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1 INTRODUCTION

Befesa Salt Slags Ltd operate a salt slag processing operation at Fenn's Bank near Whitchurch. The site operates under an environmental permit, a condition of which is that there will be no discharge from the site to controlled waters. Whilst the site is operational, water received by the site (from incident rainfall and drainage from surrounding third party land) is used in the process. However, the site is currently being decommissioned prior to closure, and the use of water in the site process has ceased. Currently, water is being actively managed by tankering off-site, but this is not a viable long term solution.

Natural Resources Wales are the regulator for the site, and have requested that Befesa Salt Slags take steps to ensure that there is no unpermitted discharge of water from the site during the closure process and in the longer term. Befesa wish to retain the current permit rather than surrender it.

This technical note presents background information for the site and outlines a water management strategy to ensure that any discharge from the site under dormant conditions is compliant with the Environmental Permitting Regulations 2016.

2 SETTING

Details on the land adjacent to the site have been obtained from Amec Foster Wheeler's 2018 report 'Wardle Landfill Drilling and Monitoring Report'.

A former aluminium foundry, now a small industrial estate, lies to the south of the site and shares the access road. A landfill associated with the former foundry lies to the southwest; the base of the landfill has been proven at 85 m aOD. A ditch runs past the western site boundary which ultimately discharges to the Redbrook c. 200 m northwest of the site. The site and its environs are shown on Figure 3.1. The site elevation is approximately 90 m aOD.

3 SUMMARY OF DRAINAGE

The site comprises an access road, an office and car park area, operational buildings with roadways and yards, and soft landscaping areas. A storm water lagoon with capacity of 4,000 m^3 (possibly reduced by siltation) is sited in the south of the site. The lagoon is pumped to a storm water receptor which is then pumped to holding tanks for use in the process. The lagoon is currently at full capacity, with an ammonia concentration of c. 60 mg/l. A reedbed and ditch lie on the eastern side of the access road which receive groundwater flow from a field to the east, and are pumped to the car park drains. Additional drainage from the field to the east is routed to the site access road via pipes.

Drainage from the roofs is directed to the car park drainage system, and the car park drains are pumped to the lagoon. Drainage from the access road and site roads and yards are pumped to the storm water receptor.

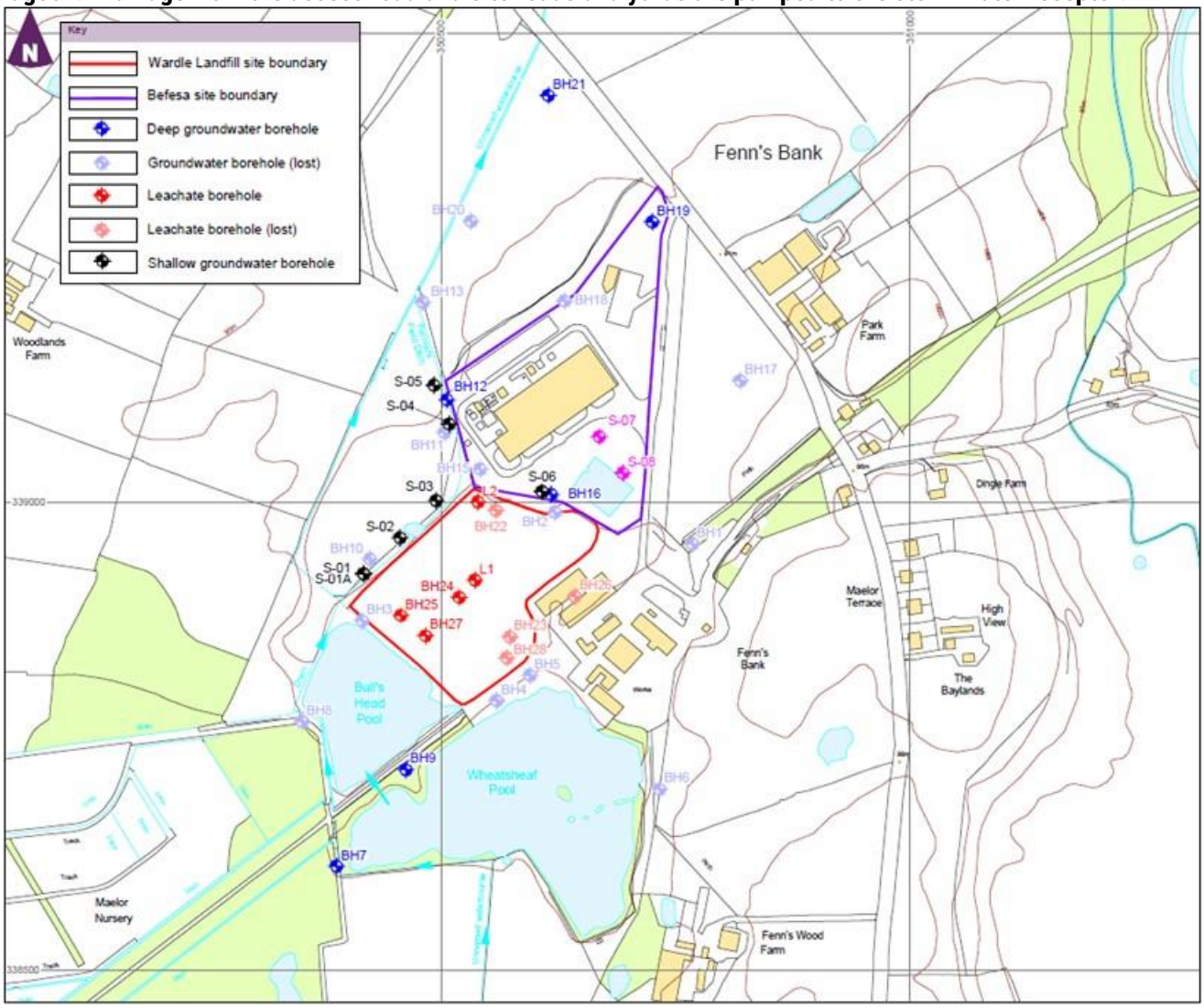

Figure 3.1 Site boundary and landfill (from Amec Foster Wheeler, 2014)

Table 3-1 summarises the drainage system.

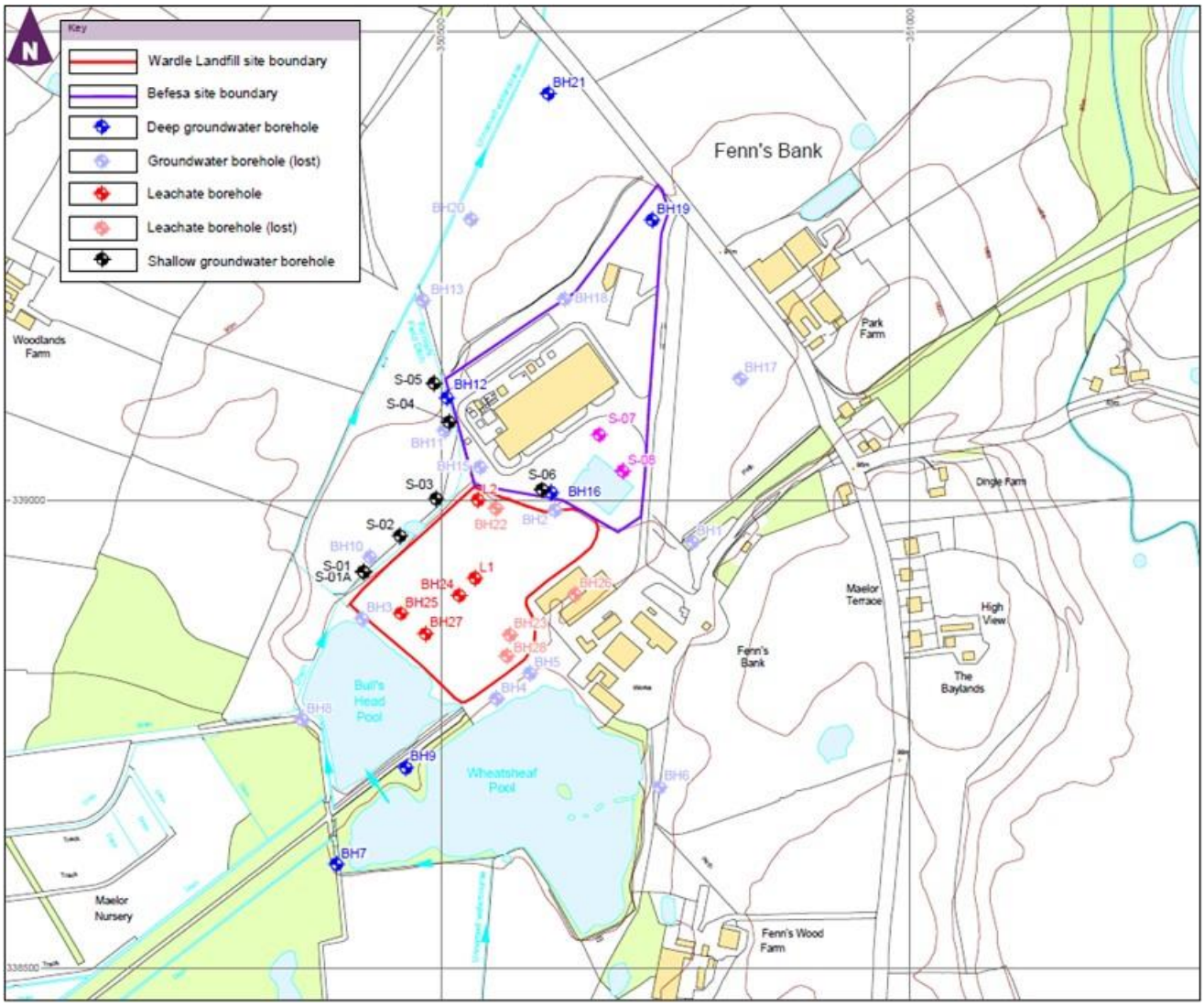

Figure 3.1 Site boundary and landfill (from Amec Foster Wheeler, 2014)

Table 3-1 Summary of site drainage

Drainage system	Sources of water	Storage m^3	Discharges to
Roof	Rainfall	none	Gravity feed to car park drains
Storm ditch and reedbed	Groundwater, incident rainfall	Approx. 165 m^3 assuming 0.5 m deep	Pumped to car park drains
Access road	Rainwater, farmers field	Estimated 300 -500 m^3 storage on site roads and car park under wet conditions (assume area 2 x car park with 10 cm water)	Pumped to storm water receptor
Car park	Rainwater, roof run-off, sewage treatment output		Pump 1 and Pump 2 to lagoon
Roadways	Rainfall		Storm water receptor
Lagoon	Car park drains	4000 m^3	Storm water interceptor
Storm water interceptor	Access road, car park, roadways, lagoon	Unknown	Process

4 GROUNDWATER

Around 56% of the site area comprises soft landscaping. It is assumed that water falling on these areas infiltrates the ground but is ultimately captured by the site drainage system, as groundwater levels are very high in the area.

Groundwater quality is thought to be heavily compromised due to the historical landfill adjacent to the site. Average concentrations of ammonia in the storm ditch on the east of the site, which is thought to be groundwater fed are around 47 mg/l. Monitoring results from the wider area around the site range from 2.68 mg/l to 1640 mg/l.

The volume of groundwater flowing onto the site has not been quantified; it is possible that groundwater is captured by site drains and pumped to the lagoon or storm water interceptor.

Amec Foster Wheeler[1]report that the local geology comprises glaciofluvial deposits (sands and gravels) and Till to a depth of at least 25 m bgl, overlying Triassic Mudstones and Halites. Groundwater levels are shown as falling to the northwest across the site from 90 m aOD in the area of the lagoon, to 87 m a OD in the car park. The groundwater gradient is 0.005. Results of permeability testing are between 0.3 m/d and 10.7 m/d. On this basis, groundwater flow in the top 5m of saturated ground below the site may be of the order of 4.5 m^3/d.

5 HISTORICAL BACKGROUND WATER QUALITY

Amec Foster Wheeler report the following ammonia concentrations from sampling in 2017:

- Background groundwater quality (upstream of the landfill) was 0.93 – 1.5 mg/l
- Landfill leachate was 186 – 744 mg/l
- Downgradient of the landfill and upgradient of the site, groundwater concentrations were 690 mg/l
- Onsite groundwater concentrations were 1.94mg/l, 1.58 mg/l and 179 mg/l
- Groundwater concentrations downstream of the landfill and adjacent to the western boundary ditch were 1.56 and 4.65 mg/l
- Surface water concentration from a manhole in the field to the east was 248 mg/l
- The concentration in surface water ponding at the west of the site was 536 mg/l, and from 164 mg/l to 240 mg/l in the western boundary ditch.

Water quality sampling is ongoing at the site during decommissioning. It is not yet clear what the steady-state water quality around the site will be once the site is fully decommissioned, and an assessment of the medium and long term water quality will be made once these works are further progressed.

6 SITE WATER BALANCE

In order to develop a water management strategy, the volume and quality of water on the site needs to be estimated. Under operational conditions, all water incident on the site plus water from adjacent land was used in the process. This volume is thought to have been around 40,000 to 50,000 m^3/a.

An estimate of effective rainfall volumes has been made (rainfall minus evaporation) for different areas of the site, as shown in Table 6-1. Also considered are the volumes of water generated for a 100 mm, 80 mm and 50 mm storm event (no evaporation is included). These represent extreme rainfall events, with the 100 mm event approximately a 1 in 100 year storm event.

[1] Amec Foster Wheeler, 2018. Wardle Landfill, 2017 Drilling and monitoring report ref 39299RR010i2 November 2018

Table 6-1 Effective rainfall volumes (m^3)

Effective rainfall (m^3)	Whole Site	Roads and yards (not car park)	Buildings and car park	Soft area (no lagoon)	Lagoon
Area m^2	47264	9554	9330	26380	2000
Annual Total	**13916**	**2813**	**2747**	**7767**	**589**
Average day in January	84	17	16.6	47.	3.7
100 mm storm (no evaporation)	4726.4	955.4	933	2638	200
80 mm storm (no evaporation)	3781	764	746	2110.4	160
50 mm storm (no evaporation)	2363	478	467	1319	100

It can be seen that the annual total of around 13,916 m^3 is significantly less than the volume used historically in the process. It is likely that the field to the east of the site may generate a similar volume of water, being of a similar area, and there may be run-off from the former foundry site to the south which collects in the access road. Whilst Befesa is not responsible for managing third party water generation, an assessment of the catchment area and drainage arrangements of these off-site sources is required if off-site sources of water are to be quantified. Both of these sources are likely to be impacted in terms of water quality.

Table 6-2 shows an outline water balance for the site, highlighting where there are uncertainties.

Table 6-2 Outline water balance

IN	m^3/a	OUT	Comment
Effective rainfall	14,000	Formerly used in process	40,000 – 50,000 m^3/a
Groundwater flow into drains	<1600?	Currently actively managed by tankering off-site	Data on volumes is being collated. Expense is not sustainable
Surface water flow and drainage from adjacent land	>15,000?	Future site discharge via passive or active management	Will be equal to inflows minus recharge to groundwater
		Recharge into groundwater	Currently unknown but can be quantified

7 STRATEGY:

The following strategy is proposed:

- Quantify the water balance in terms of quantity and quality of water that will require management in the medium and long term
- Minimise the volume of water entering the permit area from adjacent land
- Quantify the likely volume and quality of site discharge
- Establish an acceptable discharge quality for contaminants of concern
- Propose passive and/or active management measures to achieve the acceptable discharge limits
- Discuss and initiate process for consenting the site discharge in accordance with the Environmental Permitting Regulations

Management measures are likely to include blocking off inflows from adjacent land, adjustments to drainage arrangements to achieve gravity drainage from the site where appropriate, and ensuring that storm flows are

appropriately managed. If water quality requirements cannot be met by passive dilution, or mixing, consideration may have to be given to treatment prior to discharge.

The identification of appropriate discharge consent limits for chemicals of concern will require careful assessment of the quality of the receiving water, which is impacted by proven landfill leachate and poor quality surface water and groundwater quality in the local area.

The following works will be undertaken to implement the strategy:

- Inspect drains, establish connections and invert levels, identify any sumps and repairs needed
- Establish what the connections and arrangements at the northern site discharge are (currently not operating)
- Establish water quality and groundwater level monitoring programme to inform strategy
- Investigate the components of flow (surface water vs groundwater from adjacent land) into the storm drain
- Quantify water balance for the site
- Estimate loading of chemicals of concern on different parts of the water balance
- Investigate options to prevent surface water entering the site from adjacent land, and implement
- Investigate options to fill in storm ditch to the east to prevent groundwater from entering the on-site surface water system, and implement
- Estimate likely long-term quality of site discharge under passive management arrangements
- Evaluate current and likely future baseline water quality in the surrounding area especially the Redbrook receiving water course and its tributaries.
- Evaluate potential impacts to receiving waters under passive site discharge arrangements
- Report to NRW.

Table 7-1 shows the proposed monitoring programme; the offsite surface water sampling locations are shown on Figure 7.1. The location and accessibility of historical and recent NRW boreholes is not certain, and the monitoring location plan will be updated once this information becomes available.

Table 7-1 Proposed monitoring programme

Item	Details
Groundwater levels	To be measured in NRW boreholes on a monthly basis (dependent on access)
Groundwater quality	Samples to be taken from NRW boreholes on a monthly basis (dependent on access)
Surface water quality: on-site locations	storm water ditch, lagoon, surface water ponded at south west site corner, manholes on access road, northern site discharge point, ponded water on car park, access road, eastern and southern corners of yard, western yard road
Surface water quality: off-site locations	farmers field manholes (3 no), stream to west of site (points, e, f, g, h, I, j, p and q from Wood 2017 report), Redbrook.
Water quality monitoring suite	Initial monitoring round: pH, EC, chloride, sulphate, alkalinity, nitrate, nitrite, ammonia, calcium, magnesium, potassium, sodium, arsenic, barium, boron, beryllium, cadmium, chromium, copper, mercury, iron, manganese, lead, nickel, vanadium, selenium, zinc. Well-head parameters: DO, EC, pH, redox, temperature Subsequent monitoring rounds

Item	Details
	pH, EC, chloride, sulphate, ammonia, potassium, sodium, copper, lead, zinc plus contaminants of concern identified in the initial monitoring round
Sampling protocols	Low flow purging and sampling for groundwater samples with assessment of well-head parameters Cross-contamination prevention measures in place Retention of samples in clean vessels supplied by the laboratory with appropriate preservatives and vessel type Transport to UKAS accredited laboratory under chain of custody procedures
Frequency	2 monitoring events 2 weeks apart to inform the water management strategy with further monitoring to be advised on the basis of those results, likely to be monthly for 3 months with subsequent review or alteration to comply with conditions of a discharge permit.

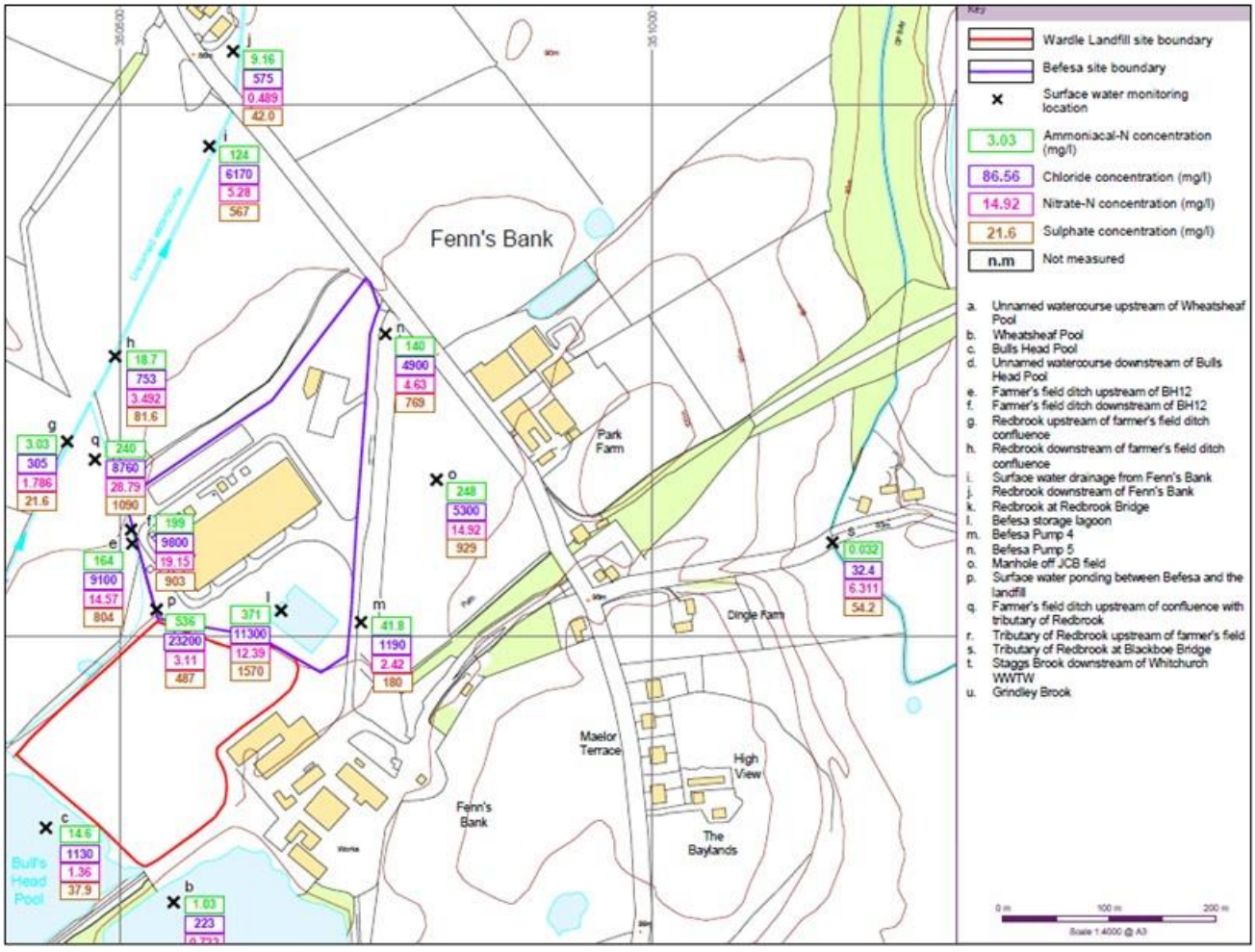

Figure 7.1 Surface water sampling locations from Amec Foster Wheeler, 2017.

8 LIMITATIONS AND RESTRICTIONS

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