdown when capacity is reached to prevent overflowing of the storage tanks. Reagent tanks will also be secondary contained. All storage tanks and vessels will be stored within the bunded hardstanding area.

Appropriate training will be provided to personnel on the safe handling, use and disposal of any process chemicals. Spill kits will be provided in areas of chemical handling and storage and personnel will be trained in their use.

In the unlikely event of a leak or spillage from on-site plant or storage tanks, the cause of the spillage will be identified and recorded so that further leaks or spillages may be prevented. Details of the spilled material and estimated quantity involved, and remedial actions taken will be recorded.

It is considered that in accordance with the above measures the facility complies with BAT 19.

[3.4.2] Air Emissions

Reference has been made to Chapter 6.1 (General BAT Conclusions) of the BREF document, BAT conclusion 13 and 14. BAT 13 relates to the techniques employed to control of odour emissions. BAT 14 relates to the techniques used to control diffuse emissions of dust, organic compounds and odour. BAT 15 and 16 relate to emissions to air from flares and are not applicable. Reference has also been made to Chapter 6.5 (BAT conclusions for the treatment of water-based liquid waste) of the BREF document, BAT conclusion 53.

Air emissions are not expected to occur as part of the RO plant operation due to the low loading of volatiles within the leachate and prior storage of leachate within holding tanks. The RO plant is therefore unlikely to represent a significant odour source. The treatment system is located within an ISO container which will further limit the potential for odour.

Doors and hatches will be kept closed when access is not required to minimise the potential for emissions. The treatment vessels and associated equipment (pipework, valves and level alarms) will be serviced no less frequently than annually or in accordance with the manufacturer's recommendations.

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Further controls are not considered necessary for controlling odour emissions due to the lack of odour expected to be produced by the plant and proximity of nearby receptors.

There is one potential point source emission from the carbon dioxide stripping tower. However, this is required to correct the pH prior to discharge.

It is considered that further measures in accordance with BAT 13, 14 and 53 are not required due to the absence of significant emissions.

[3.4.3] Accidents and Incidents

Reference has been made to Chapter 6.1 of the BREF document, BAT conclusion 21.

Management and control of spills and leaks are addressed in earlier sections of this report.

The LTP will be surrounded by 1.8m high security fencing. The entrances to the compound (vehicle and pedestrian access) will be protected by lockable gates, which will be kept locked at all times outside of operational hours. CCTV is to be installed.

Site staff will be briefed that in the event of evidence suggesting unauthorised access or vandalism being found, the matter must be reported to the police. If the incident involved unauthorised tipping or spillage of any waste, the Environment Agency will be informed.

Site gates and perimeter fencing will be inspected regularly in accordance with the site's management system and any repair work will be undertaken as soon as is practicable. Where possible a temporary repair will be implemented by the end of the working day.

A detailed accident management plan is included within the site's management system. The accident management plan includes an incident record and assessment system.

It is considered that the facility complies with BAT 21.

[3.4.4] Noise and vibrations

Reference has been made to Chapter 6.1 of the BREF document, BAT conclusion 17 and 18.

The LTP will be positioned within a relatively remote location. Noise from the RO plant is not expected to be significant. Noise associated with the LTP may arise from motors associated with the RO plant and vehicle movements. The following measures are in place to limit the potential for nuisance noise:

- The motor which drives the plant has been selected to minimise the potential for noise emissions.
- Plant and services are enclosed as far as practicable to minimise the potential for noise emissions.
- Regular maintenance of plant and machinery.
- Use of manufacturers exhaust silencers, as appropriate.
- Plant and vehicles will be turned off when not in use.
- Vehicle speeds will be limited on site.
- A complaints procedure is in place at the site.

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Measures for limiting the potential for nuisance noise are detailed within the site's management system. A noise survey for the RO plant has been carried out in support of the planning application for the plant.

It is considered that the facility complies with BAT 17 and 18.

[3.5] Raw Materials

Reference has been made to Chapter 6.1 of the BREF document, BAT conclusion 22.

Raw material usage is limited to the following quantities of reagents:

- Sulphuric acid to be stored in a 20m^3 bunded tank;
- Citric acid to be stored in 25kg bag (3kg used daily);
- Anti-scalant (Vitec 7000) to be stored in a 230kg drums (1kg used daily); and
- Alkaline detergent (P3 Ultrasil 14) to be stored in 20kg bag (7kg used daily).

The Operator will store a 2 – 4 weeks supply of the above on site, dependant on supplier availability.

A list of raw material will be maintained as part of the site's Environmental Management System (EMS). Material use will be regularly reviewed and will be minimised through the effective replacement with suitable materials where possible. The available options for waste minimisation are limited given the nature of the activities.

Water use is limited to wash water and water for welfare facilities. Water usage will be monitored and recorded, and water usage will be reviewed every 4 years.

Purchasing procedures for ensuring appropriate product specification will be in accordance with the EMS.

It is considered that the management of above actions are compliant with BAT 22.

[3.6] Energy Management

Reference has been made to Chapter 6.1 of the BREF document, BAT conclusion 23.

The RO plant requires the provision of energy primarily through electricity as the main energy source for the process. Energy for the LTP will be sourced from the landfill gas utilisation plant (when operational). The RO plant process requirements are:

- Total power installed = 77kW
- Consumption = 38kW
- Daily power consumption = 6.318kWh per m^3

Standard energy efficiency measures will be adopted and will include:

- maintenance and inspection of plant to ensure efficient operation;
- selection of energy efficient equipment;
- use of energy efficient lighting; and

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- appropriate use of insulation and lagging.

Energy usage will be regularly reviewed in accordance with the requirements of the Permit on an annual basis. Energy usage information is collected during the plant operation with visual trend analysis available.

It is considered that the management of above actions are compliant with BAT 23.

[3.7] Waste Recovery or Disposal

Reference has been made to Chapter 6.1 of the BREF document, BAT conclusion 24.

Waste generated is limited to:

- small quantities of sludge removed during periodic maintenance of the tanks which will be removed by suitable suction tanker and disposed of in accordance with the Duty of Care;
- concentrate which is tankered off-site and disposed of at a suitable treatment facility; and
- packaging such as drums which will be re-used (where it is technically and economically feasible to do so) or recycled.

It is considered that the management of above actions are compliant with BAT 24.

[3.8] Closure

The infrastructure, site surfaces and location within the landfill permit boundary mean that there will be an inherently low risk of pollution to the site and its' environs during the ultimate decommissioning process.

Storage tanks and pipe work will be removed and or decontaminated. A closure plan will be maintained through the lifetime of the LTP. This will contain, but is not limited to, the following information:

- plans of all buried services;
- plans to remove or flush out any buried pipelines and vessels; and
- methods for dismantling buildings and processing equipment.

Further information with regards to Closure Management is provided within the site's management system.

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Appendix A.

RO Plant Specification

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Appendix B.

Leachate Quality Data

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Drawings

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