Radioactive Waste Management

Response to consultation

National

Geological Screening

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Executive Summary

The national geological screening exercise is one of the three initial actions set down in the 2014 White Paper *Implementing Geological Disposal*. The White Paper requires that RWM in its role as developer of a geological disposal facility, carry out a national geological screening exercise based on the safety requirements identified from the published generic disposal system safety case studies.

National geological screening is an exercise to bring together existing information about aspects of geology that are relevant to the long-term safety of a geological disposal facility and make it available in an accessible form. It will provide authoritative information for England, Wales and Northern Ireland that can be used in early discussions with communities about their geological potential to host a geological disposal facility.

Guidance setting out how the information will be assembled and presented was developed in the early part of 2015 and issued for public consultation during the period 8 September to 4 December 2015.

As a result of the consultation RWM received a total of 78 responses from a range of stakeholders, including learned societies, academics, local authority organisations, geoscience professionals, non-governmental organisations and interested individuals.

In response to the key question regarding the appropriateness of the proposed approach a clear majority of respondents were supportive. Many comments were provided, which have enabled the Guidance to be refined, and have provided insights to the range of wider questions that stakeholders have regarding the implementation of geological disposal.

This document forms RWM's response to the feedback provided, and describes how the national geological screening Guidance will be modified in light of that feedback. It also points to other available information where respondents have referred to wider questions on geological disposal. Such feedback will also inform our planning for production of future information materials.

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Introduction

The national geological screening exercise is one of the three initial actions set down in the 2014 White Paper[1] *Implementing Geological Disposal*. The White Paper requires that Radioactive Waste Management (RWM) in its role as developer of a geological disposal facility (GDF), carry out a national geological screening exercise based on the safety requirements identified from published disposal safety case studies.

National geological screening is an exercise to bring together existing information about aspects of geology that are relevant to the long-term safety of a geological disposal facility and make it available in an accessible form. It will provide authoritative information for England, Wales and Northern Ireland that can be used in early discussions with communities about their geological potential to host a GDF.

Before setting out to deliver the national geological screening, RWM has set out its proposals in an open and transparent way and subjected these to public consultation.

This document forms RWM's response to the feedback provided, and describes how the national geological screening Guidance has been modified in light of that feedback. It also points to other available information where respondents have referred to wider questions on geological disposal. Such feedback will also inform our planning for production of future information materials.

DEVELOPMENT OF NATIONAL GEOLOGICAL SCREENING GUIDANCE

The 2014 White Paper identifies three initial actions to be progressed so that the geological disposal facility developer can engage with communities that may be interested in finding out more about hosting a future geological disposal facility. The national geological screening exercise is one of these initial actions. It responds to a publicly-expressed desire for more information about the geology of the UK before discussions start about siting for a GDF.

National geological screening will utilise existing information about geological attributes that are relevant to the long-term safety of a geological disposal facility and present this information in an accessible form for use by potential host communities. It is not intended to be able to definitively rule areas as either suitable or unsuitable. In line with the White Paper the national geological screening will apply to England, Wales and Northern Ireland.

The White Paper requires that RWM undertake this work in a "suitably open and transparent manner", and that we engage with the public and expert stakeholder communities from the outset to determine what geological attributes could and should be included within the scope of the national geological screening exercise.

The national geological screening exercise has two parts. The first part involved developing Guidance which set out how the information would be assembled and presented. The second part involves applying the Guidance and producing outputs. The outputs are envisaged to be a series of brief narratives, one for each of the geological regions defined by the British Geological Survey, describing the key characteristics of the geological environment and their relevance to the safety of geological disposal. The narratives will be illustrated with maps where this is appropriate. In order to provide confidence in the robustness of the Guidance and to give an independent view on whether it can be implemented successfully using existing geological information, the Department of Energy and Climate Change requested the Geological Society of London to establish an Independent Review Panel.

Production of the national geological screening draft Guidance commenced in September 2014 with a launch meeting held at the Geological Society of London. The draft Guidance was developed in the period 2014/2015, by a project team led by RWM and supported by geoscience specialists and potential users of the information. Development of the draft Guidance was supported by an extensive programme of engagement events for both specialist and non-specialist audiences. In the period September 2014 to March 2015 eighteen events were held designed to both inform stakeholders about national geological screening and to facilitate input to the draft Guidance during this development phase.

The draft Guidance was presented to the Independent Review Panel at a meeting on 23 June 2015[2]. RWM took account of the feedback received and finalised the draft Guidance ready for public consultation. RWM issued a report describing the changes made as a result of the Independent Review Panel review[3] and issued the finalised draft Guidance for public consultation[4] in September 2015.

The draft Guidance comprised:

- Section 1: Introduction
- Section 2: Context
- Section 3: National geological screening Guidance
- Section 4: How to take part (in the consultation)
- Appendix 1: Devolved administration positions
- Appendix 2: Geological attributes

Throughout this process the Committee on Radioactive Waste Management was involved in their scrutiny capacity and provided comments[5] on the developing draft Guidance.

PUBLIC CONSULTATION

Consultation on the draft Guidance was held between 8 September and 4 December 2015.

A number of engagement activities were held before and during the consultation period.

A pre-consultation media event was held at the Science Media Centre to introduce RWM to the national media and to brief the national press on the rationale and international support for geological disposal, as well as promoting the national geological screening Guidance consultation. The consultation launch on 8 September included a briefing for trade and technical media, who would have an interest in the technical aspects of the draft Guidance.

In addition, RWM directly contacted a wide range of targeted stakeholder groups prior to the launch to alert them and their members to the consultation. RWM also used its mailing lists, e-bulletin list and lists of stakeholder organisations to spread the message as widely as possible.

RWM held twelve workshops at various locations to support the consultation and to provide opportunity for groups and individuals to find out more, inform their consultation responses and engage directly with RWM geological and safety specialists. The locations and dates were chosen so as to maximise the convenience for attendees with city centre locations and a mix of daytime and evening events. Materials from the initial meeting, including a video of the presentation provided by the RWM Siting Director were made available online.

In order to quality assure the consultation process, including the lead-up to the consultation, the consultation itself and post-consultation analysis and response, RWM has engaged the Consultation Institute to provide an independent review of the management and delivery of the consultation. The Consultation Institute has significant expertise in this area and is recognised as a leading independent assessor of standards in public consultations.

The Consultation Institute provided advice and guidance on the design of the consultation process. They have monitored the activities, including attending one of the workshops without advising RWM in advance of their presence. Once the consultation is complete, with responses and final Guidance published, the Consultation Institute will issue a formal assessment of the quality of the exercise overall.

FOLLOWING THE CONSULTATION

The feedback received as a result of the consultation has been addressed in an update to the Guidance. The changes made are described in Section 3 of this report. The revised Guidance was reviewed by the Independent Review Panel before final approval by RWM.

In preparation for the next stage of the national geological screening exercise, RWM has worked with the British Geological Survey to prepare detailed technical instructions and supporting protocols that will be used to define the geological information to be assembled for each of the geological attributes and the form of its presentation.

The Independent Review Panel has reviewed these detailed technical instructions before they are applied to generate the national geological screening outputs. The Independent Review Panel will also review the outputs on completion and before they are published.

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Response Summary

The consultation document setting out the draft Guidance posed four questions.

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?

Question 2 – The proposed sources of information are summarised below. To what extent do you think that these sources are appropriate and sufficient 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?

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

A total of 78 responses were received from a variety of stakeholders including learned societies, academics, local authority organisations, geoscience professionals, non-governmental organisations and interested individuals.

The majority of respondents were supportive of the draft Guidance and changes to the proposed approach are not required. There were suggestions regarding local geological information that may prove useful but which cannot be considered in this national screening stage because there is insufficient data available at a national scale and/or because the amount of work that would be needed to screen for them would be disproportionate to the value of the exercise. These points will however be important considerations when more detailed work is undertaken in a much more focussed manner as part of a future site selection stage.

There were also useful suggestions regarding information to be provided which are at a level of detail which would not affect the Guidance itself but which have been taken forward within the scope of the detailed technical instructions which have been prepared in support of the application of the Guidance.

A number of responses have suggested where the Guidance could be refined to avoid ambiguity and these have been taken into consideration.

Other responses identified the need for further context or for further information on the wider issue of geological disposal. These insights will inform RWM's planning for the provision of information to meet stakeholder and public information needs when the siting process begins.

In the next Section we summarise the responses provided to the consultation questions. We have not attempted to respond to each individual response, but instead we have grouped the responses and provided a "response theme" that is representative of a number of similar responses. For each response theme we provide our reply and an action where appropriate. In some cases the action might be to revise the Guidance (i.e. Section 3 of the Guidance document) or to add further explanatory information within Section 2 or one of the Appendices. In other cases we point to other materials in development. In some cases we believe that our reply is sufficient and that no further action is required, and where this is the case this is clearly stated. As part of our analysis we have attempted to determine whether there is a relationship between response theme and stakeholder group, but have found no clear correlation. Response themes have in general been contributed to by various stakeholder groups.

The response themes are summarised in the Appendix which also identifies the number of respondents contributing to each theme.

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Response to Consultation Questions

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?

The approach to providing national-scale information on geology relevant to geological disposal described in the draft Guidance was developed over several months and following meetings and engagement events with various stakeholder groups. The draft Guidance was also reviewed by the Independent Review Panel and changed in response to their advice. We recognise that even having taken these steps there may be other approaches, or other views on what would constitute a successful or appropriate approach. Question 1 was designed to check that our proposals were robust and not missing some key components.

Of the 78 responses, 70% of those expressing an opinion supported the proposed approach. Most respondents, particularly those from the geoscience community and local Government, provided additional comments and suggestions which have been considered and actioned as described below.

RESPONSE THEME 1.1:

Provide a more detailed description of the safety requirements and how the geological attributes help to meet them. Some attributes will be more important than others and consideration should be given to provision of an explicit hierarchy. The linkages between Tables 1 and 2 should be explained.

Reply: The consultation document provided only a very brief discussion of the long-term safety requirements of a GDF and how the different geological attributes contribute to meeting these requirements. Feedback was received from several respondents, particularly from the geoscience community, stating that we should make clear the linkage between them. We accept this point and have provided further explanation of the safety requirements themselves and how the attributes listed in Table 2 are relevant to meeting these requirements listed in Table 1.

Action: Modify Appendix 2 to make clear the linkage between the safety requirements and the geological attributes.

RESPONSE THEME 1.2:

Provide the rationale that supports the three specified generic geological environments as being suitable to host a geological disposal facility

Reply: The three generic geological environments identified as being potentially suitable to host a geological disposal facility were identified in 2010 by RWM and described in the report *Steps Towards Implementation*[6]. These environments were used as the basis of generic designs and safety studies published in the 2010 generic *Disposal System Safety Case*[7].

These safety case studies will be updated and reissued in 2016 and clearly demonstrate how safety is provided for the three generic geological environments.

Action: RWM will update and reissue the generic Disposal System Safety Case later in 2016. No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 1.3:

Explain how an engineered barrier system and geological environment work together so that it is the "disposal system" as a whole that provides safety

Reply: The intent of geological disposal is to provide containment of radioactivity and isolation of wastes for a sufficiently long period to allow radioactive decay to diminish the hazard such that any residual activity reaching the surface environment will not cause harm to people or the environment. This is achieved by provision of multiple barriers, both engineered barriers and natural barriers (i.e. the geology). It is the totality of all the barriers that provides safety: the geological environment in which the waste is placed, the containers in which the waste is packaged, the backfill placed between the containers and the rock, and the form of the waste; they all have a role to play.

The exact characteristics of the geology will not be known until we have identified a site and characterised it; however we do understand the geological attributes which will be important to the eventual long-term safety case and have developed generic illustrative GDF designs and safety cases for the three different generic host rocks. These help us to explain what a GDF could look like, the role of the different barriers and how they will contribute to safety for each of the different geological settings. The generic designs and safety cases were published in 2010 and have been referred to in the national geological screening Guidance as providing the basis for the identified safety related geological attributes. Further information on the 2010 safety case is available in the generic *Disposal System Safety Case* documentation[7].

We recognise that demonstrating the linkage between geology and safety is an important factor for the success of the safety case and are preparing an update to the generic safety case which provides an improved description of the role of the geological environment, including both the host rock and any cover rocks. This improved Environmental Safety Case will be peer reviewed and published later in 2016 in time to support the launch of the siting process.

Action: RWM will prepare an updated generic Environmental Safety Case and issue this as part of the generic Disposal System Safety Case later in 2016. No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 1.4:

The Guidance is too technical for a lay audience. The guidance is not detailed enough for a community to know about their region

Reply: Geological screening is a national exercise based on existing information. The aim is to show what is known about geology that is relevant to geological disposal safety on a national-scale. Equally the screening should highlight where there are gaps in our geological knowledge. When the regional narratives and where appropriate, supporting maps, are made available, then if a community is interested in finding out more we would open a discussion with them about geology and safety specific to their region or area.

We recognise that the way in which geology contributes to the long-term safety of geological disposal is a technical subject and have tried to use accessible language within the consultation document as far as possible. However ultimately we have to strike a balance and the Guidance has to be meaningful to the geological professionals that will use it.

Action: We do not propose changes to the Guidance to address this point but we are preparing information materials aimed at a non-technical audience on issues associated with the Guidance and geological disposal which will be available when the siting process begins.

RESPONSE THEME 1.5:

It is not clear what will be ruled out. Should there be specific 'screening out' attributes?

Reply: National geological screening is an exercise to bring together existing information about geology that is relevant to the long-term safety of a GDF and make it available in an accessible form. The 2014 White Paper recognises that "no national exercise will be able to definitively rule all areas as either 'suitable' or 'unsuitable'". It is likely however that screening may lead to some areas being identified as unsuitable for hosting a GDF; this may occur for example because of no suitable host rock or because of the presence of deep mines.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 1.6:

Consider trialling the narratives and maps before publication. One suggestion is to undertake a dry-run using data from an area that would otherwise not be included in the national geological screening outputs

Reply: The suggestion of a 'dry-run' to trial the approach would require the use of geological data. It was suggested that this could be sourced from an area or region that would not otherwise be included in the national geological screening outputs. If this suggestion was taken up then the dry-run would be undertaken using geological information from an area that lay outside the RWM remit for screening but raised comparable geological issues. For RWM to effectively extend screening to a region beyond its remit is not considered appropriate. However the overall idea of trialling the outputs and the different presentation approaches to test their effectiveness prior to finalisation is being considered.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 1.7:

Topics associated with groundwater flow and hydraulic gradients

- **document should recognise topography as a driving force for groundwater flow**
- **the merit of long groundwater travel paths should be discussed in relation to low permeability host rock, since both contribute to radionuclide transport**
- **is groundwater chemistry relevant?**

Reply: We recognise that groundwater will often flow from topographic highs (hills and mountains) to topographic lows (valleys and plains). This is due to the development of hydraulic gradients. However at the depths of interest for a GDF, the groundwater may be hydraulically isolated from surface influences such as topography due to the presence of low permeability barriers. We have modified the Guidance to include a discussion of topography in the regional narrative texts to recognise these points.

We agree that long groundwater travel paths are helpful to the safety case by inhibiting and delaying the movement of groundwater from the GDF to the near surface environment. This can be provided by a low permeability host rock as suggested in A2.3 of the consultation document or by the combination of host rock and overlying cover rock as indicated in A2.5 of the consultation document. We have revised the way in which we describe this within Appendix 2 to make this clearer.

Groundwater chemistry is important both to identify old groundwater with a long residence time, and to match the engineered barrier to the geological barrier. It will need to be considered in detail at the site-specific safety case stage and is included as an attribute within the national geological screening exercise.

Action: Add additional text to address the influence of topography in paragraph 3.25 of the Guidance and to address the effect of groundwater travel paths in Appendix 2. No changes are proposed for the topic of groundwater chemistry as this was already covered within the national geological screening Guidance.

RESPONSE THEME 1.8:

Topics associated with climate change

- **document should recognise sea level changes, acidification, weather extremes and other impacts of global warming**
- **recognising that disposal facilities could be located beneath the seabed, coastal surface facilities would need to be protected from future sea-level rises**

Reply: Rising sea levels may have an impact on the location or design of the surface facilities of a GDF. However due to the flexibility in the relative locations of the surface and underground components this is highly unlikely to make a given volume of potential host rock unsuitable. Although changes in sea level would affect hydraulic gradients in coastal areas, these changes would need to be considered at the site-specific level to understand whether they were significant to the safety case. Some generic text will be developed to explain this within the narratives prepared for the regions located along coastlines.

Action: Add additional text on sea level change as part of the *Natural processes* discussion in paragraph 3.26.

RESPONSE THEME 1.9:

Topics associated with catastrophic events (tsunamis, tidal surges, meteorite impact and earthquakes)

- **consider the impact of tsunamis and extreme tidal surges on surface facilities**
- **discuss meteorite impact (some geological terrain may be better able to cope with such impact than others)**
- **provide an explanation of seismic activity at depth and at surface**

Reply: Whilst tsunamis and extreme tidal surges may have an impact on the location or design of the surface facilities of a GDF, the short duration of these surface events would not impact on the conditions at the depth of a GDF. Resilience to such surface events is one of the benefits of geological disposal in the longer term once the facility is closed and sealed.

A meteorite strike that was sufficient to affect the conditions at the depth of GDF would be a significant global event. It is not considered that any particular UK geological setting would be more robust to such an event than any other, or more likely to be hit, and therefore we do not propose to provide information relating to potential resilience to meteorite strikes.

Data from the British Geological Survey indicates that the majority of earthquakes measured in the UK occur at a depth significantly greater than 1 km. Any ground rupture associated with these earthquakes is too deep to directly affect the integrity of a GDF. In addition, the indirect ground shaking associated with these earthquakes would be significantly less damaging at the depth of a GDF than that experienced at surface. These points will be made clear in the regional narratives.

Action: No changes are proposed to the national geological screening Guidance to address these points.

RESPONSE THEME 1.10:

Should aquifers be considered as a resource?

Reply: Aquifers are indeed an extremely important resource and their location will be discussed in the regional narratives to ensure that any potential impacts can be considered at an early stage with communities. However aquifers differ from other geological resources in that they are limited to the top 400 m or so because below these depths they do not contain water of suitable quality for human consumption. The presence of an aquifer in the top 400 m does not necessarily make an area unsuitable if a potential host rock below this depth is hydraulically isolated from the aquifer by intervening low permeability rocks. For this reason aquifers are considered separately from other geological resources, the presence of which may impact the full 200 to 1,000 m range.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 1.11:

Should microbes be considered?

Reply: Although the potential effects of any microbes contained in the groundwater at depth will be taken into account during the development of any site-specific safety case, there is insufficient information available to consider variations in these impacts at the national scale.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 1.12:

Provide information on whether a GDF could be sited in regions where fracking (or other resource exploitation) is being considered

Reply: We propose to provide information on areas which have been mined for resources in the past, areas which are currently being exploited for resources now and areas which have been identified as having potentially exploitable resources (such as shale gas) in the future. For those which have been mined previously or are currently being exploited these activities have affected the ground conditions and this would need to be taken into account when considering the potential to host a GDF.

For potentially exploitable resources, areas made available for licensing by the Government and areas for which companies have purchased licences will be discussed in the narrative to inform early discussions with communities.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 1.13:

Discuss the heat dissipation capacity of different rock types with respect to their suitability as host rocks

Reply: Different rock types have different thermal properties which will affect the potential layout and spacing of the underground modules designed for the emplacement of heat producing wastes. These differences will affect the site-specific design of a GDF but do not affect long-term safety. This information is not relevant therefore to the national geological screening exercise.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 1.14:

When developing the detailed technical instructions give consideration to these detailed (but important) points: permeability will vary with depth (likely to be higher close to the surface), minimum thickness of potential host rock, definition of "major" when applied to faults and fractures

Reply: The detailed technical instructions have been developed by RWM and the British Geological Survey, and reviewed by the Independent Review Panel. There are no implications for the Guidance as a result of this theme, but the points made have been considered in the development of the detailed technical instructions.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 1.15:

We should make our detailed criteria publicly available

Reply: The detailed technical instructions which define how the Guidance will be implemented have been developed by RWM and the British Geological Survey. They have been reviewed by the Independent Review Panel and made publicly available on our website.

Action: The detailed technical instructions are available online.

RESPONSE THEME 1.16:

Standardised terminology / definitions should be used to avoid future misinterpretation

Reply: Definitions of technical terms in the Guidance and the eventual outputs will be provided to ensure that any differences between our usage and wider geological usage are made clear. A glossary was provided to support the consultation and will be updated to support publication of the outputs.

Definitions of technical terms used in the detailed technical instructions are provided in supporting protocols.

Action: Update the Glossary to support publication of the national geological screening outputs.

RESPONSE THEME 1.17:

Emphasise that attributes can be positive or negative: those in Table 2 give the impression of being negative

Reply: We agree that attributes can be positive or negative and that our current listing of information sources in Table 2 tends to emphasise features that we wish to avoid. These are the features that are relevant at national scale: positive attributes such as sorption properties, or mineralogy, will be relevant for the site-specific safety case and will be identified as part of the site characterisation programme. To provide a more balanced picture we have expanded the description in Appendix 2 which provides a clear linkage between the attributes and the long-term safety requirements of a GDF.

Action: We have added further text in Appendix 2 of the Guidance document.

RESPONSE THEME 1.18:

Detailed suggestions for improvements to text addressing description of geological columns, role of deep brines, reference to BGS offshore maps and reports, role of attributes may vary depending upon concept selected, description of human intrusion, role of mineralogy and description of evaporite

Reply: We agree with the feedback received about geological columns and have included additional text to clarify the meaning in paragraph 3.16.

We agree that we should provide information on host rock containing deep brine groundwater and this is the intent of paragraph 3.25. Paragraph 3.25 has been modified to make this clear.

The British Geological Survey offshore maps have already been used in the development of the BGS UK3D model which has been extended to cover geology up to 20km offshore. No changes to the Guidance were needed.

We recognise that the exact role of the geological attribute within the eventual safety case will vary dependent upon the disposal concept selected for a particular site. The geological attributes therefore are not requirements hence the objective of the national geological screening exercise is to provide available information on the identified attributes so as to facilitate engagement with interested communities. No changes to the Guidance were needed.

We will make it clear that the geology contributes to consideration of likelihood of human intrusion rather than controlling consequences. This has been changed in Table 1.

We agree that mineralogy of the rock may contribute to the safety case but cannot reflect this in the national scale information. This will be addressed by the site-specific safety case when a site has been identified and characterised.

We agree with the point that some forms of evaporite (e.g. anhydrite) can be brittle and sustain open fractures. We have clarified the text in paragraph 3.15.

Action: Changes have been made to the national geological screening Guidance as discussed above.

Question 2 – The proposed sources of information are summarised below. To what extent do you think that these sources are appropriate and sufficient for this exercise?

The sources of information available to support the national geological screening exercise were developed following discussion with the British Geological Survey and were reviewed by the Independent Review Panel. Question 2 was designed to identify whether there are other relevant information sources that we may have missed.

Several respondents questioned why we were not referring to detailed geological information that may be available for specific areas (for example as generated in the 1980s and 1990s by Nirex). Others emphasised that we would need to be clear about uncertainties in the data and how these will be resolved as the siting process progresses. Our replies to these comments are set out under the response themes below.

Of the 78 responses, 65% of those expressing an opinion supported the proposed sources of information.

RESPONSE THEME 2.1:

Topics associated with the limitations of existing information and gaps

- **explain limitations and gaps in the information sources (and how these would be filled for communities entering the process)**
- **the data gap analysis will be extremely important in future stages of the project**

Reply: We agree that this is an important issue. We are working with the British Geological Survey to develop consistent ways to explain the limitations and gaps in the information, drawing upon experience in other sectors nationally and internationally. We recognise that communicating the uncertainty in the geological understanding for each region is very important and we have updated the Guidance to emphasise this point. Reducing this uncertainty will be the aim of investigations during the siting process. Initially wider geological uncertainties will need to be resolved to focus in on a suitable area for detailed site investigation. Further work will then involve iteration with the engineering design and safety case teams to ensure that the investigations are focused on the uncertainty which is material to the safety and design of the GDF. The regional narratives will provide a high level consideration of the likely investigation approaches needed to reduce the uncertainty. This has been made clear in the Guidance. There will be a specific protocol setting out our approach to treatment of uncertainty in the documentation supporting the detailed technical instructions.

Action: Add additional text to the *Form of outputs* section explaining that the outputs will identify the uncertainty associated with the understanding and the high level investigation approaches needed to reduce this uncertainty.

RESPONSE THEME 2.2:

Explain why reference is not made to work done previously on site selection in the 1980s and 1990s

Reply: No previous study has considered the national distribution of geological attributes which may have potential for the geological disposal of all the waste types within the UK's higher activity radioactive waste inventory. The present exercise is based upon an improved understanding of the UK geology which takes into account the new data and information which has been collected since these previous studies were undertaken.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 2.3:

Explain why reference is not made to the detailed site characterisation work undertaken by Nirex in West Cumbria

Reply: During the 1980s and 1990s Nirex undertook investigation work at a small number of sites across the UK. This work was focused on specific sites and the data is held by the British Geological Survey in the publicly accessible National Geological Archive. The stratigraphic and structural understanding from these investigations has been incorporated into BGS's UK3D model and some of the deep boreholes are specifically included in the model. The UK3D model will be a key resource in the application of the Rock Type and Rock Structure elements of the screening. Where the site specific data, such as groundwater chemistry, is of relevance to the regional understanding this will also be used to inform the regional narrative texts.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 2.4:

Explain why we are not using more detailed information sources where they are available

Reply: The White Paper[1] defines the national geological screening exercise as bringing together high level geological information relevant to the GDF safety cases. Detailed information relating to specific sites is outside the scope of this high level national exercise but would be used at the next stage in the consideration of specific areas in discussion with communities during the siting process.

Action: Text has been added to Section 1 which explains that detailed local information would be considered during the siting process.

RESPONSE THEME 2.5:

Explain why we are not using peer reviewed academic journal articles (BGS maps may not be up to date; there is more recent information and analysis in journals)

Reply: The British Geological Survey's UK3D model represents BGS's up to date national level understanding of the geology of the UK based upon a wide range of sources including key academic journal articles. Many of the other primary information sources, such as the BGS baseline chemistry report series draw upon and reference academic

journal articles. However if other articles are identified by BGS during the application of the screening Guidance which are significant to the regional or national understanding, they will be used to inform the outputs. This approach was reflected in the draft Guidance.

Action: No changes are proposed to the national geological screening Guidance as we consider that this point is already addressed.

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?

The proposals for the form of outputs were developed based on our understanding of what was achievable and could be delivered on a reasonable timescale. We tested these proposals with the Independent Review Panel but were aware that we had not sought the views of potential users of the information. Question 3 was designed to provide potential users and non-experts the opportunity to provide inputs on what they would find useful if they were using the outputs to assess the geological potential of their communities.

Many respondents gave helpful feedback and our replies below give an indication of how we will take these suggestions forward. Of the 78 responses, 64% of those expressing an opinion supported the proposed form of outputs.

RESPONSE THEME 3.1:

Emphasising that different stakeholders will require access to differing levels of information and detail

- **narratives should be clear and easy to understand (use of plain English recommended), with use of graphics as appropriate and pointers to more detailed information if needed**
- **explain how people can access tiered levels of information in the outputs**
- **more detailed and technical outputs will be necessary for geoscientists and learned bodies e.g. it may be necessary to apply some form of sub-division to existing BGS Regions**

Reply: We recognise that a wide range of people with differing levels of geological understanding will want to access and understand the outputs of the national geological screening exercise. We intend to produce the information in a tiered manner which allows all stakeholders to understand the key conclusions but also provides the technical underpinning for those with the relevant geological expertise. This has been made clear in the Guidance.

Action: Text has been added to the *Form of outputs* section explaining that the outputs will be provided in a tiered manner which facilitates access by both lay and geological stakeholders.

RESPONSE THEME 3.2:

Feedback associated with the form of the proposed maps

- **scale of 1:625,000 is not detailed enough to identify sites and/or areas within local authority boundaries**
- **maps should include sufficient detail for people to be able to approximately locate their community**
- **maps should all be produced to the same scale**
- **the outputs as described may be too complicated for the lay-person with little or no knowledge of geology**
- **manage expectations about the level of detail likely to be provided in the outputs (these may not be as detailed as some stakeholders hope for). Consideration should also be given to how uncertainty is represented within the maps**
- **overlapping edges of maps would be useful (especially if there are structures of interest near the boundaries of maps)**

Reply: The White Paper[1] makes it clear that this is a high level national screening exercise and it is not intended to target individual sites for development. This will come at a later stage during the siting process where more detailed maps and information will be needed.

A map scale of 1:625,000 scale (approximately 1 inch to 10 miles) is considered to provide the appropriate basis for such an exercise. The maps for all regions will be produced to the same scale and will be provided with an appropriate Ordnance Survey overlay indicating towns and cities, meeting the expectation that users will be able to approximately locate their community.

We recognise that users of the outputs will have varying abilities in accessing information from maps and hence propose that the regional narratives will provide an alternative textual explanation of the distribution of the attributes. We are also considering the use of other media (e.g. video, animations) to make the outputs more widely accessible.

We agree that the provision of overlaps between maps is a good idea and are working with the British Geological Survey to incorporate appropriate overlaps into regional maps to facilitate stakeholders whose interest lies on the boundary between regions.

Action: The Guidance has been modified within the *Form of outputs* section to explain that the maps will be provided at 1:625,000 scale (approximately 1 inch to 10 miles), with an overlay indicating towns and cities. The need for an appropriate overlap around regional maps has also been noted.

RESPONSE THEME 3.3:

Suggested additions to the proposed regional narratives and maps

- **indicate the relative confidence in the suitability of different areas (by for example a ranking system)**
- **provide a summary that identifies all suitable areas**
- **provide a national summary giving over-arching conclusions about the information presented for example there is a lot of suitable geology in the UK**

Reply: The ultimate suitability of an area to host a GDF safely is dependent on a combination of geological attributes for which information is being provided where it is available at a national scale. Given that the uncertainty in the different attributes in each area will vary it is not considered to be of value to rank areas on suitability at this stage in the process. However it may be possible to identify some areas which are not suitable and these will be indicated in the regional narratives. We agree that some form of Overview would be helpful and are considering how this can be accommodated.

Action: No changes are proposed to the national geological screening Guidance.

RESPONSE THEME 3.4:

Feedback emphasising the need for the outputs to be clear on uncertainties in the data and requesting information be provided on the extent to which further preliminary investigations are likely to be necessary to address uncertainties

- **the amount of further preliminary investigations likely to be necessary should be indicated**
- **explain the uncertainty in the data used to produce the outputs, hence the uncertainty in the narratives and maps**

Reply: We agree that this is an important issue and understand that we must communicate the uncertainty in the geological understanding for each region and have updated the Guidance to emphasise this. We have also reflected this in the detailed technical instructions that will be used to define the work to be undertaken by BGS in the implementation of the Guidance.

Action: Additional text has been added to the *Form of outputs* section explaining that the outputs will identify the uncertainty associated with the understanding and the high level investigation approaches needed to reduce this uncertainty.

RESPONSE THEME 3.5:

Recommendations that other media/tools be used to communicate the regional-scale information

- **a video/television documentary should be produced for engagement with a wide audience**
- **consider web, app-based or GIS formats for presentation of outputs**
- **consider interactive 3D visualisations as a tool to engage with the public**
- **face to face meetings and other proactive community outreach methods will be needed to explain the geological outputs**

Reply: We agree that there are different tools and media that we could usefully use to convey the results of the screening to different stakeholders. We are actively considering a number of approaches to extend the accessibility of the outputs to as wide a range of stakeholders and individuals as possible. The consultation feedback and discussions with stakeholders and individuals during the consultation events have provided us with some very useful ideas on the appropriate mix of communication approaches.

Action: Additional text has been added to the *Form of outputs* section to indicate that we will explore the use of additional media to communicate the outputs of the national geological screening exercise.

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

Question 4 was included to provide an opportunity for respondents to make us aware of other topics or issues that are important for the national geological screening exercise but which were not covered by the other questions.

Several stakeholders thought that the national geological screening Guidance needed further support and context material and this should be included in the introductory chapters. We agree that the provision of such information is important; however this is a wider subject for us than just national geological screening and is germane to all aspects of our work. Our replies below point to where such further information can be found currently. We are also using this feedback to influence the development of further information materials and media.

RESPONSE THEME 4.1:

Describe who RWM is and provide support to the statement that RWM is the expert in geological disposal. Is RWM the best organisation to develop the safety narratives?

Reply: RWM is a subsidiary of the Nuclear Decommissioning Authority and has been established as the delivery organisation for the UK's proposed geological disposal facility for higher activity radioactive waste. The 2008 White Paper[19] and the 2014 White Paper identify RWM as the developer of the proposed geological disposal facility. RWM (and its predecessor organisations), has a long track record in the field of geological disposal design and safety studies and is well respected in the international radioactive waste management arena. The safety narratives will build upon the geological disposal safety studies published in 2010[7]. RWM is in a unique position to manage production of the safety narratives.

Further information on RWM and its role in the development of a geological disposal facility is available in the RWM Corporate Strategy[8].

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 4.2:

Explain the role of the regulators

Reply: The Environment Agency and the Office for Nuclear Regulation (ONR) are the two independent regulators that scrutinise RWM's work on the geological disposal of radioactive waste. Ultimately RWM will need a Nuclear Site Licence (from ONR) in order to develop a particular site and a series of Environmental Permits before we can start to undertake intrusive investigations and construction. Even at this preparatory stage the regulators are scrutinising RWM activities to ensure that they remain fully aware of the

way our programmes are developing and are able to offer advice and comment where appropriate. For RWM, it gives us confidence that our work and plans are consistent with regulatory requirements and expectations. The regulators work together to make sure that any future facility will meet their required high standards for environmental protection, safety, security, radioactive waste transportation and safeguards. Further information on the role of the independent regulators in the progression of geological disposal is available in the regulators' joint annual report on their scrutiny programme for geological disposal[9].

Action: No changes are proposed to the national geological screening Guidance.

RESPONSE THEME 4.3:

Provide more information on the role of the British Geological Survey their credibility to support this process

Reply: The British Geological Survey (BGS) is a public sector organisation responsible for advising the UK Government on all aspects of geoscience as well as providing impartial geological advice to industry, academia and the public. It is the UK's premier provider of objective and authoritative geoscientific data, information and knowledge. Further information about the BGS can be found in their annual report[10].

BGS and RWM have developed the detailed technical instructions that will be used to implement the national geological screening Guidance. The detailed technical instructions have been reviewed by the Independent Review Panel. It should be noted that these instructions are by their nature technical and designed for use by geology professionals.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 4.4:

Feedback on the role of the Independent Review Panel

- **provide more information on the credentials of the Independent Review Panel (i.e. the members) to independently assess the process**
- **the Independent Review Panel is critical to building trust in the process**
- **concerns that the Independent Review Panel is not independent of the nuclear industry**

Reply: The need for an Independent Review Panel (IRP) to scrutinise the national geological screening proposals was established by the 2014 White Paper. The Geological Society of London was recognised as the leading learned society in this area and was asked by the Department of Energy and Climate Change to form the panel. The panel members were selected to provide a broad range of geoscience expertise with backgrounds in both industry and academia. The aim was to achieve a panel which could work in an authoritative and balanced way. Some members are experienced in the UK radioactive waste environment, two members are from overseas to give a different perspective, and the Chair has geological expertise from outside the radioactive waste field. Two panel members were selected from a call for volunteers from Geological Society members. The Society's council approved the criteria for the panel, and the Chair, once appointed,

worked with the President to appoint the remaining panel members. More information, including information on the experience and background of IRP members has been published by the Geological Society on its website.

The IRP has an important role in providing independent and authoritative scrutiny of RWM's proposals. The IRP's deliberations are openly published and it seeks to provide the level of challenge that the public would expect and hence helps to build trust in the process. It is noted that some members have been involved with the nuclear industry in the past. This does not challenge the IRP's independence: it provides expertise and insight into some of the specialist aspects of the geoscience underpinning geological disposal and is balanced by the other members from other backgrounds.

Action: No changes are proposed to the national geological screening Guidance.

RESPONSE THEME 4.5:

Further information is requested on how the national geological screening Guidance will be applied and how this fits within the overall context of the national geological screening initial action

- **explain what screening entails. Emphasise that the screening exercise will not identify sites and is not intended to 'screen in' or 'screen out'. Some respondents suggest that the term screening is not a good description**
- **provide an explanation of the next steps and timeline for the siting process; manage expectations for the level of detail expected in the outputs**
- **explain what happens to assess site suitability before borehole investigations**
- **explain who will independently review the process and/or the outputs in addition to the Independent Review Panel**

Reply: Geological screening is a precursor to the siting process and is intended as one of the initial actions to provide information that will help communities decide whether to participate, and to make early discussions more productive. In that respect it is correct that the screening exercise will not identify sites and is not intended to. The screening exercise comprises two parts:

(i) Developing the Guidance – the subject of the national geological screening Consultation.

(ii) Applying the Guidance and developing the geological information that will be published as a series of narratives and associated maps.

Following consultation the national geological screening Guidance has been revised and published. Detailed technical instructions and supporting protocols, specifying how the Guidance will be applied and defining in detail the form of the outputs have been produced. These have been reviewed by the Independent Review Panel. The Guidance and detailed technical instructions are being published online. They will be applied during 2016 (part (ii) of the screening exercise) to develop a series of regional-scale narratives with associated maps. These outputs from the screening exercise will be reviewed by the Independent Review Panel and once finalised, will be made available online.

The initial actions (of which the national geological screening is one) will provide additional information before the siting process is formally launched in 2017. The 2014 White Paper sets out the initial actions and timeframe going forward from the launch of the siting process. The three initial actions are:

- national geological screening
- preparing to work with communities
- developing land-use planning processes

Completion of the initial actions will provide the basis for communities to consider whether they wish to seek further information and engage with RWM as the developer. A key tenet of the voluntarist process is that the developer will be working with communities that are willing to participate in the siting process. It will involve engagement with communities to identify and assess potential sites over a number of years.

Detailed geological evaluation will be carried out within selected volunteer communities with the aim of identifying suitable rock volumes for a GDF site within the area. The area will be investigated first through more detailed desk studies drawing on all available detailed information. This will be followed by a programme of non-invasive geophysical investigations to target potential sites within the area. Once potentially suitable sites have been defined, a programme of borehole investigation will be undertaken after obtaining the necessary regulatory and development consents. The precise investigation methods used will depend on the local geology, and if it becomes clear that no suitable geology for a GDF is present anywhere in the area, the investigations will end.

In due course, after the results of the new investigations have been interpreted and reconciled with existing information, and when RWM, Government and the communities are satisfied that there is sufficient information to demonstrate whether the sites are suitable, RWM will select the site (or sites) at which it plans to seek regulatory and development consent to progress to construction of a GDF. A test of public support would also be carried out in any participating community and this would need to be positive to allow development to proceed.

As set out in the 2014 White Paper, the Committee on Radioactive Waste Management (CoRWM) is playing a scrutiny role throughout the national geological screening process. CoRWM provided oversight during the development of the Guidance.

Action: Additional text has been added to the Introduction of the national geological screening Guidance to explain CoRWM's role in providing independent scrutiny.

RESPONSE THEME 4.6:

Provide information on the other initial actions, explain timescales and next steps

- **explain the voluntary process and the outputs of other initial actions and how these will be brought together for discussion with potential communities**
- **provide contextual information on other initial actions and programme for GDF implementation, including how a GDF supports higher activity waste management**
- **explain that surface planning issues will be dealt with in developing the National Policy Statement**
- **explain outputs of working with communities initial action including access to independent third-party advice, 'right of withdrawal' and proposed test of public support**

Reply: National geological screening is one of three initial actions that are being undertaken either by the UK Government's Department of Energy and Climate Change (DECC) or RWM. The three initial actions are described in the 2014 White Paper as follows:

- national geological screening
- preparing to work with communities
- developing land-use planning processes

The national geological screening initial action is being undertaken by RWM; the other two are being led by DECC. The preparing to work with communities initial action is addressing matters of community representation, testing community support, and community investment. Inputs to this initial action have been sought via a call for evidence[11] and from the Community Representation Working Group, an advisory group established by DECC with the intention of providing expert input to the various aspects of the initial action. Further information on this work and the involvement of the Community Representation Working Group is available from DECC.

The developing land-use planning processes initial action is focussed on establishing the land-use planning framework that will be used as the basis for developing a future GDF. Such a GDF and the associated deep boreholes for site characterisation have been designated as Nationally Significant Infrastructure Projects, and DECC under this initial action is developing documentation to support such an approach including production of a National Policy Statement.

The outputs of national geological screening are therefore one part of a set of information, which will also include the outputs of the other two initial actions. This set of information will be used in engagement with communities that may be interested in hosting a GDF. This process of engagement will begin after the siting process is formally launched in 2017.

Collectively, the outputs of the initial actions will be used to address questions that communities may raise as they consider whether to become involved in the siting process. By having answers to fundamental questions on topics such as community representation, decision making and investment, safety and geology, and land-use planning, early discussions should be more productive and therefore increase the possibility that communities may wish to find out more about the siting process. Further information on the process established by Government is available from DECC.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 4.7:

Provide context information on what is a GDF, why we need one and why this is preferable to alternatives like deep borehole disposal

Reply: The UK has accumulated radioactive waste from a range of sources including generating electricity in nuclear power stations, using radioactive materials in industry, medicine and research, and from defence-related nuclear programmes for over 60 years. A key part of dealing with the UK's nuclear legacy is the management of higher activity radioactive waste and its eventual disposal. Government has studied the various options for dealing with higher activity waste and following review by the independent Committee on Radioactive Waste Management (CoRWM), accepted their recommendations that geological disposal should be pursued as the preferred option. Further information on what a GDF is and why we need one is available in the publication Managing Radioactive Waste a Guide for Communities.

The UK Government is committed to implementing geological disposal for the safe and secure management of higher activity radioactive waste over the long term and favours an approach for selecting a site that is based on working in partnership with communities.

Regarding the deep borehole disposal approach, this is a proposed form of deep geological disposal which would involve the emplacement of certain types of waste in special large diameter boreholes at a depth of some kilometres. This technology is not currently as mature as the mined geological disposal approach although is being investigated overseas. RWM is maintaining a watching brief on the development of this technology: our approach is described in our Technical Programme[12]. It is not currently government policy to adopt this approach, but if it were to be adopted in future for the appropriate parts of the UK's waste inventory, the information that we will gather in the national geological screening exercise would be an important part of the process for selecting suitable sites for deep boreholes and designing the borehole engineering strategy. As a result, we do not believe that the screening we are proposing to carry out pre-empts any decision to investigate deep borehole disposal, nor would the work be wasted if deep boreholes were to be adopted for disposal of some wastes.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 4.8:

Provide context information on radiological protection and on the environmental impact of radioactivity and GDF in general. Explain how a GDF is designed to provide protection in the short term and long term

Reply: The philosophy of geological disposal is to place higher activity radioactive waste deep underground providing containment and isolation of the wastes thereby protecting the surface environment from the harmful effects of the radioactivity.

RWM recognises that safety of a future GDF is paramount and will progress to develop such a GDF only if it is convinced that it can be implemented at a particular site safely. In order to do so RWM will develop a safety case setting out its understanding of the characteristics of the site and how safety will be provided in the short and long term if it is used to host a GDF. The safety case will need to be scrutinised and accepted by the independent regulators before construction can start.

In order to support the siting process RWM has developed a generically based safety case which has been used to support the identification of the important safety related geological attributes that will be used for the production of the geological information being developed within the national geological screening initial action. RWM is updating its safety case in 2016 and will be available on the same timescale as the initial actions.

Before publication, the safety case will be subject to independent peer review and following publication will be scrutinised by the independent regulators.

Information about radioactivity and radiological protection is published by many bodies including RWM, regulators and public health bodies such as Public Health England.

In addition the Food Standards Agency publishes information on radioactivity in food and the environment[13]. The report combines the Agency's monitoring results with those of the Environment Agency, the Northern Ireland Environment Agency and the Scottish Environment Protection Agency. The survey measures radioactivity from different parts of the food chain, including for people who live close to nuclear sites and eat locally produced food. The report also assesses how much radioactivity people would absorb from authorised radioactive discharges in the environment, for example the air.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 4.9:

Provide information on other key issues including: transportation of waste, management of heat generating wastes, disposal of plutonium, build-up of gases, sealed containers to ensure water cannot enter, and human intrusion

Reply: The RWM geological disposal safety case will need to address all aspects of the GDF covering construction, operation and evolution of the system in the long term following closure. For each stage the safety case will demonstrate that RWM understands

how the waste packages, the engineered structures and natural environment will behave and contribute to the necessary containment of the harmful activity. The safety case was last published in 2010[7] and is being updated in 2016.

The generic safety case addresses all higher activity waste types (high level and intermediate level waste (and a small fraction of low level waste not suitable for existing disposal arrangements) and materials that might be classed as waste in the future (spent fuel, plutonium and uranium). The generic safety case explains how these wastes and materials would be packaged for safe transport and disposal, how they would be safely transported to the site of the geological disposal facility, how it is planned that they would be emplaced in a GDF and how the engineered and natural barriers would contribute to containment and protection of the environment and future generations.

The long-term safety case will need to demonstrate that RWM understands the safety implications as the GDF evolves over the very long term including implications of natural events such as future ice ages and man-made events such as drilling into the facility (human intrusion) by future generations prospecting for minerals for example.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 4.10:
Explain what other infrastructure would be required to support a GDF

Reply: A GDF can be considered to comprise two parts:

- the surface site
- the underground site

These two sites will be connected by an access which could either be an inclined tunnel or a vertical shaft, or the facility might use both types of access for different purposes. The surface site need not be directly above the underground site; engineering and mining experience shows that they could be laterally separated by several kilometres.

The surface site will house the waste package reception facilities, rail sidings (assuming that rail is used for waste transports), ventilation plant, access roads and access(es) to underground, maintenance, administration and welfare facilities. The surface site will also need to accommodate the necessary facilities for a large-scale 'construction site'.

Geological disposal will also create the need for a number of supporting facilities:

- research laboratories
- a packaging plant where wastes, spent fuel and plutonium are packaged into disposal containers
- a canister factory to manufacture disposal containers
- interim storage facilities where packaged wastes can reside whilst awaiting availability of the GDF

These facilities could be developed in the vicinity of the GDF subject to agreement of all concerned.

Further information on the infrastructure requirements will be found in RWM's generic Disposal Facility Design report which will be published in late 2016. Information on the other facilities that may be needed to support a GDF are published in the RWM report on manpower and skills[14].

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 4.11:

Provide information on inventory of waste for disposal (type of waste being considered in terms of radionuclide content and levels of activity) and clarity on new build compared with legacy waste (volume, radioactivity, heat generation)

Reply: The inventory for geological disposal is described in the 2014 White Paper *Implementing Geological Disposal* and RWM uses this as the basis for all its design and safety case work. The specific types of higher activity radioactive waste (and nuclear materials that could be declared as waste) which would comprise the inventory for disposal in a GDF are:

- high level waste arising from the reprocessing of spent nuclear fuel at Sellafield
- intermediate level waste arising from existing nuclear licensed sites, and defence, medical, industrial, research and educational activities
- the small proportion of low level waste that is not suitable for disposal in the national Low Level Waste Repository
- spent fuel from existing commercial reactors (yet to be declared waste) and research reactors that is not reprocessed
- spent fuel (yet to be declared waste) and intermediate level waste from a new build programme up to a defined amount
- plutonium stocks – in the form of mixed-oxide spent fuel or residual plutonium not re-used in new fuel manufacture (yet to be declared waste)
- uranium stocks – including that arising from enrichment and fuel fabrication activities (yet to be declared waste)
- irradiated fuel and nuclear materials (yet to be declared waste) from the UK defence programme

RWM has taken the White Paper "inventory for disposal" and generated a detailed dataset of the characteristics of these wastes and materials. This dataset is used as the basis for all our recent technical design and safety case studies. The dataset is described as the Derived Inventory[15].

This 2013 Derived Inventory is presently being used as the basis for design and safety case studies which will be published later in 2016.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 4.12:

Explain how long the waste packaging itself would last

Reply: Before any wastes are packaged for disposal RWM works with the waste producer to ensure that the wastes are conditioned and packaged in a passive and disposable form so that any wastes packaged today should be compliant with future transport and disposability requirements. Packaging standards (and associated guidance) based on our concepts and safety cases for transport and geological disposal have been published by RWM. Further information on the waste packaging specifications and how RWM works with waste producers is available in our report *Radioactive wastes and the assessment of disposability of waste packages*[16].

The lifetime defined for a waste package is dependent upon the activity content of the waste (more hazardous wastes are expected to be contained for longer) and on the "safety functions" placed upon the waste package. Clearly it will need to provide safe containment during handling and emplacement operations and in the longer term following closure of the facility. However the post-closure containment function will be shared between the engineered system and the natural geology and the latter will only be confirmed following characterisation of the site. Because of this uncertainty RWM is taking a conservative approach and assuming for instance that spent fuel will be packaged in a very long lasting container, a container that will provide containment for several hundred thousand years.

Further information on the performance of waste packages and their contribution to the safety case will be provided in the generic Environmental Safety Case planned to be published later in 2016.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 4.13:

Provide information from overseas regarding package longevity and disposal facilities

Reply: The approach being adopted by RWM is similar to that being adopted in other geological disposal programmes overseas. The Swedish programme for instance, utilises steel and concrete containers for the packaging of low and intermediate level waste and containers manufactured from high-grade copper for the packaging of spent nuclear fuel. Planning for geological disposal is further advanced in Sweden than here in the UK and the Swedish waste management organisation has completed the siting process and has submitted a licence application to commence construction. Further information on the Swedish licence application is available from the Swedish waste management organisation SKB.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 4.14:

Explain how a GDF may differ in higher strength rock, lower strength sedimentary rock and evaporite in terms of its form, engineering and cost. Explain how excavated rock spoil will be managed

Reply: The generic design and safety case studies previously published by RWM have recognised the importance of the geological setting in determining the design and safety features of a GDF. Generic illustrative designs have been published for GDF's constructed in higher strength rock, lower strength sedimentary rock and evaporite[17].

These generic designs and safety cases are presently being updated and will be published in time to support the launch of the siting process. These are intended to provide greater insight to the design and performance of a disposal system in these different geological host rocks. Furthermore, consideration will be given to the effect of different cover rocks.

The new reports will provide updated illustrative designs (for the current inventory for disposal), costing information, updated scientific evidence base and updated safety cases covering the different geologies.

The generic design report will describe how rock spoil is managed for each of the generic geological environments.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 4.15:

Provide information on the history of previous site selection in the UK and why it was not successful

Reply: A number of attempts have been made in the UK to find sites where geological disposal of radioactive waste could be implemented. Positive and negative observations from the past attempts have been considered and lessons learned are adopted in the process now being implemented.

The Nirex siting process for intermediate level waste ended in 1997 with the rejection of a planning application for the construction of a Rock Characterisation Facility in West Cumbria. The Nuclear Decommissioning Authority published an account of the siting process which led to the selection of the site in West Cumbria in 2005[18].

This was followed by a reappraisal of Government policy and led to publication of the *Managing Radioactive Waste Safely* White Paper in 2008[19]. The MRWS process was being followed with communities in West Cumbria forming a partnership to explore with Government whether their communities might be suitable to host a GDF for higher activity waste but this came to an end in January 2013.

Government carried out a lessons learned exercise, issued a call for evidence[20] and consulted on a revised siting process. The revised siting process set out in the 2014 White Paper *Implementing Geological Disposal* addresses many of the issues identified

through this lessons learned exercise. In particular the new process is intended to provide information prior to the start of the siting process on safety and geology and sets in motion initial actions to address community representation and investment and land-use planning, topics identified as key enablers to a successful siting process.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 4.16:

Add explicit reference to using international experience relevant to the siting of a GDF

Reply: As part of its research into carrying out geological screening RWM has reviewed approaches to geological assessment in Sweden, Finland, Canada, Switzerland and France. Each country has taken a different approach in both scope and purpose of screening.

RWM has taken relevant aspects of these approaches into consideration in developing its own approach to geological screening and is learning from the experience gained by these more advanced programmes. Lessons drawn from one country cannot necessarily be applied to another and it would not be appropriate to make simplistic comparisons. However, valuable learning has been gained in identifying common principles and experience.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 4.17:

Need to implement the Guidance and subsequent stages in a way that promotes trust in the process. Openness and transparency, provision of information and being clear about uncertainties will be key

Reply: The process for national geological screening has to address uncertainty both in the source data and in the way it has to be interpreted. RWM recognises that the way that these are addressed must engender trust. RWM accepts that the national geological screening has to rely on the input of expert knowledge by geoscience professionals and that there is limited opportunity for wider stakeholder input or checking. For this reason the national geological screening Guidance has been subject to public consultation and has been reviewed by the Independent Review Panel. Furthermore the updated Guidance and the detailed technical instructions and protocols that have been developed to implement the Guidance have been reviewed by the Independent Review Panel before they were published. The whole process has been undertaken under the oversight of the Committee on Radioactive Waste Management (CoRWM).

RWM recognises the important role that openness and transparency plays in trust building. The Guidance and the detailed technical instructions and protocols have been made publicly available online.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 4.18:

Too little publicity around the public meetings and consultation

Reply: RWM recognises the need for active engagement with our various stakeholders if we are to be successful in our aim to deliver geological disposal on behalf of the nation.

Development of the national geological screening Guidance and subsequent public consultation were supported by a number of initiatives to raise awareness and to communicate with stakeholders. To publicise the launch of the consultation we contacted all stakeholders on our mailing list and e-bulletin list and a wide range of organisations from learned societies, academia, local government, non-governmental organisations through to the nuclear industry and wider supply chain.

We continue to encourage stakeholders and individuals that are interested in our work to subscribe to our e-bulletin.

Action: No changes are proposed to the national geological screening Guidance to address this point.

Issues raised that were outside the scope of this consultation

In responding to Question 4 some stakeholders raised issues that were broader than national geological screening. These are recorded and replied to in the following section.

RESPONSE THEME 5.1:

Respondent questions the justification for geological disposal for higher activity radioactive waste

Reply: Radioactive waste management is a devolved matter: the policies of the UK Government and devolved administrations are set out in Appendix 1 of the draft national geological screening Guidance. Geological disposal for higher activity radioactive waste is the policy for England, Wales and Northern Ireland.

The 2008 *Managing Radioactive Waste Safely* White Paper was issued following detailed review of all the options for waste management by the independent Committee on Radioactive Waste Management (CoRWM). Having considered the evidence, CoRWM recommended to Government that geological disposal was the preferred approach when compared to the risks associated with other methods of waste management[21].

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 5.2:

Respondent questions construction of new nuclear generating capacity

Reply: The UK Government is committed to delivering a low carbon and affordable energy mix of renewables, new nuclear and clean gas and coal, which will provide continuous low carbon generation and reduce the UK's dependence on fossil fuel imports. Government believes that nuclear power stations have a vital part in the energy strategy to help ensure a diverse mix of technology and fuel sources, increasing the resilience of the UK's energy system. Nuclear power is a proven technology able to provide continuous low carbon generation and is forecast to be the lowest cost form of low carbon generation. These potential benefits mean that new nuclear power stations have an important role to play in the UK's energy future.

Information on the background and rationale for new nuclear build is available from the Department of Energy and Climate Change.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 5.3:

Screening should seek areas with the best geological barriers

Reply: The policy of the UK Government as set out the 2014 White Paper *Implementing Geological Disposal* is to follow a voluntarist approach for siting, that is to say an approach based on working with communities that are willing to participate in the siting process. This was originally a recommendation from the Committee on Radioactive Waste Management (CoRWM) (Recommendation no 10)[21] and which was accepted by Government and reflected in the 2008 *Managing Radioactive Waste Safely* White Paper.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 5.4:

A GDF should be monitored and an 'emergency plan' developed for implementation in the event that the facility does not behave as expected

Reply: The GDF will be monitored during the operational waste emplacement phase and checks undertaken to confirm that the various barriers are behaving as expected. The final closure step will only be taken following further confirmatory checks and presentation of a final safety case. The final closure step will only be undertaken when the independent regulators are satisfied with the safety case. Further information on the development of the safety case and the permissioning stages defined by the independent regulators is published in the report Guidance on Requirements for Authorisation[22].

The GDF design and safety case will be made on the basis that human intervention and monitoring will not be required to maintain safety after the decision has been made to close and seal the facility. RWM would not progress to the closure stage if there was any doubt about the facility's long-term safety. RWM recognises however that there may be some eventualities which call for the recovery of wastes that have been emplaced underground and sets out its position in its Retrievability Position Statement[23].

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 5.5:

Spent nuclear fuel should not be considered as waste

Reply: The preferred management route for spent nuclear fuel once discharged from a reactor, whether to be reprocessed or declared as waste and consigned for geological disposal, is a matter for the owner of the spent fuel, subject to meeting necessary technical and regulatory requirements. Within the UK, some spent nuclear fuels, notably fuel from the Magnox reactor fleet and some fuel from the Advanced Gas-cooled Reactors (AGR) are managed through reprocessing whilst the remainder of the AGR fuel and fuel from the UK's pressurised water reactor is currently held in storage pending disposal.

The inventory for disposal currently used by RWM as the basis for planning and technical studies is as defined in the 2014 White Paper and assumes that the GDF should be designed to accommodate spent nuclear fuel from AGR and PWR power stations and from new-build nuclear power stations up to 16 GW(e) installed capacity. This is considered to be a conservative approach as it means that safety case studies and future siting will be undertaken on the basis that spent nuclear fuel is included even if as the respondent suggests, spent fuel is not in the event considered as waste.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 5.6:

West Cumbria does not have geology that would be suitable to host a geological disposal facility

Reply: The national geological screening exercise is not intended to answer this question. The process being followed in West Cumbria under the previous *Managing Radioactive Waste Safely* White Paper was terminated before consideration was given to geological suitability. If a community in this area were to come forward in the future, the outputs of the national geological screening exercise would inform the consideration of the potential suitability at that stage.

Some respondents included personal criticism of RWM Chief Geologist Professor Bruce Yardley, suggesting that since moving to RWM he has changed his views to suit RWM's perceived intentions. It would be extremely surprising if Professor Yardley's views had

not evolved, as he moved from being an independent academic with a long-standing interest in radioactive waste disposal and specialist knowledge of the underpinning geology and geochemistry, to being Chief Geologist at RWM. The changes are not the fundamental shifts that are implied, as is clear from a full reading of the transcripts of the meeting with Cumbrian MPs on which these respondents base their remarks. The response also assumes that Professor Yardley will be personally responsible for interpretation of the geological information supplied by the British Geological Survey as a result of the screening exercise. This is not correct. The RWM geologists and safety experts will work together to summarise the geological information in a way that highlights the aspects that are relevant to GDF safety for the main outputs of screening, and the underpinning BGS reports and information sources will be available to those who wish to go into the technical detail.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 5.7:

Do not screen across the whole of England, Wales and Northern Ireland: focus on the areas that may wish or are minded to volunteer, or exclude areas that may be problematic for other reasons e.g. transport

Reply: Geological screening is one of the three initial actions designed to provide additional information before the siting process is formally launched in 2017. The three initial actions are:

- national geological screening
- preparing to work with communities
- developing land-use planning processes

Completion of the initial actions will provide the basis for communities to consider whether they wish to seek further information and engage with RWM as the developer. A key tenet of the voluntarist process is that the developer will be working with communities that are willing to participate in the siting process. It will involve engagement with communities to identify and assess potential sites over a number of years.

The initial action on national geological screening responds to feedback received in reply to the Government's call for evidence issued in 2013[20]. The process set out in the then current White Paper[19] led to consideration of geological suitability only after a community had made a 'decision to participate' and many respondents commented that this was too late and that early engagement on geological suitability would be preferable.

Since the national geological screening initial action is providing information and facilitates engagement between a community and RWM, other issues such as transport or other problematic topics can be dealt with as part of the planned engagement.

Action: No changes are proposed to the national geological screening Guidance to address this point.

RESPONSE THEME 5.8:

The respondent questions the success of an overseas geological disposal project

Reply: There are several geological disposal projects being pursued overseas; some are more mature and further advanced than here in the UK, others are less advanced. Whilst we can learn lessons from overseas projects and gain some confidence in our own proposals these are all individual projects and will be subject to their local constraints and challenges. In the UK we will concentrate on making the case for geological disposal to deal with the UK's inventory of higher activity wastes and within the framework established by the 2014 *Implementing Geological Disposal* White Paper.

Action: No changes are proposed to the national geological screening Guidance to address this point.

4

Conclusion

The national geological screening exercise is one of the three initial actions set down in the 2014 White Paper *Implementing Geological Disposal*. The White Paper requires that RWM in its role as developer of a geological disposal facility carry out a national geological screening exercise based on the safety requirements identified from published disposal safety case studies.

Guidance setting out how national scale geological information will be assembled and presented was developed in the early part of 2015 and issued for public consultation during the period 8 September to 4 December 2015.

RWM has reviewed the feedback received and in light of this the national geological screening Guidance has been refined. In response to the key question regarding the appropriateness of the proposed approach a clear majority of respondents were supportive. Many comments were provided, which have enabled the Guidance to be refined, and have provided insights to the range of wider questions that stakeholders have regarding the implementation of geological disposal.

The revised Guidance together with the detailed technical instructions and protocols defining how the Guidance is to be implemented has been reviewed by the Independent Review Panel and approved by RWM.

The approved Guidance, which has been published online, forms the basis for the second part of the screening exercise which is application of the Guidance and production of the national scale information.

It is expected that the outputs from the national geological screening will be available to support discussions with interested communities when the siting process begins in 2017.

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Appendix

The following table gives a breakdown of the number of responses that are covered by each response theme. Individual responses are available from the RWM website: they are anonymised, but ordered by stakeholder group.

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?

Identifier	Response Theme	Number of contributors
1.1	Provide a more detailed description of the safety requirements and how the geological attributes help to meet them. Some attributes will be more important than others and consideration should be given to provision of an explicit hierarchy. The linkages between Tables 1 and 2 should be explained.	10
1.2	Provide the rationale that supports the three specified generic geological environments as being suitable to host a geological disposal facility	2
1.3	Explain how an engineered barrier system and geological environment work together so that it is the "disposal system" as a whole that provides safety	5
1.4	The Guidance is too technical for a lay audience. The Guidance is not detailed enough for a community to know about their region	4
1.5	It is not clear what will be ruled out. Should there be specific 'screening out' attributes?	6
1.6	Consider trialling the narratives and maps before publication. One suggestion is to undertake a dry-run using data from an area that would otherwise not be included in the national geological screening outputs	3
1.7	Topics associated with groundwater flow and hydraulic gradients	5
1.8	Topics associated with climate change	8
1.9	Topics associated with catastrophic events (tsunamis, tidal surges, meteorite impact and earthquakes)	8
1.10	Should aquifers be considered as a resource?	2

Question 1 continued

Identifier	Response Theme	Number of contributors
1.11	Should microbes be considered?	1
1.12	Provide information on whether a GDF could be sited in regions where fracking (or other resource exploitation) is being considered	8
1.13	Discuss the heat dissipation capacity of different rock types with respect to their suitability as host rocks	1
1.14	When developing the detailed technical instructions give consideration to these detailed (but important) points: permeability will vary with depth (likely to be higher close to the surface), minimum thickness of potential host rock, definition of "major" when applied to faults and fractures	1
1.15	We should make our detailed criteria publicly available	4
1.16	Standardised terminology / definitions should be used to avoid future misinterpretation	1
1.17	Emphasise that attributes can be positive or negative: those in Table 2 give the impression of being negative	1
1.18	Detailed suggestions for improvements to text addressing description of geological columns, role of deep brines, reference to BGS offshore maps and reports, role of attributes may vary depending upon concept selected, description of human intrusion, role of mineralogy and description of evaporite	9

Question 2 – The proposed sources of information are summarised below. To what extent do you think that these sources are appropriate and sufficient for this exercise?

Identifier	Response Theme	Number of contributors
2.1	Topics associated with the limitations of existing information and gaps	7
2.2	Explain why reference is not made to work done previously on site selection in the 1980s and 1990s	3
2.3	Explain why reference is not made to the detailed site characterisation work undertaken by Nirex in West Cumbria	5
2.4	Explain why we are not using more detailed information sources where they are available	7
2.5	Explain why we are not using peer reviewed academic journal articles (British Geological Survey maps may not be up to date; there is more recent information and analysis in journals)	3

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?

Identifier	Response Theme	Number of contributors
3.1	Emphasising that different stakeholders will require access to differing levels of information and detail	25
3.2	Feedback associated with the form of the proposed maps	12
3.3	Suggested additions to the proposed regional narratives and maps	9
3.4	Feedback emphasising the need for the outputs to be clear on uncertainties in the data and requesting information be provided on the extent to which further preliminary investigations are likely to be necessary to address uncertainties	12
3.5	Recommendations that other media/tools be used to communicate the regional-scale information	14

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

Identifier	Response Theme	Number of contributors
4.1	Describe who RWM is and provide support to the statement that RWM is the expert in geological disposal. Is RWM the best organisation to develop the safety narratives?	2
4.2	Explain the role of the regulators	3
4.3	Provide more information on the role of the British Geological Survey and their credibility to support this process	7
4.4	Feedback on the role of the Independent Review Panel	9
4.5	Further information is requested on how the national geological screening Guidance will be applied and how this fits within the overall context of the national geological screening initial action	5
4.6	Provide information on the other initial actions, explain timescales and next steps	13
4.7	Provide context information on what is a GDF, why we need one and why this is preferable to alternatives like deep borehole disposal	7
4.8	Provide context information on radiological protection and on the environmental impact of radioactivity and GDF in general. Explain how a GDF is designed to provide protection in the short term and long term	9

Question 4 continued

Identifier	Response Theme	Number of contributors
4.9	Provide information on other key issues including: transportation of waste, management of heat generating wastes, disposal of plutonium, build-up of gases, sealed containers to ensure water cannot enter, and human intrusion	6
4.10	Explain what other infrastructure would be required to support a GDF	2
4.11	Provide information on inventory of waste for disposal (type of waste being considered in terms of radionuclide content and levels of activity) and clarity on new build compared with legacy waste (volume, radioactivity, heat generation)	5
4.12	Explain how long the waste packaging itself would last	1
4.13	Provide information from overseas regarding package longevity and disposal facilities	2
4.14	Explain how a GDF may differ in higher strength rock, lower strength sedimentary rock and evaporite in terms of its form, engineering and cost. Explain how excavated rock spoil will be managed	5
4.15	Provide information on the history of previous site selection in the UK and why it was not successful	2
4.16	Add explicit reference to using international experience relevant to the siting of a GDF	4
4.17	Need to implement the Guidance and subsequent stages in a way that promotes trust in the process. Openness and transparency, provision of information and being clear about uncertainties will be key	8
4.18	Too little publicity around the public meetings and consultation	2

Issues raised that were outside the scope of this consultation

Identifier	Response Theme	Number of contributors
5.1	Respondent questions the justification for geological disposal for higher activity radioactive waste	8
5.2	Respondent questions construction of new nuclear generating capacity	4
5.3	Screening should seek areas with the best geological barriers	4

Issues raised that were outside the scope of this consultation continued

Identifier	Response Theme	Number of contributors
5.4	A GDF should be monitored and an 'emergency plan' developed for implementation in the event that the facility does not behave as expected	4
5.5	Spent nuclear fuel should not be considered as waste	1
5.6	West Cumbria does not have geology that would be suitable to host a geological disposal facility	3
5.7	Do not screen across the whole of England, Wales and Northern Ireland: focus on the areas that may wish or are minded to volunteer, or exclude areas that may be problematic for other reasons e.g. transport	2
5.8	The respondent questions the success of an overseas geological disposal project	1

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