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3rd July 2019

Dear Jonathan,

PARBOLD HILL LANDFILL SITE
RESTORATION MAINTAINANCE SCHEME

This letter is in response to questions raised in your email dated 27th June 2019 to Tom Smith as part of the consultation process for the Parbold Hill Quarry restoration proposal.

1. Pumping Rate Justification to address the following comments:

"I have reviewed the information in the TerraConsult report. Figure 1 in this report shows that the pumping rates are closely related to rainfall. This is not surprising and in my view does not necessarily mean that there is an issue with the capping and restoration of the site which requires the levels of the site to be raised. Section 1.1.8 of the TerraConsult report states that the site had no basal or sidewall lining and therefore the pumping rates could be due to groundwater ingress which a recontouring of the site would not address. The information which has been submitted to justify the development is therefore not sufficiently conclusive that the condition of the capping is the cause of high leachate levels"

Response

The calculations presented in TerraConsult report referenced 4458/R/001/01 represented a conservative assessment of the likely infiltration-derived leachate generation associated with the site. The example used in the study (Brogborough Landfill Site) was a fully capped landfill with a 1 m thick engineered clay cap with a maximum permeability of 1 x 10^{-9} m/s. It assumed the cap was covered in 1 m depth of restoration soils. Even with this low permeability cap and at a slope gradient of 1:13, it was calculated that ~ 10 % of the excess winter rainfall (that not lost to evapotranspiration) could enter the waste through the cap, increasing to 17 % if the restoration soils were saturated.

It is assumed that 10% of rainfall can enter the site outside the areas of significant settlement (approximately 7 Ha in area) where the restoration soils and cap are not saturated due to reasonably effective drainage. This equates to 2,170 m^3 of leachate produced per annum based on 310 mm excess winter rainfall quoted in the previously submitted report (7 Ha x 310 mm x 10% = 2,170 m^3). It is assumed that the area where drainage has been impeded by settlement (approximately 2 Ha in area) that the soils are saturated and would have a 17% infiltration rate and this equates to 1,054 m^3 (2 Ha x 310 mm x 17 % = 1,054 m^3). This

represents a third of the likely leachate generation in the whole site (3,224 m^3), caused by an area that occupies less than a quarter of the site area. Improvements to the restoration soils across the site would reduce this value further.

Data provided by the Operator states that 551 m^3 of leachate was removed from site in 2018. The infiltration calculations have assumed that 3,224 m^3 / year of infiltration-derived leachate is generated. This means that less than 20% of the infiltration-derived leachate generated by the site is being collected, with more than 80 % potentially entering groundwater after percolating through the full depth of the waste. This does not take into account preferential pathways in the capping material where infiltration could be higher. In isolation and regardless of any groundwater inputs, infiltration-derived leachate therefore represents a significant source of potential pollution to groundwater. If groundwater was infiltrating the site, even greater quantities of leachate may be being produced and adversely impacting groundwater quality.

The rapid response times for pumping after rainfall events make infiltration-derived leachate generation the most likely source for a number of reasons:

- The depression in the site profile due to settlement has created a focal point where the potential driving head of liquid into the waste is particularly high (as described above);
- The ground in the surrounding area slopes downward in all directions from the local highpoint to the north (High Moor). This limits the catchment for groundwater derived infiltration. Precipitation falling on natural ground is just as likely to run off at the rates described above further reducing infiltration potential. There are a number of surface water courses and physical barriers uphill of the site which direct surface run off away from the site.
- Groundwater flow typically follows the surface topography in permeable strata and it is likely the hydraulic gradient vicinity of site is steeply toward the south. The ground also slopes steeply away to the west, south and east of the site, preferentially draining both surface water and groundwater away from the site. Free flowing groundwater may moderate further the potential for increasing groundwater levels resulting from a limited infiltration catchment

The likelihood of leachate generation being primarily associated with groundwater inundation is therefore likely to be low compared to the quantifiable volumes predicted as a result of infiltration from the driving head of water through the landfill cap.

2. Leachate Volume Justification to address the following comments

"Whilst you have included the rainfall data, I can find no information on the volumes of leachate that you are having to pump and demonstration that these are unusually high. It is understood that there is a financial cost to the continued pumping of leachate. However, that in itself is not an argument that can amount to very special circumstances. You will need to demonstrate that there is a pollution control issue that only a recontouring of the site can address."

Response

The response to Question 1 above established that a significant quantity of leachate will be generated as a result of infiltration through the cap regardless of any groundwater ingress. Liquid percolating through the cap has a higher potential to leach polluting substances as it passes through the full waste profile. This is reflected by samples taken from the leachate extraction point.

Table 1 summarises the environmental quality data provided by the Operator based on samples taken at the site during 2017 and 2018. This includes:

- Groundwater quality from boreholes around the site;
- Leachate quality data taken from the extraction sump; and,
- Relevant Drinking Water Standards (DWS) or Environment Quality Standards (EQS) for each substance.

Table 1. Summary of Groundwater and Leachate Quality (2017 and 2018)

Monitoring Point		Substance							
		Amm-nitrogen (mg/l)	Chloride (mg/l)	Chromium (µg/l)	Nickel (µg/l)	Sodium (mg/l)	COD (mg/l)	BOD (mg/l)	TOC (mg/l)
	DWS	0.39	250[1]	50[2]	20[2]	200[2]	N/A	N/A	N/A
Groundwater (H) N/side BH 36	max	0.09	52	1	6	34	31	3	8
	min	0.09	50	1	3	30	7	3	2
	mean	0.09	51	1	4.5	32	19	3	5
Groundwater (W3) BH 21	max	0.16	110	13	11	80	61	3	19
	min	0.1	74	4	6	68	24	3	5
	mean	0.13	92	8.5	8.5	74	42.5	3	12
Groundwater (K) S/side BH 56	max	0.19	81	3	6	32	24	3	9
	min	0.07	51	1	3	29	23	3	4
	mean	0.13	66	2	4.5	30.5	23.5	3	6.5
Groundwater (L) S/side BH 58	max	2.5	18	10	23	20	46	3	25
	min	1.3	14	2	5	14	35	3	5
	mean	1.9	16	6	14	17	40.5	3	15
Leachate Pumping chamber	max	390	710	24	65	600	560	72	390
	min	260	480	13	39	390	350	12	180
	mean	325	595	18.5	52	495	455	42	285

It is evident that concentrations of the substances identified in Table 1 in the groundwater are in the majority below relevant DWS (there are no DWS standards for COD, BOD or TOC in groundwater). The exceptions to this were concentrations of nickel and ammoniacal-nitrogen recorded in BH58. With the exception of nickel, concentrations of other substances were not concurrently elevated with ammoniacal nitrogen in BH58. The maximum nickel concentration was marginally over the DWS. The cause of the elevated ammoniacal nitrogen is not certain, however this borehole is expected to be down-hydraulic gradient of the unlined landfill site.

The leachate quality data is in all cases higher than the relevant DWS, and reflects the expected landfill leachate source term of a site of this age. Concentrations of COD, BOD or TOC in the leachate are at least an order of magnitude higher than the groundwater in the vicinity of the site. Although it is expected that the pollution potential of the landfill will eventually degrade to below the relevant DWS, this could take decades however and the landfill will present a pollution risk to groundwater for the duration of this period.

[1] WHO, (2011) Guidelines for drinking water quality, 4th ed, Available at https://apps.who.int/iris/bitstream/handle/10665/44584/9789241548151_eng.pdf;jsessionid=1327F8C4B603A631641FD2CDF12CA532?sequence=1>

[2] Drinking Water Inspectorate, (2016, What are the Drinking Water Standards?, Available at <http://dwi.defra.gov.uk/consumers/advice-leaflets/standards.pdf>

Leachate generated from this landfill in its present state is expected to present a significant risk to groundwater for the foreseeable future. This is driven by surface water infiltrating the waste and generating a polluting leachate, however, the infiltration process at this site is being exacerbated in particular by settlement of the waste preventing effective drainage over a wide area. The placement of appropriate restoration material at the site will significantly improve the surface drainage and hence reduce the pollution potential associated with the site. The irregularities in the site surface currently make it very difficult to maintain and regularisation of the surface profile will result in significant improvements to landscape and overall landfill management.

We trust that the information provided with this letter is sufficient to address the questions raised.

Yours sincerely
for and on behalf of TerraConsult Ltd

Phil Roberts