Your ref WS010003
ARROW ref 10024954
Nicola Escott ref 10024302

ARROW 6 - Responses to the Examining Authority's First Written Questions and Requests for Information

by
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Incomplete Application Documents:

1. In our earlier submission we noted our concerns about the application documents still being incomplete. The applicant subsequently provided some of the missing information – most notably the long-overdue Hydrogeological Risk Assessment. As a result we have been able to respond to that and now include a detailed report on the geological and hydro-geological conditions – including the impacts of the old mineshafts in the western extension site and the implications for basal heave associated with the hydraulic pressures on the liner by the local groundwater and the proposed operation of the site as an 'hydraulic trap'.
2. The report (ARROW 5) concludes that the proposals present a significant risk to the water environment, and that key aspects of the Environmental Statement concerning baseline characterisation, contaminant transport modelling and proposals for monitoring and surveillance are not adequate to ensure that these risks can be controlled or mitigated. In addition, proposals for treatment and management of groundwater discharge may be entirely inadequate, creating a potential for flooding and pollution, and it is not certain that hydraulic containment can be achieved in this complex hydrogeological setting.
3. Additionally it has now been possible to assess the implications of the site in terms of the period over which operations would present a hazard to groundwater, human health and the environment. That assessment is included below.
4. Unfortunately, however, there remain significant gaps in the information that has been made available – most notably the technical details of gas, groundwater and engineering included in the application for the Environmental permit are not yet in the public domain (and our request to the Environment Agency for copies of technical appendices to allow us to make as part of this process have been refused because the Environmental Permit application has still not yet been 'duly made'). These difficulties have been compounded by the Environment Agency response being non-specific in terms of detail in order not to prejudice the determination of the Permit application.
5. The responsibility for this lack of co-ordination between the planning and

pollution control applications lies squarely with the applicant and their delay in submitting the permit and their failure to provide copies of the details in that application as part of this planning application.

6. For the avoidance of doubt none of this relates to issues which sit purely within the domain of the Environment Agency but all the data relates rather to questions arising in relation to the requirements of the Environmental Assessment Regulations and the consideration of the requirements of Annex 1, paragraph 1.1 to the Landfill Directive as required of planning authorities by Schedule 25, Part 2, paragraph 4(2) to the Environmental Permitting (England and Wales) Regulations 2010 SI 2010 No. 675.

TIMESCALES TO REACH the POST-OPERATIONAL PHASE:

1. The timing of the late and post-operational phases of the model for the site have not been included in the application. The information would have been available to the consultants from Landsim but they clearly chose not to include it. This is a major and important omission as it goes to the central question of the sustainability of the proposed extension and the time over which the proposed landfills site represents a hazard to human health and the environment.
2. However a simple calculation can be used to demonstrate the timescale to completion with ingress of rainwater through the cap. This calculation requires that the 'mean hydraulic retention time' (MHRT) of the landfill site (i.e. the period of time it would take to flush one 'bed volume' of water through the site) is calculated. This is a straightforward matter[1]:

   The assumptions made are that

   Fc - Wastes field capacity[2] 38% by weight moisture content

   Ir - Infiltration rate into waste c.30 mm pa

   ρ - Density 0.9 tonnes/m^3 (as in the calculations by Hannah Fraser)

   D- Site depth = The designed settled restoration levels of the proposed landfill are 77 m OD on the central plateau, with the majority of the site area lying between 76 and 68 m OD. If the formation depth was 50m then the post-settlement depth of the site would be about 26m in the deepest part of the site which is that most relevant to the longer stabilisation periods. If coal is extracted from 40 m AOD as seems likely then the maximum depth of the waste would be c. 36m

   $$MHRT = Fc \times \rho \times D/Ir$$

   $$= 0.38 \times 0.9 \times 36/0.03$$

   $$= 410 \text{ years}$$

3. Assumptions of higher waste density would increase the flushing time – if the waste had a denisty of 1.5 tonnes/m^3 , for example, then the MHRT would increase to about 600 years. If the site depth was 26m rather than 36 m then the MHRT would reduce to 296 years.
4. The reduction in leachate concentration by flushing can be calculated[3] as

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[1] See, for example, 'Timescales to Completion', The Surveyor 6/6/93

[2] Field Capacity is defined as: "The condition when the waste contains the maximum amount of moisture that it can retain against the pull of gravity when allowed to drain freely. Any further addition of water would cause an equal amount of free leachate to drain from the waste." The figure of 0.38 is derived from the original WMP 26 which gives a figure (Fig 3.42 p 42) of general relationship between moisture content and waste density. The field capacity at a density of 1 tonne/m^3 is about 33% and rises to about 43% both @ 0.8 tonnes/m^3

$$Cv=C_o e^{-BV}$$

Where

Co is the initial concentration

Cv is the concentration when BV bed volumes have been removed

BV is the number of bed volumes flushed

5. The passage of 4.6 bed volumes of fluid is required to reduce the concentration of a contaminant in a completely mixed landfill by two orders of magnitude (e.g. from 1,000 mg/l to 10 mg/l – reflecting the average concentrations in the leachate at Whitemoss) assuming the contaminant is all in solution at the outset. For ammoniacal nitrogen with a starting concentration of 2,000 mg/l[4] it would take 6.9 bed volumes to reach a concentration of 2 mg/l.

6. To achieve long term storage quality assuming, conservatively, that waste was homogeneous and without allowing for the reduction in flushing efficiency due to preferential pathways etc it is therefore estimated that between 5 and probably upto 10 bed volumes must be flushed through a site.

i.e. a total time of between 2,050 and 4,100 years.

7. Even if all the effective rainfall [5] (c 160 mm pa) was allowed to enter the site the timescale to flush would still be many hundreds of years. To this must be added the time to reach field capacity and, less predictably, the time to flush areas with higher local concentrations and those have been bypassed by the inevitable short circuits.

8. It is perhaps not surprising, therefore, that the application is silent on the timescales necessary to achieve the completion state at which pumping can be stopped and groundwater allowed to restore to natural levels as this is an enormously long and self-evidently unsustainable timescale. This also indicates the commitment that would be required to leachate management far exceeds any reasonable assumption about the future commitment to the landfill site which would be to pump and treat leachate for thousands of years, This is clearly unrealistic but the alternative option would be that leachate would rise within the site and establish a hydraulic gradient out of the site and into groundwater before the concentrations had reduced to benign levels.

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[3] This is the approach used by most researchers, see for example, 'The Role and Operation of the Flushing Bioreactor', IWM sustainable Landfill Working Group. Chapter on Technical considerations for waste management. It is also the basis for the calculations within Landsim.

[4] The assessments of leachate concentrations in the applications are upto 2046 mg/m3 (Table HRA 3). The applicants use a log triangular distribution in their landsim assessment which reduces the impacts of higher levels in the model – there is not an appropriate or conservative approach to modeling.

[5] total rainfall is given in the previous IPC application as 863 mm pa but no effective rainfall figure was given then (or in the current application). This has been taken from UK Waste figures from the unsuccessful but nearby Round O application.