Suirbhéireacht Gheolaíochta Éireann
Tor an Bhacaigh
Bóthar Hadington
Baile Átha Cliath 4

Geological Survey of Ireland
Beggars Bush
Haddington Road
Dublin 4
Tel. +353 1 6782000
Direct +353 1 6782780
Fax. +353 1 6782569
http://www.gsi.ie
Email: Groundwaterinfo@gsi.ie

Dr. Ian Marnane
EPA
Headquarters
PO Box 3000
Johnstown Castle Estate
Co. Wexford

4th April 2007

Dear Dr. Marnane,

Re: Waste License Application Ref. No. W0231-01, Fingal Landfill

Thank you for your letter of November 30th, 2006, with further queries requesting the GSI's comments. My responses are below.

(i) The cross-section in the GSI's report (Bog of the Ring Source Protection Zone) was constructed using established methods of (a) choosing a section line orientation; (b) marking-off Formation/Member boundaries from the bedrock map along the section; (c) computing apparent bedding dips as a function of the section/bedding dip orientation and vertical:horizontal exaggeration; (d) extrapolating Formation/Member boundaries into the subsurface using basic geological principles, and published thickness data. The section in the GSI's report honours the published map (Sheet 13) boundaries. However, as pointed out by Kevin Cullen, it is notable that, in the 2D section construction, the Loughshinny Formation as drawn does thin significantly from north to south. I have spoken to the Bedrock Section within the GSI and they note that the limestones were deposited along a synsedimentary fault and therefore do change in thickness. They also display a change from shelf-type pure bedded limestone immediately adjacent to the fault to more basinal-type, impure limestones further south, away from the North Dublin Fault zone. Please see the attached diagram, abstracted from the GSI report accompanying Bedrock Sheet 13 (Mc Connell, Philcox, Geraghty, 2001). Discerning the precise nature of the bedrock geometry is complicated by the thick blanket of glacial tills covering the bedrock, and the mapped boundaries may need revision in the light of more information. However, the cross-section, as drawn in the report (Bog of the Ring Source Protection Zone), could be improved by accounting for the change from shelf- to basinal-type limestones from north to south. However, as the impure limestones (Loughshinny, Naul and Lucan Formations) behave in a hydrogeologically similar manner, this distinction is not critical in the assessment of groundwater flow in the area to the south of the Bog of the Ring. What is more important is the depth to which significant fracturing and fissuring occurs.

(ii) Regarding the pumping test results presented in Section 3.5.3 and in Appendix 12 of Volume 5, Technical Appendix H, there is insufficient information presented to completely re-assess the pumping test data. Only "Sample output[s] of analysis for each well" are provided in Appendix 14. From visual inspection of these graphs, the analyses seem generally reasonable in terms of curve matching and of type curve selection. The assumed bedrock aquifer thickness of 50m may be a little on the large side since, as discussed below, there is a general decrease in bulk permeability with depth (excepting large faults/fractures at depth that may be intercepted by pumping wells). However, the actual aquifer thickness to use in a partially-penetrating well analysis in fractured rock is difficult to quantify in the Irish fractured bedrock aquifer context.

Table 5 (Summary of Pumping Test Results, Volume 5, Technical Appendix H) indicates, through the range of transmissivities quoted for each well, that a variety of curve fits was used. Again, this is normal for many pumping test analyses, where more than one solution can be found, due to the non-standard behaviour of real aquifers. The storativity results given are reasonable for a confined, fractured aquifer.

Cont'd./

The pumping tests were carried out to ascertain the transmissivity of the aquifer immediately below the proposed landfill to establish the properties of the groundwater pathway through which potential pollutants may migrate off-site. As potential pollution will impact mainly on the shallower zone of the aquifer, travelling predominantly laterally, the determination of the properties in the upper zone of the aquifer is probably sufficient.

With regard to K. Cullen's comments in his letter of 13/09/06, it is not necessarily possible to make a direct scale-up of transmissivity from a 10m open interval to a 39m open interval. This is partly because of the high degree of heterogeneity in fractured aquifers, but mainly due to the fact that, in general, fracture density and fracture aperture decrease with depth. Hence fracture permeability, which is a function of fracture density, aperture and interconnectivity, tends to decrease with depth also.

In terms of the resource potential of the aquifer to the south of the Bog of the Ring, whilst high transmissivities are certainly one component of a potentially significant groundwater resource, sufficient recharge to the aquifer is also required to balance-out abstractions whilst also maintaining existing groundwater flow to natural systems (e.g., rivers and other ecosystems). The recharge can only be estimated by mapping the subsoil permeability and thickness in the catchment area upstream of the proposed landfill. Further pumping tests around the site would not necessarily add to the body of knowledge, but may simply confirm what is already known about the site.

(iii) The southern margin of the Zone of Contribution to the Bog of the Ring boreholes was first defined by identifying the natural groundwater divide using hydrogeological principles. The projected southwards migration of the groundwater divide under pumping conditions was then estimated using model predictions and trigonometric projections. Due to the way the model was constructed (i.e. constrained by a 'no flow' boundary at the southern margin, coincident with the natural groundwater divide), the modelling study predicts, but cannot confirm, the assumed location of the groundwater divide. The modelling can indicate potential variations in the lateral position of the divide, depending on pumping rate and the rate of recharge to aquifer in the Bog of the Ring area. However, uncertainties inherent in the model parameters, together with relatively coarse grid-cell discretisation, result in uncertainty in the magnitude of the predicted lateral movement of the ZOC under pumping conditions. The GSI's Source Protection Zone report is of use as a starting point for assessing the location of the groundwater divide. However, the report also recommended that there should be field data collection to verify the location of the groundwater divide.

Data presented in the EIS improve somewhat the understanding of the location of the groundwater divide, relative to the understanding when the GSI Source Protection Zone report was finished, since new data were available. However, as pointed out in the report by Mott McDonald (Review of Environmental Impact Statement, 7th September 2006), data from three boreholes appear to have been omitted from the interpretation of the groundwater head contour map. Paul Ashley, in the same report, also notes that the piezometric level in the artesian boreholes was not constrained. Further, that the seasonal variation in the location of the groundwater divide is not established, particularly for drought situations. From inspection of Figure 8 in Volume 5, Appendix H of the EIS and also of Figure 2, Review of Environmental Impact Statement (September 2006, Mott McDonald), there appear to be insufficient monitoring points in the area between Rowans Little, Courtlough and Hedgestown/The Five Roads to ascertain with a high degree of confidence (a) the location of the groundwater divide and, particularly, (b) its lateral migration as a function of seasonal variations in recharge.

I hope that the information provided above answers satisfactorily the questions in your letter. Please accept my apologies for the delay in replying to you.

Yours sincerely,

Natalya Hunter Williams
Project Hydrogeologist
Groundwater Section

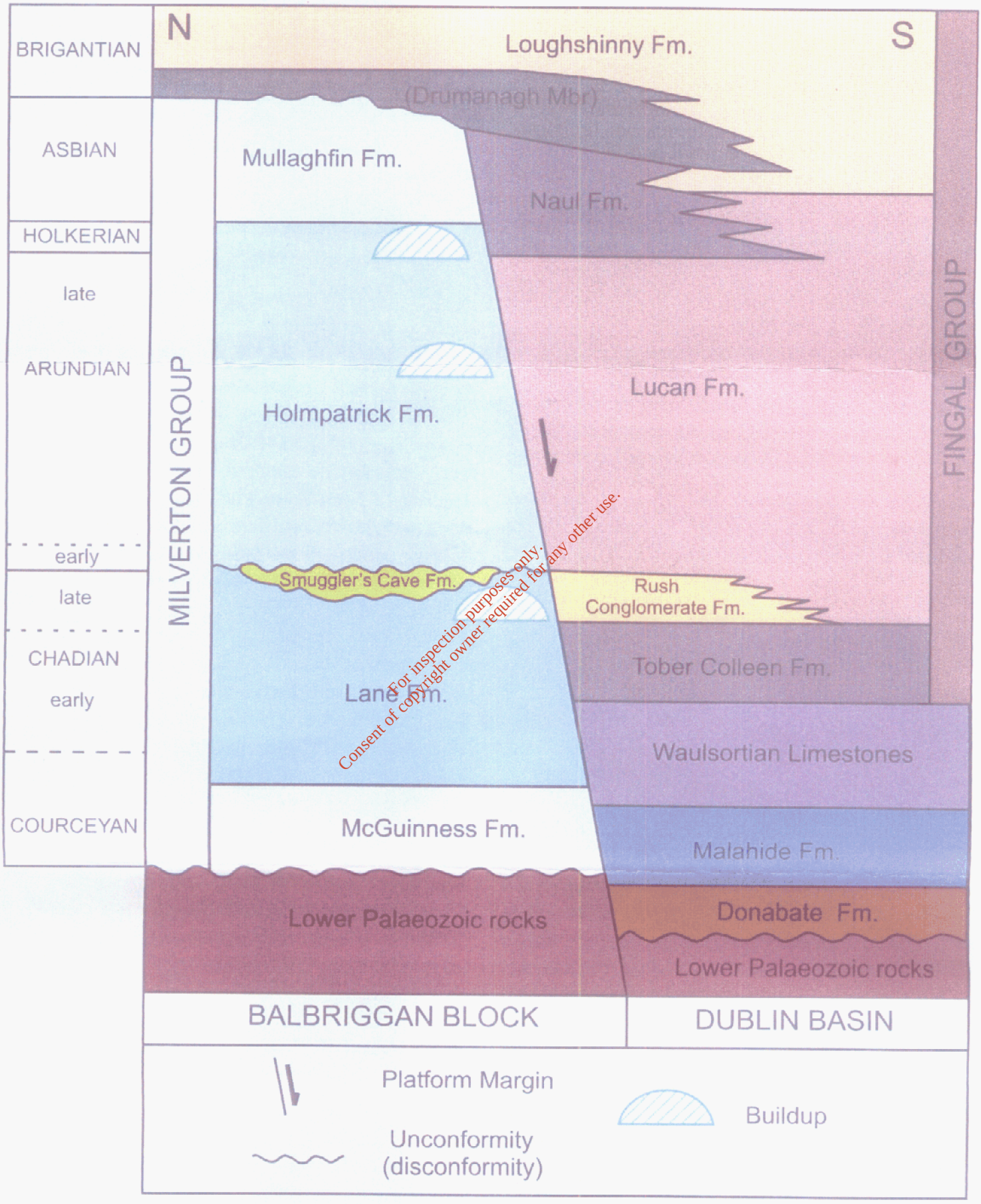

Figure 6. Dinantian successions in north Co. Dublin (after Nolan 1989, Somerville *et al.* 1992)

From McConnell, B., Philcox, M. & M. Geraghty (2001) - A Geological Description to accompany the Bedrock Geology 1:100,000 scale map Series, Sheet 13, Meath. Geological Survey of Ireland.