

Question 1: To what extent do you think our proposed approach to providing national-scale existing information about geology relevant to long-term safety is appropriate? Please give your reasons.

In terms of providing national-scale existing information about geology relevant to long-term safety (the 'approach') NNL believes that the approach is generally appropriate. Indeed the descriptions of geological attributes that will be examined are entirely appropriate. However, NNL has some concerns about a small number of specific aspects of the approach, and believes that because of these, the approach may not achieve its aims. These aspects are described below. NNL also has some reservations about the draft National geological screening document itself. These are described in the final section. Section 3.15 NNL suggests that the statement about evaporate rocks is misleading: this rock type is certainly weak and can creep, but this needs to be put in context, if it is even necessary to mention these parameters at this stage in the process. For example, unlike coal mines which typically require pit props to support tunnels, the levels in salt and evaporate mines typically do not as the rock is strong and robust enough to support the excavation itself. It is only over time that the rock type shows its weakness by creeping. This context in terms of timescales and other rock types must be clearly presented. The fact that open cracks in evaporate rocks can sometimes seal themselves is missed completely. Additionally, "weak" is a specific geotechnical term utilised in the European standard for geotechnical and geological rock and soil descriptions, Eurocode 7 (Eurocode 7: Geotechnical Design Part 1: General Rules. BS EN 1997-1:2004. 22 December 2004). Care should certainly be exercised when using brief descriptors such as "weak" and "creep" and in fact NNL suggests that they are actually not required here. The sentence "Evaporite rocks have formed as ancient seas and lakes evaporated and often contain bodies of halite, for example, that provide a suitably dry environment" is awkward and requires rewording. The statement that these rocks "often contain bodies of halite" may suggest that halite is something different to an evaporite, which is not true. NNL suggests that rewording the sentence to something along the lines of "Evaporite rocks were formed as ancient seas and lakes evaporated and often comprise large bodies of halite (rock salt) that (for example) provide a suitably dry environment". Section 3.16 Section 3.16 states that RWM propose to use "geological columns for each region to identify which of the rock units shown on existing BGS geological maps are likely to contain each of the potential host rocks". This proposal is slightly misleading on a number of fronts: • It is not clear what the term "geological column" means. NNL suggests that clarity should be given as to what the term "geological column" refers to, since this could refer to a number of geological column types (e.g. lithostratigraphy, lithology, chronostratigraphy etc). • Whilst geological columns are often used to represent the key or legend to rock types on a geological map, they can also present information on rocks that are not present at the surface. For instance, a regional lithostratigraphic column can easily show rocks down to any depth (including down to maximum GDF depths), some of which may have only limited representation on a BGS geological map, or in some cases may not appear at all. Thus the stated proposal to "identify which of the rock units shown on existing BGS geological maps are likely to contain each of the potential host rocks" crucially misses out those rocks in a region that do not appear on the region's BGS geological map. A potential host rock type may be present under an area in GDF-suitable extent and thickness, yet may not appear at all on the geological map, and thus (according to Section 3.16) cannot appear on the geological column. NNL suggests that Section 3.16 is re-worded to include the appearance on geological columns of potential host rock types that may be present at GDF depths but not present on geological maps (concealed rocks).

Question 2: To what extent do you think that the proposed national information sources are appropriate and sufficient for this exercise? Please give your reasons.

NNL agrees that the proposed sources of information are to a large extent appropriate and sufficient for this exercise. However, NNL suggests that there are limitations inherent in the information set proposed for each attribute and these are discussed here: Rock type, Rock structure, Groundwater BGS maps, memoirs and stratigraphic summaries do not provide a completely up to date source of information for rock type. Whilst the BGS have a long-running programme to update each map, memoir and stratigraphic summary covering England, Wales and Northern Ireland, a number of maps and memoirs have not yet been updated. Some of these date back several decades. However, in many of the areas covered by these, geological research has resulted in the publication of sometimes numerous peer-reviewed academic journal articles. To not utilise this source of up to date information, particularly to supplement old and obsolete information would and should be questioned by experts, regulators and the lay public. In order to utilise the most up to date information, NNL recommends that peer-reviewed academic journal articles should be included as a principle source of information, particularly where the memoir, map or stratigraphic summary is not recent. NNL suggests that this should also be the case for rock structure and groundwater attributes. Natural processes NNL agrees that the use of the BGS Commissioned Report, Potential Natural Changes and Implications for a UK GDF (British Geological Survey et al, 2013) should be the primary source of information for assessment of potential natural changes in the geosphere. This report utilised the extensive knowledge, expertise and understanding of a number of expert co-authors who themselves utilised all available information the BGS hold, plus numerous key peer-reviewed journal articles, and is therefore the most up-to-date synthesis of natural processes. Resources NNL supports the use of all the information sources for this attribute in the National geological screening exercise, and believes that this dataset is the most up-to-date and comprehensive one available for this exercise.

Question 3: To what extent do you agree or disagree with the proposed form of the outputs from geological screening? What additional outputs would you find useful?

NNL agrees that the proposed form of the outputs from geological screening is certainly appropriate and all should be retained in any future draft of the National geological screening guidance document. In particular the use of narratives and accompanying maps seems to be the most useful method of disseminating output with all audiences, and in particular public stakeholders. However, there are a number of attributes where NNL believes that additional outputs would be necessary, or at the very least, beneficial. These are discussed here: Rock type, rock structure and groundwater: RWM note that in the narrative rock type descriptions will be "illustrated with a geological column". As per a previous comment earlier in this response, if geological columns are to be the primary source of illustration some clarity in the guidance needs to be provided on what information will be included in such a device. NNL supports the use of maps to accompany the narratives, but suggests that some explanation is needed to describe the types of maps and set them in context. For instance a geological unit's distribution and thickness can be simply represented by an isopach map, whilst the topographical expression of the top of a unit can be represented by a structure contour map, both of which can show faults and other geological structures. These maps are likely to be important in a comparison with the existing surface geological maps, yet it is highly likely that public stakeholders will not understand these maps, never mind be able to compare them with current maps. Some explanation should be provided at some point in the process. For both rock type and rock structure, NNL suggests that maps and geological columns may not be enough to explain the descriptions contained in each narrative. Where possible a range of suitable geological cross sections should accompany each narrative. Both these and the maps could also be used to highlight any gaps in information. Cartoon sections could be used in descriptions but care needs to be exercised, especially where representing depths and putting GDF locations in context of surface features (thus, for example, learning lessons

of the media's continued use of completely out of scale and context cross sections to illustrate shale gas exploration). For groundwater, the descriptions to be presented in the narrative are believed to be appropriate, as are the use of maps. However, similarly to rock type and structure, cross sections may be useful in putting maps and descriptions in context. Natural processes: The proposed descriptions within the narratives are appropriate, as are maps of seismicity. Since there have been a number of glaciations with different extents, NNL suggests that it may be necessary to show more than one national map of past glaciation. NNL also suggests that it may be useful to present 3D visualisations of development and maximum thickness over time of ice sheets. Resources: NNL suggests that the proposed descriptions for resources within each narrative is appropriate, as are the proposed regional maps of historic and contemporary exploitation of metal ores, industrial minerals, coal and hydrocarbons at >100m depths.

Question 4: Do you have any other views on the matters presented in the draft Guidance?

The draft Guidance is generally appropriate but there are a number of issues with the current draft that NNL recommends should be addressed as soon as possible. These include (i) the fundamental question of whether or not the exercise described in the guidance can really be classed as screening if screening is merely an incidental "possibility", and (ii) the clarity of the approach itself. These are described here: "Screening" or not? - A dictionary definition of "screening" is "tests or examinations to discover if there is anything wrong with something". Therefore, a key point to note about the whole document is that, in order to qualify as a "screening" exercise, it should contain some element of screening. NNL suggests that aside from providing geological information the two key aims in a screening document should be: (a) to specifically assess the regions defined in the National Geological Screening Guidance document, utilising criteria that should also be defined in that document, and the information gathered and presented in the narratives; and (b) to use this assessment to identify any areas that are unsuitable for hosting a GDF (and thus not worth further investigation). There is loose reference in Section 1.3 to the possibility that screening may lead to some areas being identified as unsuitable for hosting a GDF, but the sentence leads one to conclude that the identification of unsuitable areas would be incidental and not part of the actual screening exercise itself. If this, and the required assessment, is not to be part of the exercise, then the exercise is simply one of information gathering only, with no screening involved, and the title "National Geological Screening Guidance" should be re-considered. Clarity of the approach - It should be noted that the approach itself, is difficult to follow since its components are not expressly stated, and these are distributed throughout the document (e.g. mixed in with 'guidance and criteria'). The actual approach is not as clear as it could be. For example: Subsections 2.18 to 2.21: If these are indeed descriptions of the approach (as the subheading suggests) then they could form the basis of a separate chapter entitled "Approach to Geological Screening" - as a subsection to the "Context" chapter their importance is lost. The sub-heading itself is slightly misleading since Subsections 2.18 to 2.21 actually describe tasks already undertaken as part of an approach, rather than the approach itself. The appearance within Chapter 3 of a subsection called "Screening Approach" increases confusion, as does the inclusion within the "Form of Outputs" subsection of paragraphs that could be included in an "Approach" chapter. A single "Approach to National Geological Screening" could be developed from this. Such a chapter could look like this: APPROACH TO NATIONAL GEOLOGICAL SCREENING A) Definition of guidance 1) Definition of long-term safety requirements to which geological environment must contribute: Evidence and understanding from the RWM safety case were gathered and used to define long-term safety requirements to which the geological environment must contribute (see Guidance in Section 3). 2) Identification of relevant geological attributes that could contribute to satisfying these long-term safety requirements: Relevant geological attributes that could contribute to satisfying these long-term safety requirements were

identified (see Appendix 2 for further detail). 3) Development of National geological screening Guidance that would enable the screening of UK geology to identify locations, areas and volumes of rock that possess these attributes (and screen out those that do not) : National geological screening Guidance that would enable the screening of UK geology to identify locations, areas and volumes of rock with these attributes, was developed in collaboration with the geoscience community, oversees waste management organisations and wider interested parties (including over twenty meetings across the UK to share our work and help shape our approach). This guidance, which is described in more detail in Chapter 3 (National geological screening guidance), comprises a set of criteria which will enable areas/volumes of potential host rock to be disregarded as 'definitely unsuitable' (not worth further investigation) or promoted as 'potentially suitable' (i.e. meriting further investigation). 4) Submission of draft National geological screening guidance to Independent Review Panel : A draft of the National geological screening guidance was submitted to an IRP by the Geological Society, and comprising a group of seven expert geologists from the UK and overseas. The IRP was asked to assess whether the screening Guidance was technically sound; could be applied using existing geological information; and provided a basis for assessing the prospects for developing a long-term safety case in a range of geological settings to accommodate the UK inventory of higher activity waste 5) IRP to provide RWM with written review comments and discuss at meeting to be held in public: The IRP provided us with written review comments and held a meeting with us in public in London to discuss their views. The facilitators of the meeting also prepared a report of the meeting B) Application of Guidance 6) Undertake National geological screening for England, Wales and Northern Ireland (but not Scotland which has a different higher activity waste management policy) based on the detailed screening guidance: Not undertaken yet 7) Provide descriptions of geology at a regional scale and indicate prospects for long-term safety: Not undertaken yet 8) Present outputs of screening as a series of brief narratives describing the key characteristics of the geological environment of 13 geological regions in England, Wales and Northern Ireland, including assessment of the prospects for long-term safety (including definition of areas/volumes that are definitely not suitable, and those that may be). Narratives will be illustrated with maps where necessary. Regions will be aligned to those adopted by the BGS for its Regional Guides: Not undertaken yet References - British Geological Survey, National Nuclear Laboratory, University of Manchester Dalton Nuclear Institute. Potential Natural Changes and Implications for a UK GDF. Minerals and Waste Programme COMMISSIONED REPORT CR/12/127. 2013.

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Do you agree to your responses to this consultation being published?

Yes