Pollington 1763-HRA-R1
Response to Schedule 5

Provide an updated HRA.
The HRA should also consider the impact that climate change and any changes to the abstraction regime at the Public Water Supply could have in relation to the groundwater levels at the site and the sensitivity of the modelling undertaken. You should read the section "A changing climate" under the published Develop a management system guidance, and Climate change: risk assessment and adaptation planning in your management system. Groundwater rebound in relation to climate change could utilise the UK Climate projections (UKCP18) and the available BGS future flows data. The LandSim model will need to be updated to incorporate a range of justified unsaturated zone thickness, and logarithmic distributions for hydraulic conductivity of the unsaturated zone and aquifer pathways. The leachate head level applied will also need to be justified in relation to the waste hydraulic conductivity selected. As the choice of waste hydraulic conductivity is not a simple parameter to define for the base of the waste pile, the "calculate maximum head simulation" is not always the most helpful in trying to identify the fixed leachate head values. It can be simpler to calculate this outside LandSim.

Current research into climate change (e.g. UKCP18 and BGS future flows data) indicates that with a changing climate we are likely to have drier summers, with more risk of drought and wetter winters, with the period of recharge being shorter and more intense. This could result in short term groundwater rebound in the winter months. With rainfall intensity likely to increase, the potential effects of 40% more rainfall should now be considered within hydrogeological risk assessments.

More assessment in relation to the following parameters has been requested.

1. Unsaturated zone thickness
2. Hydraulic conductivity
3. Leachate head

Climate change and Unsaturated zone thickness

The conservatisms in the existing HRA should first be considered. There is an obvious cone of depression in the direction of the public supply borehole which will both increase the hydraulic gradient towards the borehole and increase the unsaturated zone thickness. In both instances conservative values have been assumed within the risk assessment. The minimum recorded thickness of unsaturated zone has been used across the whole base of the landfill within the assessment, when in reality the thickness increases towards the public supply borehole. A further sensitivity analysis has been carried out on the thickness of the unsaturated zone reducing it by 1m in thickness. This could be equated to a rebound of groundwater levels during intense periods of recharge caused by climate change in the winter months.

A review of the BGS future flows data for Permo-Triassic Sandstone indicates that for the period 2041 – 2070, maximum predicted rebound is of the order of 1m, using Heathlanes as the closest sandstone borehole with future flows data.

It is considered that groundwater rebound has sufficiently been assessed by the model.

Climate change and infiltration

The Landsim model has been revised to model an increase of 40% infiltration. Results in Table 1 show that all concentrations remain below the EAL.

Table 1: Results for additional sensitivity scenarios

Determinand	Scenario 1	Scenario 1 + 140% infiltration	Scenario 1 + hc distributions	EAL (mg/l) UKDWS unless stated	LOQ (mg/l)
Arsenic	4e-6	4.3e-6	4e-6	0.01	0.005
Barium	6.8e-5	1e-4	7.5e-5	0.7 [1]	
Cadmium	<1e-8	<1e-8	<1e-8	0.005	
Chromium	7.8e-5	1.3e-4	8.3e-5	0.05	
Mercury	1.4e-7	1.3e-7	1.5e-7	0.001	0.0005
Molybdenum	1.2e-5	1.4e-5	1.3e-5	0.07 [1]	
Nickel	<1e-8	<1e-8	<1e-8	0.02	
Lead	<1e-8	<1e-8	<1e-8	0.01	0.005
Antimony	8e-8	1.7e-7	8.2e-8	0.005	
Selenium	3.5e-5	7.7e-5	3.5e-5	0.01	
Zinc	<1e-8	5.3e-8	<1e-8	0.0109 [2] bioavailable + background	
Chloride	108	127	100	250	
Fluoride	0.62	0.78	0.56	1.5	
Sulphate (as SO4)	193	225	176	250	
Phenol	5.8e-4	0.0019	5.4e-4	0.0077 [2]	

	Hazardous substance

Hydraulic conductivity

The hydraulic conductivity of the aquifer has been modelled as a uniform distribution between the lower and upper inter quartiles for the Sherwood Sandstone aquifer based on transmissivity data from the British Geological Survey Major Aquifers publication. The HRA notes that there is site specific pump test data from the public supply borehole, which would put the hydraulic conductivity of the aquifer on site at the upper end of the BGS interquartile data. Modelling the full interquartile range within the Landsim model is a conservative approach, as this will give lower rates of dilution than the site specific data would derive. Given that there is less than an order of magnitude between the lower and upper interquartile values, a logarithmic distribution of hydraulic conductivities within the model does not appear appropriate. The model is, however, rerun using a triangular distribution, including the geometric mean:

TRI (5.4e-6, 1.16e-5, 2.4e-5) m/s.

For the unsaturated zone the modelled hydraulic conductivity was 5.4e-6 m/s. Using a similar order of magnitude variation between lowest and highest values used for the aquifer, the following triangular distribution is used for the unsaturated zone

TRI (1e-6, 5.4e-6, 1e-5) m/s.

The results are presented in Table 1 and show very little difference to the originally modelled Scenario 1.

Leachate head

A manual calculation of the landfill water balance demonstrates that a build up of leachate at the base of the landfill is unlikely. This is presented in section 5.4 of the HRA. A number of scenarios were assessed as shown in Table 2. This indicates that a build up of leachate head above the landfill liner would be unlikely unless the permeability of the liner was as low as 7e-9 m/s. A fixed head is required within the Landsim model in order to allow the contaminant model to simulate, therefore, a nominally low head, as used: TRI (0.05, 0.1, 0.2), is considered appropriate.

Table 2: Water Balance

Area of landfill surface (m2)		53500							
Area of landfil base (m2)		34000							
Normal Scenario		Rainfall (mm/yr)	Rainfall (m/s)	Base hydraulic conductivity (m/s)	Rain infiltration m3/s	Rain infiltration m3/yr	Basal Seepage Q (m3/s)	Basal Seepage Q (m3/yr)	Ratio base : rainfall seepage
Rainfall infiltration		150	4.76E-09		2.54E-04	8.03E+03			
Seepage through the base				1.00E-07			3.40E-03	1.07E+05	13
Increased rainfall									
Rainfall infiltration		120	3.81E-09	1.00E-07	2.04E-04	6.42E+03	3.40E-03	1.07E+05	17
Rainfall infiltration		150	4.76E-09	1.00E-07	2.54E-04	8.03E+03	3.40E-03	1.07E+05	13
Rainfall infiltration		200	6.34E-09	1.00E-07	3.39E-04	1.07E+04	3.40E-03	1.07E+05	10
Rainfall infiltration		300	9.51E-09	1.00E-07	5.09E-04	1.61E+04	3.40E-03	1.07E+05	7
Rainfall infiltration		400	1.27E-08	1.00E-07	6.79E-04	2.14E+04	3.40E-03	1.07E+05	5
Rainfall infiltration		500	1.59E-08	1.00E-07	8.48E-04	2.68E+04	3.40E-03	1.07E+05	4
Decreased basal hydraulic conductivity									
Basal seepage		150	4.76E-09	5.00E-08	2.54E-04	8.03E+03	1.70E-03	5.36E+04	6.68
Basal seepage		150	4.76E-09	1.00E-08	2.54E-04	8.03E+03	3.40E-04	1.07E+04	1.34
Basal seepage		150	4.76E-09	8.00E-09	2.54E-04	8.03E+03	2.72E-04	8.58E+03	1.07
Basal seepage		150	4.76E-09	7.00E-09	2.54E-04	8.03E+03	2.38E-04	7.51E+03	0.94
Basal seepage		150	4.76E-09	6.00E-09	2.54E-04	8.03E+03	2.04E-04	6.43E+03	0.80
Basal seepage		150	4.76E-09	5.00E-09	2.54E-04	8.03E+03	1.70E-04	5.36E+03	0.67

The HRA has been updated to incorporate the above information, with text highlighted as appropriate.