

Annex 1. Submission from Bruce McKirdy, NDA

Summary

1 The geology of West Cumbria is potentially suitable for hosting a geological disposal facility. The
2 British Geological Survey's study¹ of West Cumbria's geology ruled out about 25% of the area as
3 having unsuitable geology, the remaining 75% includes rock types similar to those being
4 investigated in other countries for hosting a geological disposal facility. Therefore, further
5 investigation of the geology of West Cumbria is justified.

6 The suitability of a particular geological environment for hosting a geological disposal facility is
7 established by the development of a safety case which needs to satisfy the independent nuclear
8 regulators, how the engineered² and natural geological barriers work together to isolate and
9 contain radioactivity. Therefore the suitability of a particular geological setting needs to be
10 assessed in the context of a specific waste inventory and engineered barrier design. Safety
11 cases developed internationally demonstrate that a combination of engineered and natural
12 barriers can provide safe geological disposal in a range of different rock types. NDA has
13 reviewed the applicability of these safety cases to the range of UK wastes and geological
14 environments. This review showed that there is a range of repository concepts which could be
15 adapted to enable safe and secure geological disposal of UK wastes in a number of different
16 geological settings.

17 There is a wide range of techniques available to support development of an understanding of
18 geological environments such as those present in West Cumbria. In particular, there have been
19 a number of significant advances in both characterisation and modelling techniques since the
20 1990s investigations in the area. Thus we are confident that we could understand a site in West
21 Cumbria in sufficient detail and with enough certainty to be able to assess the effectiveness of its
22 natural isolation and containment characteristics as a contribution to the overall safety of a
23 geological disposal facility.

What types of geology are considered suitable to house a GDF

24 There is a range of geological environments that are suitable for hosting a GDF. The test of
25 suitability of a particular geological environment for geological disposal is that the safety case
26 demonstrates, to the satisfaction of the independent nuclear regulators, that the engineered
27 barriers will work together and in combination with the natural barrier afforded by the geological
28 environment to prevent radionuclides being released to the surface environment in amounts that
29 could cause harm to life and the environment.

30 While safety is a national responsibility, the International Atomic Energy Agency sets safety
31 requirements and gives guidance on geological disposal. It sets a requirement for a multi-barrier
32 system in which the various engineered and natural barriers contribute to the two principal
33 objectives with respect to providing safety - the isolation of the wastes and the containment of the
34 radionuclides associated with the wastes.

35 The guidance explains that multiple safety functions enhance both safety and confidence in
36 safety. The presence of multiple safety functions provides assurance that even if one safety
37 function does not perform fully as expected (e.g. owing to an unforeseen process or an unlikely
38 event), other safety functions will ensure that the overall performance of the disposal system as a
39 whole is not jeopardized. The guidance recognises the role of the geological barrier in
40 contributing to containment by protecting the engineered

¹http://mrws.decc.gov.uk/en/mrws/cms/disposal/site_selection/initial_screen/west_cumbria/west_cumbria.aspx

² The "engineered barriers" include the fuel or waste material itself, waste encapsulation materials such as glass or cement, the waste container, and protective materials placed around the container within the disposal facility.

41 barriers and preventing water ingress and also in isolating the radionuclides for the long term. It
42 states that:

43 *‘A promising site should display evidence of favourable natural containment and isolation*
44 *characteristics for the waste types under consideration and should provide indications*
45 *that all necessary engineered barriers to prevent or retard the movement of radionuclides*
46 *from the disposal system to the accessible environment can be implemented. This*
47 *evidence needs to be tested in subsequent detailed site investigation, characterization*
48 *and associated safety assessment modelling’.*

49 It also gives some general characteristics of suitable geological environments. These include
50 mechanical strength suitable for safe construction, operation and closure and stability so that
51 safety is preserved during future evolution. The geological environment should restrict
52 groundwater movement to the facility and result in sufficiently long travel times that reduce their
53 concentration at the surface.

54 As it is necessary to consider the engineered system and the geological environment together in
55 order to assess safety, an appreciation of the types of geological environment which might be
56 suitable can be obtained from safety cases for geological disposal prepared by overseas
57 agencies. These safety cases consider the pathways by which radioactivity could be released to
58 the surface environment, including transport in groundwater or as gases, and demonstrate that a
59 combination of engineered and natural barriers can provide safe geological disposal in a range of
60 different geological settings.

61 Sweden and Finland have developed safety cases for disposal of spent fuel in higher strength
62 rocks such as granite. France and Switzerland have developed safety cases for disposal of a
63 range of different radioactive wastes in lower strength sedimentary rocks such as clays or
64 mudstones. The USA is already operating a geological disposal facility for intermediate-level
65 waste in an evaporite environment (salt). The combination of engineered barriers and layout of
66 the facility selected by these countries has been tailored to meet the requirements of the
67 particular geological environment. For example, in Sweden groundwater return times are
68 relatively short and the highly-engineered barrier system for spent nuclear fuel comprising a
69 thick-walled copper canister surrounded by a bentonite buffer makes a strong contribution to the
70 containment of radionuclides. The rock provides protection of these barriers. In France, where
71 the natural groundwater movement through the clay rocks is significantly slower and groundwater
72 return times are far greater, the requirements on the container are less stringent as the natural
73 barrier provides a much greater contribution to the long-term containment of radionuclides. In the
74 safety case developed in the UK in the 1990s³, the geological barrier provided by the Borrowdale
75 Volcanic group overlain by St Bees sandstone contributed significantly to safety by providing a
76 long travel time somewhere between that expected in Sweden and France.

77 NDA has reviewed the applicability of these safety cases to the range of UK wastes and
78 geological environments. This review showed that there is a range of geological disposal
79 concepts which could potentially be adapted to enable safe and secure geological disposal of UK
80 wastes in a number of different geological settings. However, a definite answer on suitability of a
81 particular location can only be given once the combination of engineered barriers and the
82 surrounding geological environment have been considered together.

What is known about the geology of West Cumbria and its suitability to house a GDF?

83 The British Geological Survey’s study of West Cumbria’s geology ruled out about 25% of the
84 area as having unsuitable geology, leaving rock underlying 75% (1,890km²) as potentially

³ Nirex 97: An Assessment of the Post-closure Performance of a Deep Waste Repository at Sellafield (5 Volumes),
Nirex Science Report S/97/012, 1997

85 suitable. We know the main rock types in the remaining area include rock types similar to those
86 being investigated in other countries for hosting a geological disposal facility.

87 There is a large amount of information available for the area close to the Sellafield site which was
88 studied extensively during investigations in the 1990s. In total, 29 deep boreholes were drilled.
89 The majority of those focussed on the area of about 5 sq km identified for the proposed
90 underground facility. Most lengths
91 of the boreholes were drilled to obtain a core. Additional data were obtained by running wireline
92 geophysical logs, in which devices are lowered down the boreholes to provide a continuous
93 measurement of a variety of physical parameters of the rock. Some devices were used to provide
94 an image of the borehole walls to supplement the information on the fractures in the rock which
95 was obtained from examination of the cores.

96 Testing was carried out in the boreholes both during and after drilling to determine parameters
97 such as groundwater pressures and hydraulic conductivity which affect the pattern and rate of
98 groundwater flow through the rock. Groundwater samples were taken and analysed to provide
99 data on the age, source and history of the groundwater.

100 It has been claimed that the Public Inquiry into the Rock Characterisation Facility (RCF) has
101 already ruled out West Cumbria (or even Longlands Farm) on grounds of geology. This is
102 incorrect. The Inquiry does not rule out West Cumbria or even Longlands Farm. The Secretary
103 of State's reasons for refusal of the Nirex Planning application were the conventional
104 environmental impacts of the RCF, such as its impact on visual amenity and protected species.
105 He listed two other areas as areas of concern which would also have justified refusal of the
106 appeal:

- 107 • Scientific uncertainties and technical deficiencies in the proposals presented by Nirex
108 - the application was premature;
- 109 • The process of the selection of the site and the broader issue of scope and adequacy
110 of the environmental statement – the process was not transparent.

111 In his report of the Inquiry, the inspector did state that, in his judgement, the site was not suitable;
112 however, he did acknowledge that the assessment did not completely rule it out. Furthermore,
113 he based this conclusion on an early evaluation of the site which used as input data, only
114 information collected up to July 1993, about 25% of the final total, was available for analysis. A
115 further assessment called Nirex 97 which was subjected to external review⁴ considered a much
116 more substantial set of field data and research results and also included a number of significant
117 modelling innovations, particularly in the modelling of the hydrogeological regime.

118 The safety of a GDF needs to be assessed by the appropriate nuclear regulators, rather than a
119 planning inspector, and the current regulatory regime ensures that this vital step would form a
120 key part of planning a geological disposal facility. Since 1997, improvements have been made in
121 the regulatory regime for implementing geological disposal which now requires early engagement
122 with regulators and a permit to be granted before borehole investigations can be undertaken.
123 Even if this region of West Cumbria were to volunteer within the current process, the earlier
124 information would need to be reviewed to consider the current waste inventory and engineered
125 designs

126 For the rest of the region, insufficient geological information is available to make an informed
127 decision on whether any sub-area is suitable to host a GDF. More work would be needed to
128 gather and assess geological and related information in order to assess potential suitability of
129 different sub-areas.

⁴ Peer Review Report of Nirex 97. QuantiSci March 1998.

3. What further tests could be carried out, and to what extent is further investigation into West Cumbrian geology justified?

130 There is a wide range of techniques that could be used to increase understanding of the geology
131 of West Cumbria and so demonstrate whether a particular location would be suitable for hosting
132 a geological disposal facility.

133 Air and land-based non-intrusive techniques; including mapping, satellite imagery, aerial
134 photography and airborne and land-based geophysical surveying, would give general information
135 about the main rock volumes in the area under investigation. This would give new information
136 about the area and would provide valuable input to help target borehole investigations on those
137 regions that were most promising. Drilling of deep boreholes and the subsequent testing of the
138 rock and groundwater from inside the borehole or the testing of samples of rock and groundwater
139 removed from the borehole, would provide detailed information about the local geology and
140 hydrogeology and provide the opportunity to study samples of rock and groundwater from
141 specific sites under consideration.

142 The footprint of a GDF would be in the region of 5-20 km², depending on the particular inventory
143 and design, less than 1% of the 1890 km² remaining after the BGS screening.

144 There have been a number of important advances in techniques for measuring and interpreting
145 geological information since the 1990s⁵. The most relevant advances are:

- 146 • Improved 3-dimensional seismic surveying;
- 147 • Advances in 3-dimensional computer modelling;
- 148 • Improved understanding of the role of geology in containing radionuclides.

149 These developments would allow a more reliable understanding to be established of the potential
150 for transport of any radionuclides released from the engineered barriers of any disposal facility.
151 Coupled with 3-D information about a site, modern 3-D groundwater flow models can be used to
152 analyse both the present day flow system and the effects of possible future changes in driving
153 forces on important aspects of that system, such as flow rates and the locations of discharges at
154 the surface. They have been used recently to support the investigations of sites in fractured rock
155 in Sweden and Finland. Both these countries have developed site-specific safety cases to
156 support licence applications to construct disposal facilities in their countries.

157 We recognise that the geology of West Cumbria is relatively complex and therefore it could take
158 longer and cost more to characterise than a site in a simpler geological setting. On the basis of
159 the techniques described above, and the information available from characterisation studies for
160 other industries such as oil and gas exploration, tools and techniques are available that will
161 enable us to achieve the required level of understanding. Thus we are confident that we could
162 understand a site in West Cumbria in sufficient detail and with enough certainty to be able to
163 assess its natural isolation and containment characteristics as a contribution to the overall safety
164 of a facility. We therefore believe that further investigation into the geology of West Cumbria is
165 justified.

5 Further Information on Geology for West Cumbria MRWS Partnership, Nuclear Decommissioning Authority
Technical Note, 2011

Annex 2: Submission from Professor Bruce Yardley, University of Leeds

Preliminary Observations

Preamble

1 I am a geologist and geochemist by training and have been Professor of Metamorphic
2 Geochemistry in the University of Leeds since 1995. My research concerns fluids in the Earth's
3 crust in the widest possible terms, and in addition to purely academic work I have published on
4 the formation of ore deposits by fluid flow and on fluids in sedimentary basins. Studies of fluids
5 do not always fit into the classical divisions of geology, and in order to encourage science that
6 crosses traditional boundaries I was one of 3 founding editors of the international journal
7 *Geofluids*, first published by Blackwells in 2001.

8 My only direct involvement in work on radioactive waste disposal in Cumbria was a small project
9 carried out for BGS about 20 years ago, to investigate the conditions under which late-stage
10 mineral veins formed in a variety of rock types. However as Science Secretary of the Geological
11 Society of London during the CoRWM process, I was responsible for putting together a meeting
12 dealing with geological disposal of radioactive waste, held in January 2006. This meeting was
13 organised in part as a response to the lack of geological expertise in the CoRWM panel and
14 involved members of the panel as well as a wide range of geoscientists. Subsequently I
15 convened a second meeting in October 2008, which aimed to explain how geoscientists are able
16 to make predictions about the nature of the subsurface. Information and contributions from both
17 meetings are available on the web site of the Geological Society of London.

18 As someone who lives downwind from the Sellafield site, I am dismayed that so few people seem
19 to realise that the Radioactive Waste currently housed in Cumbria has far more potential to
20 release dangerous levels of radioactivity into the environment now than it will have in the future if
21 put into a deep repository, both because it is at the surface, and because radioactivity in waste
22 decays away rapidly.

23 To illustrate that last point, imagine that a tray containing 640 red ping pong balls is placed on the
24 table at the beginning of a 1 hour meeting. The balls behave like atoms of radioactive isotopes:
25 they can spontaneously turn green, and do so with a half life of 10 minutes. This means that, if all
26 the balls in the tray are red at the outset, then just 10 minutes in, 320 will be green. After 20
27 minutes have elapsed, just a quarter of the balls are still red, after half an hour there are only 80,
28 and so on, until at the end of the hour only 10 red balls remain. During the first few minutes there
29 is a ball changing colour every second whereas in the final ten minutes the average rate at which
30 the balls change colour is just one every minute. Radioactive waste loses its radioactivity in a
31 similar way, but with an effective half life of a few hundred years. This means that the amount of
32 radioactivity in the waste now is far greater than what will be left in a thousand year's time, let
33 alone in tens of thousands of year's time. We are living in the time period that corresponds to the
34 first few minutes of the hypothetical meeting, but much of our discussion is about the risk posed
35 by the "radioactivity" that is left after the meeting has ended.

Release of Radioactivity from Waste

36 Very few of the elements of concern have a significant solubility in freshwater under natural
37 conditions. The principal exceptions are isotopes of Caesium and Strontium, but fortunately these
38 have short half lives of around 30 years, so are very unlikely to be present to any appreciable
39 degree by the time the engineered barriers to a repository begin to fail and let in water.
40 Catastrophic exposure of radioactive waste to large quantities of surface water in contact with the
41 atmosphere could result in significant mobility of radionuclides, and this is why it is important to
42 store the wastes in a deep repository. The highest natural dissolved U concentrations known are
43 from remnants of the fluids that formed natural Uranium ore deposits. These contain a few parts

44 per million by weight of Uranium, but these fluids were very unusual, hot, oxidised brines. Even
 45 hot surface fluids today contain at most only a few tens of parts per billion of Uranium in solution
 46 (seawater has 3 ppb). It is possible to make Uranium more soluble by adding the right cocktail of
 47 chemicals to a fluid, but as long as the waste and the engineered barriers do not contain these
 48 chemicals, water that has passed through a leaky repository will still only leach Uranium very
 49 slowly and ineffectually. It has been claimed by Haszeldine that the groundwaters that will
 50 eventually reach the waste will be oxidising, and therefore have a high potential to dissolve
 51 Uranium. This claim is not based on any verified evidence of which I am aware, and in my view it
 52 is wrong on at least 3 counts.

The suitability of the Geology of Cumbria for hosting a radioactive waste repository:

53 The design of a radioactive waste repository is intended to prevent leakage of radioactive
 54 materials back to the surface. This is most likely to happen if groundwater flows through the
 55 waste, dissolves radioactive elements and then returns to the surface. While engineered barriers
 56 (notably the use of clay) can reasonably be expected to prevent this happening for a period of
 57 many hundreds of years at least, during which much of the radioactivity will decay away, the
 58 wider geological setting should also be one that provides little opportunity for groundwater flow.
 59 There is wide agreement that the ideal repository site will be in rocks with low permeability (which
 60 is a measure of how easily water flows through rock) and in a place with a low hydraulic gradient
 61 (which provides the push that causes water to flow). There are a range of ideal types of geology
 62 that have been recognised and categorised, but it is important not to lose sight of the purpose of
 63 the geological requirements and follow the classification blindly. The existence of nearby
 64 mountains means that nowhere in west Cumbria is likely to meet the ideal requirement of a zero
 65 hydraulic gradient; deep groundwater will tend to flow away from the mountains. On the other
 66 hand, how much flow occurs and how it is focussed must be understood for a specific site before
 67 it will be clear whether this is a serious issue. This leads to the other key requirement which is
 68 that the repository should be sited in impermeable rocks through which there can be very little
 69 water flow, even where a driving force is present. The two main alternatives for this are
 70 crystalline (igneous and metamorphic rocks), and clay formations. In general terms, it is clear that
 71 there are low permeability crystalline rocks in Cumbria that could host a repository. When you
 72 walk through mine tunnels in the types of "basement" rocks present at depth in west Cumbria, it
 73 is obvious that water does not flow through them uniformly. There are long stretches where the
 74 roof and walls are quite dry, then short stretches where the rocks are fractured and water may
 75 flow in quite extensively. A single sample measured in the laboratory will have a very low
 76 permeability, but the permeability measured between boreholes over hundreds of metres is a lot
 77 higher because it will include some of the fracture zones where the flow is concentrated.

78 Establishing whether there are large enough blocks of impermeable basement rocks between
 79 major fractures to site a repository requires detailed geological investigation, and there has been
 80 progress in this for the Sellafield site, but only after the failure of the Nirex appeal.

81 Considering the importance of understanding fluid flow in the subsurface, it seems remarkable to
 82 me that better information was not available at the time of the Nirex appeal. A study by
 83 McKeown, Haszeldine and colleagues, funded by Greenpeace, was cited and has since been
 84 published in two peer reviewed articles. This was a preliminary study, made using simple
 85 software that was designed to investigate large scale flow in oilfields. It is no way comparable to
 86 the type of study that would be considered acceptable by industry today. Geological divisions
 87 were made at a very general level and the effect of smaller units of contrasting permeability was
 88 not considered. The study was perfectly reasonable to make the point that the funders of the
 89 project wanted to make, namely that there was a chance that there could be significant issues of
 90 groundwater flow through the site, based on the data available, but it was not a definitive study
 91 and if more detailed information had been available some of the assumptions made would have
 92 had to be changed. In the final stages of the Nirex programme, they completed their own
 93 investigation of flow in fractured basement rocks, published in reports and as a peer reviewed
 94 paper in 2003. This study provided large amounts of information that was not available to

95 Haszeldine and confirmed that many of the assumptions made in the earlier work were not
96 reasonable. This study has been selectively quoted by Haszeldine, but contrary to the impression
97 that has been given, it indicates that the flow system is more suitable for the construction of a
98 safe repository than was previously thought. A specific geological concern is the presence of
99 many geological faults in west Cumbria. There will continue to be minor earthquakes in west
100 Cumbria and other parts of the UK, almost exclusively involving very small movements on pre-
101 existing faults. There is no reason to suppose that earthquake faulting would cause damage to
102 the integrity of a repository even if it intersected it, because the waste containers should be
103 surrounded by extensive clay barriers which would flex without breaking or transmitting stresses
104 to the drums themselves. In the past 15 years or so, our understanding of faults and their effect
105 on fluid flow patterns has come on enormously, because of the need to extract hydrocarbons
106 from faulted reservoirs as efficiently as possible. There is now the technology and software
107 available to construct detailed block diagrams of faulted regions of sedimentary basins and
108 predict where fluid will flow across faults and where it will be retarded. Comparable detailed
109 diagrams are prepared for basement rocks as part of major mining operations.

Final Remarks:

110 The geology of west Cumbria does not correspond exactly to any of the ideal models for
111 radioactive waste repositories. It is likely that better sites from a geological standpoint could be
112 found in the east of England. The immediate risk posed by waste stored at the surface is
113 however so great that geological concerns cannot be the only ones to take into consideration.
114 There is a need for urgency; for example the perceived risks from terrorist attack or from
115 economic collapse are probably greater now than they were at the time of the Nirex appeal.
116 Rejecting the work of the past 10 years leading to the White Paper and MRWS approach should
117 not be an option. Many of the geological arguments against the possibility of a safe repository
118 site in west Cumbria are unsupported by published scientific evidence or detailed explanation
119 and have not been subject to peer review.

120 There is in my view a good possibility that a suitable repository site will be found in west
121 Cumbria, although this is certainly not guaranteed.

Leeds, January 2nd 2013

Annex 3: Submission from Professor Stuart Haszeldine, University of Edinburgh

Investigations to site a radioactive waste repository in Cumbria: Evidence against proceeding to MRWS Stage 4

- 1 **1) Buildup to present position:** the UK has been generating waste from electrical power
2 production since 1956. Attempts to find a permanent disposal site was started during the 1970s,
3 continued in the 1980s with extensive surveys and 1990's with drilling in West Cumbria, and
4 recommenced in 2010-12 with MRWS (1). The West Cumbria MRWS has attempted to find
5 constructive consensus between all parties. Many important issues have been identified, but
6 none have been fully solved. The total waste volumes are not large, according to NDA these are
7 477,000 m³, i.e. 4,100 London buses or five Albert Halls. However the containment of
8 radioactivity into the next 10,000 years, and for a further 1 million years beyond that is a unique
9 challenge of extreme difficulty. In October 2012 a small subgroup of each council were expected
10 to enact their powers as DMB (decision making bodies), in deciding to move forwards into
11 MRWS stage 4. This gives permission to undertake much more detailed desk study, potentially
12 combined with investigations of geology at the surface. That decision has been delayed until 30
13 January 2013. An increasing number and diversity of objections from the public and from
14 stakeholders have emerged.
- 15 **2) Need for waste disposal site and MRWS criteria to proceed:** the UK was the first adopter
16 of nuclear power for civil purposes. For a variety of historical reasons the UK radioactive waste
17 legacy comprises difficult material which is complex, of mixed origin and chemistry, and is in
18 various stages of containment and packaging. The UK has a long-standing need to identify and
19 construct an adequately performing, cost-effective, and politically feasible option for disposal of
20 radioactive wastes from electricity production. With cost estimates £12-30 Bn, this is clearly a
21 national UK project. Volunteerism is not currently working as anticipated. The present volunteers
22 place all the MRWS eggs in one basket, and are vulnerable to shared-failure from political,
23 social, or technical reasons. The MRWS criterion 2b to proceed is "Are sufficient areas remaining
24 to make further progress worthwhile?" The NDA are persistently vague on site identification (2
25 p6) and have no criteria for failure in identifying sites. The MRWS geologist argues that a number
26 of sites require to be defined in west Cumbria, with selection criteria, before proceeding (3, p14).
27 Because substantial geological information already exists in west Cumbria a lot of this desk-study
28 was undertaken for the Nirex Inquiry (2 p26, 27), and has recently been reviewed (6, 7, 8), failing
29 to find a secure site. In other European countries the search for radioactive waste disposal sites
30 has been led by a national appraisal of geological suitability, followed by many years, even
31 decades, of dialogue and trust building between developers and communities. This has
32 maintained multiple siting options throughout many years, leading to successful repository
33 identification in Finland (spent fuel), Hungary (3) (ILW), France (HLW) and Sweden (spent fuel).
34 The UK must create and maintain multiple diverse options, because Nirex experience in 1995-97
35 at start MRWS-6, shows that GDF disposal plans could fall apart again in 2028.
36 **Recommendation:** *UK Government could make much, much, greater efforts to use the existing*
37 *information on national geological suitability, and engage in outline appraisals, of multiple sites*
38 *around the UK. Several GDF candidates should be investigated.*
- 39 **3) Timing of decision on a region or a site:** even if Cumbria decides to press ahead with
40 MRWS investigations, the time to undertake appraisals, including an underground rock laboratory
41 for in-situ investigations, will mean that the first wastes are not emplaced until at least 2040,
42 potentially 2070. With these timescales, the containment and secure storage of existing waste at
43 or near the surface is much more important than rushing towards choosing a single region for
44 long-term disposal. It is not clear that there is a compelling technical reason for 2013 to be a
45 make or break year, although there are coincidences of timing for bidders on new-build nuclear to

46 be given assurances on a route to long-term disposal.

47 **Recommendation:** *more attention is needed to temporary storage for the next 100 years*

48 **4) Principles of waste disposal:** the principles of geological burial for waste disposal have an
49 international consensus. This is that firstly waste should be conditioned and packaged in a
50 surface factory setting, secondly that waste should be emplaced deep below ground within a
51 engineered near field containment system often comprising steel or copper canisters and
52 bentonite clay, thirdly that the surrounding and overlying geology should form an essential
53 failsafe positive contribution to short-term and long-term site performance. All other European
54 nations developing a GDF can make strong evidence-based claims that the geology is positively
55 helpful. In Cumbria some proponents state that engineering can solve all geological problems
56 (i.e. that a GDF could be constructed anywhere below ground) and other proponents state that
57 Cumbria provides minimal assistance with site performance.

58 **Recommendation:** *The UK should follow international practice to seek GDF sites where the*
59 *surrounding geology can make a positive contribution to containment.*

60 **5) Linking of GDF and other nuclear projects:** the present debate is complicated by the
61 increased inventory of waste to be disposed of. This includes, for the first time, UK HLW, spent
62 fuel, and plutonium; in addition a successful GDF would be expected to host all waste from future
63 nuclear-power electricity in the UK. The characteristics of these future wastes are unknown in
64 detail because rival bidders (EDF with PWR reactors, or GE Hitachi with Gen IV PRISM reactors)
65 will produce radically different waste streams. In general terms, there is expected to be much
66 less ILW, and the HLW is expected to contain much greater short-term radioactivity and to be
67 much hotter temperature. This hotter temperature is likely to greatly complicate the groundwater
68 circulation in West Cumbria geology (see 7.8 below). Neither EDF nor Hitachi have purchased
69 options to site new nuclear plant adjacent to Sellafield. Therefore there is no direct coupling
70 between a GDF and a local nuclear new build.

71 As an additional variable, the offer from GEH is for a reactor type which can consume plutonium,
72 and convert this to non-weapons grade. If successful, a modification to the reactor design can be
73 reconfigured to burn plutonium as a fuel, completely eliminating the need for its disposal (4). In
74 principle, this is extremely attractive - but as yet unproven at commercial scale. This factor
75 means that a decision to build a new MOX plant at Sellafield could be premature, as the benefits
76 of using a small percentage of plutonium in EDF reactors would be greatly outweighed by the
77 efficiency of the GEH system. Consequently there is no direct coupling between a GDF and a
78 new MOX plant at Sellafield.

79 **Recommendation:** *the proposition for a GDF should be treated separately from additional*
80 *nuclear facilities, which may well benefit from being sited in West Cumbria.*

81 **6) MRWS process to identify a region into MRWS 4:** MRWS has been a very useful process to
82 commence a constructive dialogue between diverse stakeholders. However this has exposed
83 critical deficiencies in the design of the process.

84 6.1) It is not clear who volunteers, at present this is a small subset of the Councillors, who form a
85 DMB. There is a disconnect between these people and the rest of the Councillors, and between
86 the West Cumbria Parish councils, CALC, and the wider Cumbrian public.

87 6.2) Councillors on MRWS are frequently the same individuals forming the DMB. This is a
88 fundamental conflict of interest, especially where they have spoken for or against proceeding with
89 MRWS. In normal business, conflicted Councillors are excluded from voting.

90 6.3) The waste inventory is open-ended, to include future newbuild wastes. That makes it hard to
91 understand what is being requested, for what timescale of emplacement.

92 6.4) There are no clear metrics of public support. MRWS polling claims public agreement,
93 whereas Parish votes demonstrate the opposite.

94 6.5) The right to withdraw is highly equivocal. The ramping up of lobbying and pressure from
95 elected representatives, NDA, unions, and government during the past three months of 2012
96 since the MRWS vote was delayed shows clearly how difficult withdrawal will become as any
97 region goes deeper into MRWS stages.

98 **Recommendation:** *The terms and conditions for MRWS need to be made clearer and more*
99 *robust. A decision to proceed should not be rushed by external pressures.*

100 **7) Geological factors:** One item which has surfaced within MRWS, is that of geological
101 suitability of West Cumbria to act as a secure GDF. In European investigations, the criteria to
102 emerge are that GDF site geology should be : as simple as possible, predictable, slow
103 groundwater flow, helpful geochemistry, capable of releasing gas generated during disposal,
104 resilient to future glaciations, earthquakes and human intrusion. As stated by NDA (2, Sect 3.6-
105 3.10) *“hydrogeological characteristics and setting of the geological environment should tend to*
106 *restrict groundwater flow within the repository”*. MRWS was not able to fully understand the
107 importance that prior geological screening has played in other countries. The MRWS also was
108 not able to investigate the uniquely comprehensive investigations made in West Cumbria for
109 radioactive waste disposal by Nirex in the 1990s. The Nirex proposal failed, after 66 days
110 inquisitorial public inquiry, due to substantial geological obstacles. I contend that these geological
111 obstacles are still present, apply to the entire coastal plain of West Cumbria, and form such a
112 tangible threat to the success of a GDF that Cumbria should be abandoned entirely at this stage,
113 to avoid wasting UK attention, time and money. Some issues have been publicly stated (5, 6, 7),
114 these include and are not limited to:

115 7.1) Nirex comprehensively screened West Cumbria, selecting Longlands Farm as best site
116 7.2) West Cumbria geology is extremely complex – hence rock type is hard to predict.
117 7.3) West Cumbria geology is very fractured – that provides pathways for rapid water flow to
118 leach wastes emplaced in a GDF, and flow into potable aquifers, the sea or the surface.
119 7.4) Borehole investigations by Nirex did not succeed in achieving a predictive understanding of
120 groundwater flow – even between closely spaced boreholes
121 7.5) The topography of west Cumbria with adjacent mountains, means that groundwater flow will
122 be driven deep, and continually, through any GDF.
123 7.6) The outflow of water from a deep GDF will, eventually, be into the Irish Sea. That may be
124 internationally not-legal and needs justification by Strategic Environmental Assessment
125 7.7) The geologically long-term water geochemistry, measured by mineral crystallization, has
126 been oxidizing. The present day water geochemistry measured in boreholes, is also oxidizing.
127 This can dissolve available uranium. All other EU GDF sites have reducing waters of slow flow.
128 7.8) Simulations of groundwater with added heat from HLW and spent fuel (preliminary, by
129 University of Edinburgh, in process of peer-reviewed publication), show that natural circulation
130 flows are greatly enhanced, so GDF water returns rapidly to the surface within only hundreds of
131 years rather than tens, or hundreds, of thousands of years.
132 7.9) Simulations of CO₂ gas generation within a GDF (by Nirex) show that radioactive ¹⁴C waste
133 can return to surface within decades after closure. This fails performance standards.
134 7.10) The new proposals for a GDF to hold hot HLW and fuel (93% of the radioactivity), will
135 require site specific underground rock laboratory experiments. This construction location, access
136 and timescale does not seem to have been identified by MRWS.

137 Additionally, in the interaction of surface and subsurface assessments:
138 7.11) The National Park and environmentally sensitive areas such as SAC, SPA and SSSI are
139 still included in the regional appraisal. This has already led to public concern.
140 7.12) The “exclusion screening” by BGS in 2010 has not excluded known aquifer zones along the
141 Solway coastal plain, and has not excluded west Cumbria coastal geology which another part of
142 DECC has considered licensing for shale gas exploration in 2011. The resource conflicts have
143 not been fully identified.
144 7.13) During the MRWS process, dialogue on the geological difficulties of west Cumbria has
145 resulted in two other rock volumes being identified. Desk-based appraisal by Prof David Smythe
146 has shown that Silloth (8) is geologically implausible. Ennerdale (9) lies fully within the National
147 Park, and may also have very substantial difficulties in its geological appraisal (considered to
148 require a closely-spaced seismic reflection survey grid and access for large equipment to drill to
149 1-2km). Site access to either rock volume during GDF construction could imply extremely

150 numerous truck movements per hour for several decades.

151 **Recommendation:** *west Cumbria shows no promise for a GDF and should be abandoned.*

152 **8) Geological rationalism or historic accumulation?** It is clear that the regional geological
153 position of west Cumbria is not especially favourable. The best that has been said in favour of
154 exploration for a GDF is that “not everything is yet known about west Cumbria”. This is not a
155 good gamble on which to base the UK’s nuclear waste disposal effort. A counter argument made
156 is that “75% of the waste already exists at Sellafield”. Whilst this may be true just now, that does
157 not mean the UK should select a sub-standard permanent site because of the historical accident
158 that waste has accumulated at, and has been sent temporarily to, Sellafield. If nuclear new-build
159 occurs, then much larger amounts of radioactivity are calculated to arise around the UK, and will
160 need to be transported to a disposal site. Surface rail transport is demonstrably safe – the NDA
161 claim 10 million miles of UK rail transport without serious incident since 1962 (10). The present
162 problems are a failure of process, cherry-picking the recommendations of CORWM-1 (12), and
163 also a failure of site choice.

164 **9) Alternative sites.** If west Cumbria is a geologically poor GDF, then do other UK locations
165 exist for deep disposal of radioactive waste? During the 1980s, Nirex commissioned the British
166 Geological Survey to appraise the entire UK for radioactive waste disposal. This led to the
167 identification of generically suitable regions (11) which amounted to about 30% of UK land area.
168 Sellafield was not included. This map is still useful as it points to regions which may be
169 investigated further by interpretation of existing seismic reflection records and by scientific deep
170 drilling. Plausible candidates may be the zone between Cambridge and Norwich, regions around
171 Oldbury, Wylfa, Hartlepool, or inland from Dounreay. Although DECC have undoubtedly made
172 approaches to some regions, it is unclear that a multi-year hearts and minds consensual dialogue
173 envisaged by MRWS and by CORWM-1 has actually been seriously attempted. It is a paradox
174 that some of the most suitable areas may not be able to volunteer themselves into MRWS
175 because they have very few human population.

176 **10) Summary.** *The MRWS process is promising in a search for plausible GDF regions. However*
177 *significant flaws have emerged the way it has been challenged. Philosophically, the search for an*
178 *expensive, unique, and permanent national GDF should be led by the geology, not by local social*
179 *need. West Cumbria has particular geological adversities and complexities, which fall below*
180 *international criteria, and resulted in failure of a GDF proposal in 1997. Persisting with Cumbria,*
181 *and persisting with a single GDF option, courts a very high risk of failure and should be*
182 *abandoned. Multiple GDF options could be pursued immediately with equal vigour. There is no*
183 *necessary connection between future development at Sellafield and a GDF. The UK has wasted*
184 *many decades in fruitless attempts at radioactive waste disposal, and continued serious effort*
185 *must span several government lifetimes.*

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Annex 3: Submission from Professor Stuart Haszeldine, University of Edinburgh

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- 12) CORWM-1 signing off August 2007 [http://corwm.decc.gov.uk/assets/corwm/pre-nov%202007%20doc%20archive/doc%20archive/tier%202%20\(7\)%20-%20implementation/tier%203%20-%20implementation%20advice/2214%203%20-%20signing%20off%20final.pdf](http://corwm.decc.gov.uk/assets/corwm/pre-nov%202007%20doc%20archive/doc%20archive/tier%202%20(7)%20-%20implementation/tier%203%20-%20implementation%20advice/2214%203%20-%20signing%20off%20final.pdf)

Annex 4: Submission from Professor David Smythe, University of Glasgow (emeritus)

Why the current MRWS process should not proceed to Stage 4

1 **Where I stand.** I am grateful for this
2 opportunity to present written evidence to the *ad*
3 *hoc* committee. Due to personal circumstances I
4 was unable to accept the invitation to appear in
5 person.

6 I am a retired academic, whose career spanned
7 firstly, the British Geological Survey (BGS),
8 followed by the University of Glasgow. I believe
9 in the (now outmoded) concept of public service;
10 I have no axe to grind, either over the nuclear
11 industry or West Cumbria; I have no financial or
12 personal interests to declare; I no longer even live
13 in the UK, and am in the process of applying for
14 French nationality; I believe in honest impartial
15 science in the aid of civilised society; I follow
16 current affairs closely, especially from a
17 European perspective.

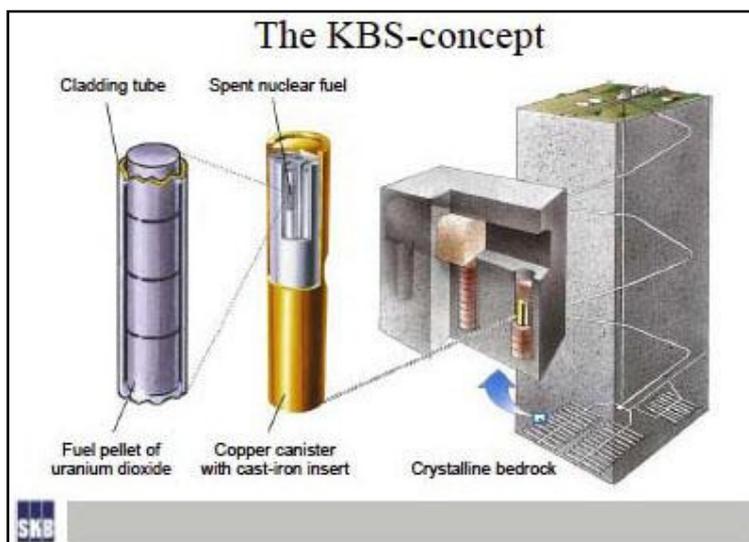
18 I served on the BNFL Geological Review
19 Panel, 1990-91. I proposed and carried out the
20 trial 3D seismic reflection survey at Longlands
21 Farm for Nirex in 1994 (a double world first – the
22 first time that an academic research group had
23 used this then novel method, and the first time
24 that a potential radwaste site had been surveyed
25 in this way). But I was so concerned about
26 Nirex's lack of understanding of the highly
27 complex geology there that I felt obliged to
28 appear against Nirex, as an expert witness for
29 FoE, at the Nirex Planning Inquiry in early 1996.

30 My concerns about radwaste disposal in West
31 Cumbria were revived with the publication of the
32 Defra MRWS White Paper in 2008, to the
33 consultation of which I had submitted a response,
34 pointing out that the 'voluntarist' approach left
35 open a return to consideration of West Cumbria.
36 My fears then have proved to be correct.

37 This submission summarises my views at
38 Stage 3 of the MRWS process. I have tried to
39 complement rather than duplicate the submission
40 of my former Glasgow colleague Professor Stuart
41 Haszeldine, whose views I largely share, and who
42 is appearing before the committee in my place. It
43 is based on many months of (*pro bono*) full-time
44 study and research. My project folder hosts some

45 9000 files, of which some 1600 are pdfs of
46 research papers and the like, and some 1700 of
47 which concern BGS
48 publications, and so on. I have spent over £1K
49 purchasing BGS maps, data, and reports where
50 necessary. Fuller details of my results can be
51 found in my MRWS consultation submission
52 (some 168 pages) and on my [website](#).

53 **Why the geology is crucial.** The final and
54 most important barrier to limit radioactive escape
55 from a repository into the environment is the
56 geology. Engineers may (over-)confidently
57 predict that their 'engineered barrier systems' will
58 succeed, so that the geology of the repository
59 hardly matters, but this is not true. Let us look at
60 the example of the Swedish copper radwaste

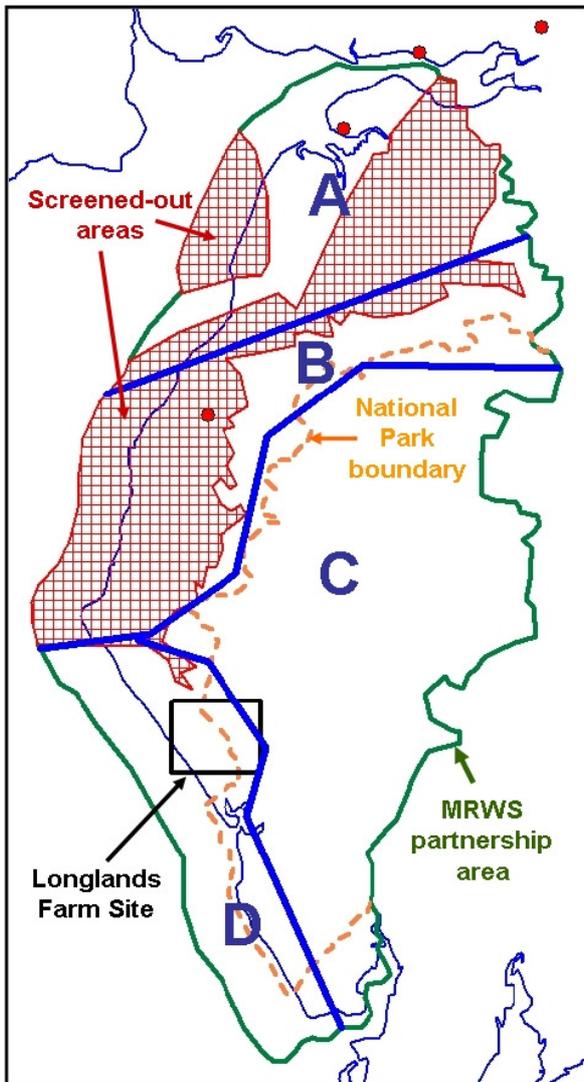


61 canisters, the KBS-3 concept. It comprises:
62 • Fuel placed in isolating copper canisters,
63 • With a high-strength cast iron insert.
64 • Canisters are surrounded by bentonite
65 clay,
66 • In individual holes at 500 m depth,
67 • In granitic bedrock.

68 The NDA has adopted this model for the UK.
69 The Swedes developed this concept in the 1970s,
70 and as late as 1999 were still predicting that the
71 canister would be corrosion-resistant (in the right
72 groundwater conditions) for a million years. But
73 the Swedes also fund an independent NGO office
74 to undertake independent critical research

75 (something lacking in the UK); this office funded
 76 and published a comprehensive study in 2011
 77 showing that there is a previously unknown
 78 leaching mechanism which can eat away all the
 79 copper within a 1000-year timescale. The several
 80 lessons to be learned here are:

- 81 • The UK must fund truly independent critical
- 82 research.
- 83 • The research timescales are decades-long (the
- 84 Swedish experience above being 35 years).
- 85 • Engineers' predictions simply cannot be
- 86 trusted when it comes to geological
- 87 timescales.
- 88 • We have to go with Nature, finding the best
- 89 natural barrier, neither fighting it nor
- 90 choosing sub-optimum geology.



91 **What is suitable geology?** Internationally
 92 agreed fundamental criteria for how to search for
 93 a potential radwaste site all converge on the same

94 broad principles. These include low hydraulic
 95 gradients (so that groundwater flows very
 96 slowly), and simple, predictable geology. Most of
 97 the Partnership area fails both of these tests
 98 immediately.

99 The whole area is very well known
 100 geologically, because the Lake District has been a
 101 classic area of geological study for two centuries.
 102 Contrary to certain views, the £400M of Nirex
 103 studies were not all concentrated within the 50 sq
 104 km Site area (see map), but extended well away,
 105 from Workington to Barrow, inland for 15-20 km,
 106 and west offshore for 50-70 km. Northern
 107 Allerdale, not studied by Nirex is, on the other
 108 hand, well understood from 40 years of oil
 109 exploration.

110 **Area A** comprises the Solway plain north of
 111 the blue line, but most of it has been screened out
 112 by the 2010 BGS exercise for DECC (red
 113 hatching), on the basis of coal and coal-bed
 114 methane resource potential.

115 A site at Anthorn Airfield had been
 116 considered during the BGS/Nirex national site
 117 search in 1988 (the red dots on the map show
 118 sites considered at that time), but was then
 119 rejected on geological grounds. The rock at the
 120 surface in the coastal plain is the Mercia
 121 Mudstone Group (MMG), which had been
 122 considered and rejected by the BGS in 1986. But
 123 Dr Jeremy Dearlove, the MRWS consultant
 124 geologist, stated in 2011 “*I understand from brief*
 125 *discussions with the BGS that the Mercia*
 126 *Mudstones within this area would also form part*
 127 *of the BGS’s “potentially suitable sedimentary*
 128 *formations”.*”

129 So the area appears to be back in play on a no
 130 more sound basis than a coffee-time chat with
 131 anonymous BGS personnel. This is not a rational
 132 way to find a repository host rock. My review of
 133 the ample available data, published by the BGS,
 134 shows that, although the non-excluded area near
 135 Silloth has simple geology, and is far enough
 136 away from the Cumbrian fells for the hydraulic
 137 gradient to be relatively low, the MMG has a
 138 hydraulic conductivity from 10,000 to one million
 139 times too high for it to be considered as a
 140 repository host rock. This is because it is a
 141 siltstone, and a brittle fractured shale, not a
 142 plastic clay host rock, such as has been found by
 143 the Swiss, French and Belgians. Furthermore, the
 144 rock volume where the repository would have to

145 be excavated, between the two screened out areas,
 146 (a) is very shallow, at around 400 m depth, and
 147 (b) is cut through by at least two large faults. The
 148 geochemical groundwater environment is
 149 oxidising, which is the opposite of what we need.
 150 The rock is classed as a ‘Secondary B’ aquifer,
 151 and there are currently active water wells drilled
 152 to more than 100 m depth. It should properly
 153 have been screened out, leaving nowhere in
 154 northern Allerdale for further consideration.

155 One also has to ask, if waste must be shipped
 156 40 km north from Sellafield to Silloth for burial,
 157 why cannot it simply continue on a longer
 158 journey to a suitable geological repository
 159 somewhere in eastern England?

160 **Area B** is a belt of complex limestone and
 161 coal geology fringing the northern and western
 162 flanks of the National Park. Much of it has been
 163 excluded already (iron and coal resource intrusion
 164 risk). The part remaining is highly faulted and
 165 comprises mainly limestone. Lastly, hydraulic
 166 gradients will be high. There is no possibility of
 167 finding a suitable host rock environment here,
 168 and none has ever been suggested.

169 **Area C** comprises the hard crystalline rocks
 170 of the National Park. The extreme relief of 800 m
 171 is sufficient *a priori* to rule it out of
 172 consideration; contrast that with the Swedish and
 173 Finnish repository sites, which both comprise
 174 coastal hard rock, and where the local ground
 175 relief is of the order of 20 m. No other country
 176 has considered placing a repository in such steep
 177 terrain – except the now-defunct Yucca Mountain
 178 site in Nevada, which was selected to be hundreds
 179 of metres *above* the water table, in a desert
 180 environment. Nevertheless, the Eskdale and
 181 Ennerdale granites have both been proposed
 182 (informally) as repository host rocks. Both bodies
 183 have a *millefeuille* pastry, or lasagne-type
 184 structure, in that layers of granite are interleaved
 185 with the slates into which they have intruded.
 186 This is complex and unpredictable. The granites
 187 have also been severely faulted after
 188 solidification.

189 The one area of the granites which appears to
 190 be clear of surface faults is the central part of the
 191 Ennerdale body, comprising Ennerdale Fell.
 192 There has also been mention of direct tunnelling
 193 obliquely from Sellafield – or, more probably,
 194 from Longlands Farm, which the NDA has
 195 inexplicably held on to, 15 years after Nirex lost

196 its planning appeal to site a test repository there.

197 Firstly, it is unlikely that this portion of the
 198 granite is different in structure from the other
 199 parts, so the likely complex structure would have
 200 to be investigated in detail. There is no question
 201 that this would involve extensive heavy
 202 engineering investigations. By analogy with
 203 Longlands Farm (and hard-rock sites abroad), 20-
 204 30 boreholes would be needed for detailed
 205 hydrogeological study over a decade or so (the
 206 2010 Entec environmental report for NDA quotes
 207 20 deep boreholes and 50 shallow boreholes). A
 208 lightweight drilling rig weighs 30 tonnes or more.
 209 This would have to be assembled *in situ* on the
 210 top of the Fell by a mobile crane. All this requires
 211 HGV-capable roadways to be cut first. The only
 212 way to image the subsurface is by a 3D seismic
 213 survey, and in this kind of terrain the only
 214 possible source would be dynamite. I estimate
 215 that around 60,000 holes, each 1 m deep, and
 216 charged with 200 g of gelignite and a detonator,
 217 would be required to image the 25 sq km of the
 218 granite in sufficient detail, together with millions
 219 of pounds-worth of sophisticated ground
 220 recording gear laid out in grids. Secondly, NDA
 221 schematic plans and volumetric calculations show
 222 that three permanent vertical shafts are required
 223 from the surface (i.e. the summit of Ennerdale
 224 Fell) to the repository.

225 All the above demonstrates that Ennerdale
 226 Fell and its surrounds would become an industrial
 227 mining zone, closed to the public for security
 228 reasons, for many decades; this is clearly
 229 incompatible with its status as part of the
 230 National Park. The NDA’s own planning
 231 documents, together with current international
 232 practice, show that it would be quite impossible
 233 to construct a repository purely by tunnelling
 234 obliquely from a surface location like Longlands
 235 Farm.

236 **Area D** comprises the coastal strip of
 237 sediments at the surface, west of the hard rocks of
 238 the Lake District. The hard rocks underlie the
 239 sediments at a few hundred metres depth. Note
 240 that the Partnership area, for the purpose of
 241 geological screening by the BGS, extends 5 km
 242 offshore.

243 The 1988 BGS/Nirex national site search did
 244 not include Longlands Farm, nor any geologically
 245 similar location. The 537 sites selected and sieved
 246 (or screened out) at successive stages included

247 only a ‘Sellafield’, where the target was a
 248 potential anhydrite (salt) layer dipping offshore.
 249 But early drilling proved that the layer was too
 250 deep. ‘Sellafield’ then shifted location (twice) and
 251 category of rock (once), and was only introduced
 252 at a late stage in the national site search. Politics,
 253 and not geology, forced this ‘cuckoo’ site onto
 254 the shortlist, and it was finally chosen over
 255 Dounreay. Longlands Farm was supposed to be in
 256 the ‘basement under sedimentary cover’ (BUSC)
 257 category, but the Inquiry Inspector perceived that
 258 it was not a proper BUSC example. It failed
 259 because the geology is far too complex and
 260 unpredictable.

261 In 2005 Nirex tried to claim that a post-
 262 Inquiry revision of its modelling (a group of
 263 documents known as Nirex 97 and issued in
 264 1997-98) now showed that the Longlands Farm
 265 site exceeds the safety threshold. This is wrong.
 266 My analysis of the modelling used to predict the
 267 water flow shows that the effect of the faults
 268 cutting the rocks has been ignored. In fact, the
 269 faults will cause contaminated water from a
 270 leaking repository situated at 650 m depth in the
 271 hard rocks to migrate obliquely upwards along
 272 the fault planes, to reach the surface in a short
 273 time. My view is supported both by theoretical
 274 modelling of fault zones, and by the empirical
 275 results of United Utilities, who stated in 2011 that
 276 they were drilling the fault zones for drinking
 277 water south of Egremont because they gave the
 278 best flow. The theoreticians conclude that fault
 279 zones on the small scale are inherently
 280 unpredictable. The improvement in computing
 281 performance since 1997 is irrelevant – the same
 282 fundamental errors will simply be recreated, but
 283 faster and in more detail. So the only safe way to
 284 find a good repository site is to avoid faulted
 285 rocks. This is what the French and Swiss are
 286 successfully doing – they have selected simple
 287 clay geology.

288 The coastal areas north and south of
 289 Longlands Farm are even worse prospects; the
 290 site around which £400M was spent could be said
 291 to have the ‘least bad’ geology in the area.
 292 Offshore west of Sellafield is also unsuitable; it
 293 comprises the same MMG as in northern
 294 Allerdale, with the same problems. In addition
 295 there would be severe political problems with the
 296 Irish and Norwegian governments, if any attempt
 297 were made to study a potential offshore location.

298 **Summary of areas A-D.** No stone has been
 299 left unturned, so to speak. There is no possibility
 300 that a rock volume exists that conforms even
 301 approximately, or in part, to the international
 302 guidelines for suitability. The ‘three wise
 303 monkeys’ approach adopted by the MRWS
 304 process, - that we do not yet know enough to rule
 305 out all the geology, because we have not yet done
 306 Stage 4 - is false. The evidence is all there in the
 307 public domain, mostly the work of the BGS and
 308 Nirex. All I have done is review and synthesise it.
 309 No-one has seriously challenged, in detail, any of
 310 my conclusions, but instead some resort to
 311 claiming that ‘only the BGS’ can decide.

312 The hubris of the engineers, that their
 313 engineering can overcome natural obstacles like
 314 adverse groundwater flow and chemistry, must
 315 not be accepted. We must, in short, go with the
 316 flow, and not try to fight Nature.

317 **Comments on the MRWS process to date.**

318 The White Paper misleadingly implies that
 319 voluntarism has been the successful approach
 320 abroad. This is disingenuous. France,
 321 Switzerland, Finland and Sweden have all made
 322 progress in site selection by doing the geology
 323 first, and only then seeking local support or veto.
 324 DECC has tried to justify putting the voluntarism
 325 cart before the geological horse by claiming that a
 326 national screening exercise would be too
 327 expensive. This is also untrue, as the overseas
 328 examples demonstrate. The assertion wilfully
 329 conflates the detailed screening-out of rock
 330 volumes with the more general search for
 331 potentially suitable geological environments. In
 332 fact, a national search by the BGS was done in
 333 the 1970s, repeated with new criteria in the
 334 1980s, and evidently nearly finished in revised
 335 form in early 2006, when a joint BGS/Nirex
 336 statement was issued to say that rather more than
 337 30% of the UK landmass had potential, and that a
 338 full report would be published later that year. The
 339 report never appeared, allegedly because of a
 340 change in government policy (i.e. the birth of the
 341 voluntarism approach). The NDA has told me
 342 that the maps on which the 30% estimate must
 343 have been based do not exist. I find this hard to
 344 believe. There is a strong suspicion that the whole
 345 process has been predetermined – it is a ‘quick
 346 fix’ designed to enable a return to West Cumbria.
 347

348 **What if one or more councils proceed to**
349 **Stage 4?** I no longer have confidence in the
350 impartiality of the BGS as an organisation,
351 although I still trust the integrity of its individual
352 scientists. **Firstly**, comparison of the draft BGS
353 2010 screening report (which was supplied
354 anonymously to me) with the final published
355 version, together with the published peer reviews,
356 show that severe alterations were made to the
357 draft. Contrary to popular belief, the final BGS
358 screening report has *not* removed aquifer rock
359 volumes from consideration; consideration of this
360 important screening criterion has merely been
361 postponed. Northern Allerdale was also initially
362 screened out in its entirety on hydrocarbon
363 grounds. **Secondly**, the BGS is angling for a
364 lucrative contract to study the Partnership area in
365 detail; this fact means that it is no longer
366 impartial. **Thirdly**, the senior BGS radwaste
367 scientist has stated on public radio that West
368 Cumbria “*offers potential*” for finding a
369 repository site; it will therefore be all-but
370 impossible for the BGS to conclude at some stage
371 in the future, that, sorry, there are in fact no
372 suitable rock volumes worthy of more study.
373 **Fourthly**, I have direct experience as a senior
374 BGS scientist myself, in 1985, of being obliged
375 by BGS management to conform to a Department
376 of Energy instruction to write a confidential paper
377 arguing a case I did not believe in. I believe that
378 this paper was then forwarded as geological
379 ‘advice’ to the F&CO. It was one of the reasons
380 that persuaded me to quit BGS employment.

381 **Conclusion and recommendations.** The
382 MRWS process should not go to Stage 4, as there
383 is ample evidence that public money will be
384 wasted, and time will be lost. Political pressures
385 will mean that a geologically poor site will be
386 chosen, but shored up by nuclear waste civil
387 engineers who will assert that they can solve the
388 insoluble, and that their grouting and filling will
389 be good for 100,000 years.

390 The urgent problem of Sellafield’s current
391 wastes should be taken care of by an interim
392 surface storage solution, to last 100 years. The
393 next 25 years can then be given over to thorough
394 research into waste encapsulation (at Sellafield),
395 together with honest and transparent search for a
396 satisfactory repository site elsewhere.

4 January 2013