

**Fact-finding session on Geological Disposal Facility  
Committee Room 7, House of Commons  
Thursday 10 January 2013 11:00-13:00**

**The Committee**

- Sir Tony Cunningham MP (Chair)
- Tim Farron MP
- Jamie Reed MP
- John Stevenson MP
- Rory Stewart MP
- John Woodcock MP
- Secretariat
- Professor John Fyfe (advisory role)

**Expert witnesses**

- **Professor Stuart Haszeldine**, Professor of Carbon Capture and Storage at the School of GeoSciences, University of Edinburgh
- **Bruce McKirdy**, Managing Director for the Radioactive Waste Management Directorate of the NDA
- **Professor Bruce Yardley**, Professor of Metamorphic Geochemistry, University of Leeds

**Transcript of discussion (not verbatim, and not to be quoted as such)**

- 1 SIR TONY CUNNINGHAM MP: To provide some background, it has been the  
2 practice of this group of Cumbrian MPs to come together every now and  
3 again on areas where there is frequently common interest, if not always  
4 agreement. We have had the Chief Constable, the Lake District National  
5 Park, the Vice Chancellor of the University and other people. Today's  
6 meeting may be in a formal setting but it is my intention to conduct the  
7 meeting in as informal a manner as possible. I will start by introducing  
8 Professor Fyfe.
- 9 PROF JOHN FYFE: I want to note that I am here not as an MP or a geologist  
10 or engineer, but as an ambassador for Cumbria, invited by the MPs in a  
11 supporting capacity.
- 12 SIR TONY CUNNINGHAM MP: Could the panel each begin by providing five  
13 minutes on your view of the subject, after which I will open to my  
14 colleagues for questions?
- 15 PROF STUART HASZELDINE: I am very pleased to be here and thank you for the  
16 opportunity and your time. I am here in my own capacity and not  
17 representing the University or any other body. I also represent the views  
18 of Professor David Smythe, who sends apologies for not being present in  
19 person due to his location in France and his wife's medical condition.
- 20 SIR TONY CUNNINGHAM MP: We understand, of course.

21 **PROF STUART HASZELDINE:** To summarise my views and those of Professor  
22 Smythe, radwaste is clearly a serious problem and needs a national UK  
23 solution: the question remains of how we go about identifying a suitable  
24 site at a UK level. The MRWS [Managing Radioactive Waste Safely] process  
25 as originally conceived is not the way the process is running now. The  
26 process for regional siting is currently based on community volunteering  
27 rather than a technical geological reason for the suitability of a site.  
28 It is clear that both geology and the engineering surroundings combine in  
29 the effectiveness of a repository. I disagree, however, with NDA that the  
30 engineering can solve all the problems that geology cannot. I consider  
31 that the process of identifying a suitable site for a GDF [Geological  
32 Disposal Facility] has been falsely linked both with the feasibility of  
33 proceeding with a programme of nuclear new build, and the long-term future  
34 of Sellafield, but these are not in fact linked. The decision of siting a  
35 GDF should be made on its own merits based on what is sensible for the  
36 wider UK, and not falsely linked to these matters. A good deal of  
37 geological information is known about West Cumbria from geological  
38 exploration (for coal, limestone, iron ore) plus the former Nirex process,  
39 which considered West Cumbria in detail. Professor Smythe and I know a  
40 great deal about West Cumbrian geology already and we know that the area  
41 has failed on surface planning reasons and on technical subsurface reasons  
42 of geology and hydrogeology. It was therefore a great surprise to us when  
43 Cumbrian Councils expressed an interest in participating, based on the  
44 public inquiry's previous failure. Professor Smythe and I have taken it  
45 upon ourselves to voluntarily assess that process. Especially noting that  
46 not all the evidence to do so has been made widely available, we have  
47 taken it upon ourselves to inform an interested public. I consider that we  
48 do know enough to know that all of West Cumbria is an unsuitable area – if  
49 the UK is serious in finding a site, the UK should look elsewhere rather  
50 than pursuing the same cul-de-sac that has been explored previously.

51 **BRUCE MCKIRDY:** I lead the Radioactive Waste Management Directorate within  
52 the NDA [Nuclear Decommissioning Authority], and it is our aim that this  
53 will eventually be a wholly-owned subsidiary of the NDA—in line with  
54 other NDA Site Licence Companies—to allow for regulatory accountability  
55 and scrutiny. My position is that it is appropriate to proceed to the next  
56 stage of the MRWS process in West Cumbria for three reasons. Firstly,  
57 there are reasonable prospects of finding a suitable site in West Cumbria.  
58 I would agree with Professor Haszeldine that there is significant  
59 geological evidence available on the region, but disagree with the  
60 professor over his interpretation of the evidence. NDA considers that the  
61 groundwater return times in the region are actually slower than in some  
62 overseas cases of repositories such as Finland and Sweden. The chemical  
63 conditions in the area are also potentially suitable and this evidence is  
64 available. Secondly, it is worth moving forward because moving to Stage  
65 Four is not about a commitment to host a geological disposal facility, it  
66 is about finding out more about the geology of region and other aspects of

67 suitability. The suitability of the region is a question of the  
68 combination of engineered and natural barriers that can be created. I  
69 would not argue that we can engineer our way into any geological system  
70 but the system does need to be tailored. For example, in Sweden a large  
71 amount has been invested into the engineered barrier within a repository  
72 and the role of geology is to provide protection for the engineered  
73 barriers. In France, where the site is situated in a region of slower  
74 groundwater return, the requirements placed on the engineering and  
75 canister are less stringent. There is clearly a trade off between the two  
76 factors, but I wouldn't argue that we can engineer a GDF into any setting.  
77 Finally, it is worth noting that proceeding to Stage Four is not an  
78 irreversible decision. We need to look at Cumbrian geology in stages. If  
79 at any stage it is not possible to make a clear safety case, the project  
80 cannot proceed. If a community wanted to pull out it could do so; the  
81 right to withdraw is embedded within the process. DECC [Department of  
82 Energy and Climate Change] has recently committed to looking at how to put  
83 this right to withdraw on a firmer legal footing, but we do know from  
84 experience overseas that trying to impose a repository on a community  
85 without a volunteer-led approach will not work.

86 **PROF BRUCE YARDLEY:** I am here not having a stake on either side, as I  
87 explained in my written evidence. I want to say clearly that the waste is  
88 in Cumbria now, and will stay there in one form or another if it is not  
89 removed. This waste is much more dangerous now than it will be in the  
90 future; this is not a case of a situation which is benign now and  
91 dangerous in the future - it will become progressively more difficult.  
92 Whether you are concerned about terrorism, or the projections in the Stern  
93 Review that we will be less able to afford to handle these issues in  
94 future, we should act now. I agree with Professor Haszeldine that there  
95 could be better sites than Cumbria found in the UK. The French repository  
96 site is placed in a geological unit known as "Oxford clay" - this language  
97 provides a hint that there are other suitable sites in the UK!  
98 Nonetheless, the challenge is to design a repository site that can suit  
99 the geology in question. What works in clay wouldn't work well in  
100 crystalline rock. I am confused by claims that the geology of the region  
101 is well understood - I have led a number of student field trips to the  
102 region, and it is well enough known at the level of resolution which  
103 allows us to create 1:500000 maps, but this is not the same as having a  
104 detailed knowledge of how the rocks look to the water flowing through  
105 them. The resolution must be greatly improved to understand these issues.  
106 It is disappointing that Professors Haszeldine and Smythe do not give due  
107 credence to the material produced during the Nirex 97 investigations. This  
108 work was conducted after the Nirex inquiry had finished - it included new  
109 scientific analysis, which was published. That work established more  
110 information about the actual fractures in the area and how water was  
111 flowing through fractures at a subsurface level. It is clear that previous  
112 work, including work conducted by Professor Haszeldine in the 1990s using

113 a general field model, must by virtue of its methodology be based on  
114 assumptions about fractures, including assumptions that fractures are  
115 widely present, whereas in reality these are present in some areas but not  
116 others.<sup>1</sup> Nirex would have benefited significantly from carrying out their  
117 work earlier – it is very unfortunate that they did not do so and I simply  
118 cannot understand why they did not. But the later work does demonstrate  
119 that it is possible to conduct further analysis to progress our  
120 understanding of the region, and it is not easy to say that the region is  
121 definitely not suitable. On the issue of the chemistry of the region, I  
122 would be happy to “go to blows” with Professor Haszeldine on issues such  
123 as the solubility of uranium at any time.

124 **SIR TONY CUNNINGHAM MP:** Thank you to all of you.

125 **TIM FARRON MP:** Thank you. That clearly involved some contradiction, but  
126 was helpful. We know enough from the BGS [British Geological Survey]  
127 unsuitability study of the region that up to 25% of the area is deemed  
128 unsuitable to house a repository. I would be keen to know from Bruce or  
129 all of you, on what basis it was possible to deem those areas unsuitable,  
130 if we understand so little about the suitability of the rock, and on what  
131 basis it can therefore be asserted that the remaining rock is more likely  
132 to be suitable.

133 **BRUCE MCKIRDY:** This unsuitability study was conducted using two main  
134 criteria: are there areas that are likely to be mined in future for  
135 minerals or hydrocarbons, and are there areas where at the depth of a  
136 potential repository (200-1000m) there are large aquifers.

137 **TIM FARRON MP:** Okay, so one reason is a matter of industrial intentions  
138 and the other is water flow.

139 **PROF STUART HASZELDINE:** I feel that this has been misinterpreted in two  
140 important ways. First, that the exclusions were made based on the presence  
141 of aquifers, and secondly, the interpretation that BGS concluded that the  
142 area remaining was suitable. That was not the intention of the report – it  
143 does not conclude that remaining areas are definitely suitable. We did  
144 some further investigation and examined some of the areas of West Cumbria  
145 that the BGS report had failed to exclude. Firstly, it is confusing to  
146 consider why the North Solway Plain and Silloth have not been excluded  
147 since the area is manifestly hosting an aquifer. Secondly, there is an  
148 inconsistency in that DECC attempted to offer shale gas licensing for a  
149 large area of coastal West Cumbria in 2011.<sup>2</sup> It is clear that DECC  
150 therefore considers this region to be potentially suitable for exploration  
151 – although this is a different part of DECC to the Office for Nuclear

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<sup>1</sup> Professor Yardley has clarified that his intention was to say that we now understand that flow is not uniform through deep fractures, but is localised in specific zones only.

<sup>2</sup> Professor Haszeldine has clarified that the relevant information is at Figure 2 of [https://www.og.decc.gov.uk/UKpromote/onshore\\_paper/UK\\_onshore\\_shalegas.pdf](https://www.og.decc.gov.uk/UKpromote/onshore_paper/UK_onshore_shalegas.pdf)

152 Development which is responsible for a repository. One can argue that it  
153 is not actually licensed yet, but there is clearly a difference between  
154 areas with real potential and those not yet excluded. In previous  
155 investigations, Nirex excluded areas in the National Park but in the  
156 current criteria, these have been retained for now. It is important to be  
157 clear that areas of outstanding natural beauty have been left in and  
158 considered as areas that are potentially suitable.

159 **BRUCE MCKIRDY:** I wish to respond as I raised this question of shale gas  
160 licensing with DECC the other day. In fact, there was no consideration of  
161 licences made on the basis of shale gas but on coal-bed methane. The area  
162 considered relevant for methane is precisely the same area which has  
163 already been ruled out by BGS. Any difference between the areas is down to  
164 the granularity of the map in question. To be clear - this response was  
165 not provided by the Office for Nuclear Development, but from the  
166 responsible team within DECC: this is all within the area that is shaded  
167 pink on the BGS report.

168 **RORY STEWART MP:** I want to take some time to better understand the  
169 geology. Would you agree that if you were working simply from first  
170 principles and not in a process guided by community views, *prima facie* in  
171 a country where there are clay soils available and where there are lower  
172 hydraulic gradients available, you would naturally assume that that would  
173 be a better place to site a repository? Is it true that siting a  
174 repository in those conditions would require less reliance on assumptions  
175 that can be difficult to prove about the extent to which engineered  
176 barriers can last?

177 **PROF BRUCE YARDLEY:** It is important to note that this is not purely a  
178 question of geology since there are also risks in transport. That would  
179 require comparison of, for example, a geologically safe site that was  
180 difficult to transport waste to, and a less geologically safe site on the  
181 doorstep of the waste. It is clear that when those siting a French  
182 repository compared crystalline rocks with clay formations, they went for  
183 the clay formation. If it were possible to find thick enough clay, this  
184 French experience suggests that one would go ahead with that option.

185 **RORY STEWART MP:** In Sweden, why was a crystalline rock chosen to site a  
186 repository?

187 **PROF BRUCE YARDLEY:** That was because they don't have thick clays of the  
188 right sort. We need very thick sequences of the right kind of clay. When  
189 we make geological maps, we colour things in at a scale that is suitable  
190 for what we walk over. But that doesn't actually mean that all the orange  
191 colour is exactly one thing, and the blue colour next to it is something  
192 else. Actually, all of them are a multitude of layers that we lump  
193 together so that we can make some sense of them in a geological map. You

194 have to understand in a little more detail about exactly what types of  
195 rocks are available.

196 **RORY STEWART MP:** In your professional opinion, is it right to say there is  
197 a high probability that the UK is more likely to contain suitable clay  
198 rocks than Sweden?

199 **PROF BRUCE YARDLEY:** Yes.

200 **RORY STEWART MP:** So to summarise those responses, Sweden chose crystalline  
201 rocks to host a GDF because there was not enough suitable clay but there  
202 is a high probability that Britain would have clays that might be more  
203 suitable than exist in Sweden. Putting aside issues of transportation...

204 **SIR TONY CUNNINGHAM MP:** Which are important...

205 **RORY STEWART MP:** Indeed, but if you were starting purely from a point of  
206 view of trying to find somewhere to deal with the possibility that over  
207 150,000 years the concrete bunker or copper bunker or whatever you have  
208 built corrodes and you are dependent on the surrounding rock conditions to  
209 protect the waste, all other things being equal, one would proceed with  
210 flatter clay geology?

211 **PROF BRUCE YARDLEY:** Just within those terms, yes, that is true - although  
212 obviously there are other parameters.

213 **BRUCE MCKIRDY:** It is important to note that it is never just within those  
214 terms - the total safety case includes the transportation safety and the  
215 long-term safety case, as well as the actual feasibility of delivery. If  
216 one looks purely theoretically, a clay geology in an area that hadn't  
217 volunteered to participate may seem better, but if the area doesn't  
218 volunteer to participate, I believe, and CORWM [the Committee on  
219 Radioactive Waste Management] believed that it would not be possible to  
220 actually site a repository there.

221 **JAMIE REED MP:** Is it correct to assert that there isn't a place in the  
222 world where a repository siting has proceeded without volunteerism? Is it  
223 correct to assert as did Professor Neil Chapman from the University of  
224 Sheffield that failure is almost guaranteed if we use a purely  
225 technically-led approach and that voluntarism brings with it a more  
226 demanding technical programme than a purely technical-led approach ever  
227 would? Is that accurate?

228 **PROF BRUCE YARDLEY:** Yes, that is clearly the case. One only has to look at  
229 what Nirex did 20 years ago to see that if one takes a purely technical  
230 approach, unless it works for the community it will not be feasible to  
231 implement.

232 **PROF STUART HASZELDINE:** I would like to note on the point of volunteering  
233 that the process as currently enacted by DECC and NDA requires communities  
234 to volunteer without any detailed knowledge of geology on which they sit.

235 **JAMIE REED MP:** But they are volunteering to enquire about the geology.

236 **PROF STUART HASZELDINE:** The limit to volunteerism is that the communities  
237 do not know whether their geology is poor, good, or adequate when compared  
238 to other sites on a UK level, and this matters in the UK perspective. Some  
239 of the best sites to house a repository may in the end have had few or no  
240 people living on them. How would such a site volunteer to be part of the  
241 process? DECC has tried to engage with local councils in the spirit of  
242 voluntarism but it is unclear from outside of DECC how robust or targeted  
243 that process has been, outside of pursuing the rather short-term option of  
244 West Cumbria. I agree that transport is an issue, but the NDA have made a  
245 strong claim on the NDA website and in its wider documentation that  
246 nuclear waste has been transported more than 10 million miles in total  
247 without incident.<sup>3</sup> We must also look at the future and the potential for a  
248 the building of new nuclear reactors. There would be waste from both  
249 existing and future reactors which required transportation to Cumbria.  
250 Even the waste already in Cumbria will need packaging for transport from  
251 the Sellafield works or store to a GDF entrance, passing through a public  
252 space, to the same high safety standards. Whichever way transport is  
253 considered, it is clear that there will need to be transport of waste  
254 either to or from West Cumbria. On that basis, the transport argument is  
255 somewhat spurious.

256 **BRUCE MCKIRDY:** I would absolutely agree that a volunteer-led approach has  
257 higher technical demands, which requires the repository programme to  
258 accommodate a whole number of factors that might otherwise not have been  
259 done. Nonetheless this is a price worth paying because the chance of  
260 success is considerably higher.

261 **JAMIE REED MP:** Stuart, do you recognise the right of people of West  
262 Cumbria to want to volunteer and to want to know whether the geology of  
263 their region is suitable? There can really be no logical opposition to  
264 moving to Stage Four, can there?

265 **PROF STUART HASZELDINE:** I do recognise those communities' rights to  
266 volunteer, but I also recognise the rights of the rest of the citizens of  
267 UK to compare the choice of West Cumbria with other parts of the UK that  
268 are less demanding in engineering terms. This would be a case of putting  
269 all our eggs into the basket of engineering a repository, rather than  
270 choosing region where geology acts as a positive attribute for safety and  
271 performance of a facility. We have seen catastrophes of engineering  
272 failures in civil engineering and civil nuclear history. If we find in 50

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<sup>3</sup> Professor Haszeldine has clarified that DRS is the transport subsidiary of NDA for moving radioactive waste: <http://www.directrailservices.com/Services/SpecialistFreight.aspx>

273 years' time that we have made a poor engineering choice it would be  
274 difficult to back out of those choices - this is not as simple as building  
275 a supermarket.

276 **PROF BRUCE YARDLEY:** I disagree - there is evidence that basement rocks in  
277 West Cumbria can be extremely impermeable and this can be seen in road  
278 sections or quarry walls in basement rocks. Yes, it is possible to see  
279 fracture zones, but it is also clear that there are intervening volumes of  
280 solid rock with low permeability. The real challenge is being able to  
281 identify where flow zones will be before excavations begin. This is not  
282 without precedent. Large mining companies must make similar assessments  
283 when creating underground mines. Given the economic incentives to ensure  
284 that oil fields are well exploited, oil fields are well known to have been  
285 exploited even when broken up by faults. It is possible to make the  
286 assumption that all faults transport fluids, but in fact the experience of  
287 oil companies often demonstrates that they find faults that nothing moves  
288 along. We do have relevant industrial expertise in the past 20 years on  
289 how to understand and work with these issues.

290 **BRUCE MCKIRDY:** It is absolutely right to know how any site in Cumbria  
291 would compare with other sites. It is imperative that this project is  
292 conducted under the proper process of the European Strategic Environmental  
293 Assessment Directive. This Directive requires us to consider reasonable  
294 alternatives. This consideration includes both reasonable alternative  
295 routes for waste management, and also alternative sites for a repository.  
296 If sites are volunteered, it will be vital to know how a volunteered site  
297 would compare with other sites that may have been identified if it had not  
298 been taken forward in a volunteered process. This is important to fully  
299 understand the environmental implications of the volunteer-led process.  
300 This must include the impacts of transport, the non-radiological impacts  
301 of transport and all wider considerations. This is an embedded part of the  
302 process.

303 **JAMIE REED MP:** Could you each expand on the impact that the nature of any  
304 particular geology would have on the safety case? I understand that  
305 whether the geology is simple or complex, the level of public protection  
306 is exactly the same - is that correct?

307 **PROF STUART HASZELDINE:** Yes, any site would be subject to the same  
308 regulatory demands. The question is about the spread of risk - for  
309 example, taking security, which cannot be accurately measured. The analogy  
310 of mining and oil companies is limited in its application - these  
311 companies admit that they don't know everything about the site even after  
312 exploited, but their ability to demonstrate that faults can be managed in  
313 a mine for 15-20 years is very different to demonstrating this on the  
314 timescales associated with a repository, which could be thousands or  
315 millions of years. It is clear that there may be a number of options for  
316 very permeable pathways - it is not the case of having a single fault



317 running through the facility. Water may be able to enter through one fault  
318 and leave through another. We must assess and handle the probability that  
319 engineering will not perform as is currently planned. Sweden provides a  
320 good example – the KBS3 proposition was adopted by the nuclear industry  
321 from SKB in Sweden on the basis that the use of copper canisters was a key  
322 part of the proposition, but subsequent further experiments have shown  
323 that those canisters erode very rapidly.<sup>4</sup> It is therefore evident that we  
324 cannot be clear about how these barriers would handle over long terms.

325 **PROF BRUCE YARDLEY:** On the issue of measuring the long-term performance of  
326 fractures and flow, it is true that mining is a short-term activity.  
327 However, the Nirex 97 analysis was able to identify both actively flowing  
328 fractures and also other fractures where it was clear from mineral  
329 deposits that there has been flow in the area in geologically recent time,  
330 by which I mean tens of thousands of years. Techniques are available to  
331 identify this. A key difference to the exploration conducted for mining is  
332 limiting the number of holes that would be created during the  
333 investigations – as soon as you make the access holes you are disrupting  
334 the environment in a way that must be managed accordingly.

335 **JOHN WOODCOCK MP:** As a supplementary question, are you saying that you  
336 accept the regulatory safeguards but you don't think that Cumbrian geology  
337 can adequately perform to them in the long term, or that you question over  
338 regulatory framework itself?

339 **PROF STUART HASZELDINE:** The regulatory framework looks both robust and  
340 sensible. However, this deals with probability, and does not provide a  
341 single answer. The analogy of rolling a dice is relevant. It is  
342 particularly important to consider the probabilities that a repository  
343 would perform in the poor performance zone. The average numbers may be  
344 fine in a number of repository scenarios, but it is clear that the risks  
345 in the poor performance zone could be much smaller or eliminated in a  
346 scenario with better geology.

347 **JOHN WOODCOCK MP:** Can I ask you all briefly what your stance is on nuclear  
348 power?

349 **PROF STUART HASZELDINE:** The UK has been a pioneer of civil nuclear power,  
350 this technology exists and is a useful contribution to the range of low-  
351 carbon generation options. If a fleet of new nuclear stations can be built  
352 safely, then that would clearly be a useful addition. The challenge for  
353 the UK is to balance the cost with benefits. There is evidence that with  
354 the reactor type favoured by EDF, the wholesale price of energy would  
355 increase substantially to about double, and it is not clear that the true

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<sup>4</sup> Professor Haszeldine has clarified that Sweden and possibly Finland have consequently halted their licensing process for a GDF whilst this is investigated with further information available at:  
[http://www.mkg.se/uploads/A3\\_folder\\_MKG\\_eng\\_\\_may\\_2011.pdf](http://www.mkg.se/uploads/A3_folder_MKG_eng__may_2011.pdf)

356 price of electricity procured from new nuclear reactors would be  
357 competitive.

358 **JOHN WOODCOCK MP:** So based on current estimates of the situation, it would  
359 not be right to go ahead?

360 **PROF STUART HASZELDINE:** The issue of new nuclear build should be decoupled  
361 from the question of waste disposal.

362 **JOHN WOODCOCK MP:** Nonetheless, I wish to understand your views on civil  
363 nuclear power to provide relevant context.

364 **PROF STUART HASZELDINE:** I am entirely agnostic. I wish to be clear that my  
365 career is now heavily focused on options for low-carbon generation, and if  
366 the UK can build a nuclear fleet safely, and this is cost-effective and  
367 can compete with renewables and other low-carbon generation, that would be  
368 a useful addition. However, cost-effectiveness is important. The price of  
369 future electricity from nuclear stations is not publically known, but  
370 there are media reports that £150 per MWh has been asked by EDF, but this  
371 does not include all the costs. This could add up to £150 per MWh, but the  
372 debt of clean up employment would remain in addition, noting that the  
373 clean up could be valuable for Sellafield and the local environment for  
374 150 years according to the NDA. It is clear that the UK is not yet paying  
375 the full costs for nuclear generation.

376 **JAMIE REED MP:** To refine John's question slightly in light of that answer,  
377 do you support plans for new nuclear build as they currently stand? Do you  
378 support the current new build programme, including the new site  
379 development at Sellafield?

380 **PROF STUART HASZELDINE:** I support the current programme, yes, but the  
381 caveat is commercial viability, and the performance and safety of  
382 reactors. I will not support new nuclear investments if the electricity  
383 would be treble the cost of energy from another source, as this is not  
384 competitive.

385 **BRUCE MCKIRDY:** The NDA position is that NDA is agnostic on new build – the  
386 role of the NDA is to decommission existing stations, and to handle legacy  
387 waste safely. Personally I support new nuclear build as a low-carbon  
388 technology.

389 **PROF BRUCE YARDLEY:** I agree with Stuart, although in slightly less detail.

390 **JOHN WOODCOCK MP:** On the idea of repository, what are people's views on  
391 the concept of building a repository to house nuclear waste? Is this the  
392 right idea for dealing with the waste, on balance?

393 **PROF BRUCE YARDLEY:** Yes, this is clearly the right approach. We cannot  
394 guarantee human civilisation for the next 5,000-10,000 years so we need to  
395 deal with this issue now in a way that the waste does not present a hazard

396 to people in future generations who may not even know what nuclear power  
397 is. It is clear that all countries who have considered the issue agree  
398 that you need to have a repository. I also think it is important to put  
399 the waste somewhere where people cannot tinker with it. Some people have  
400 expressed a desire to build a repository in a way that people would be  
401 able to go and “open a door and check on the waste”. People are not small  
402 creatures: if the purpose of the repository design is to prevent a single  
403 molecule of water reaching the waste, we do not want access for people to  
404 the waste. I do believe that once placed the waste must be closed in.

405 **PROF STUART HASZELDINE:** I agree with that point: I think that closure  
406 needs to mean closure, and retrievability is a spurious attempt to have  
407 one’s cake and eat it too. There are, however, two caveats. If a  
408 repository design involves a lot of copper, we need to consider the risk  
409 that this creates a useful copper deposit and people in future centuries  
410 may wish to steal this in the way that metals can be stolen from railway  
411 lines today. Secondly, while I do support geological disposal, I am not  
412 sure that this is appropriate for all the waste sited at the moment. Spent  
413 fuel and plutonium may not actually need disposal. The General Electric  
414 PRISM [Power Reactor Innovative Small Module] reactor could potentially  
415 turn some of these materials into a positively useful fuel. Subject to  
416 verifiable audit this may remove the need to dispose of some of the most  
417 toxic and radioactive elements of the waste inventory that may otherwise  
418 be sited in a repository.

419 **BRUCE MCKIRDY:** I agree that a GDF is absolutely essential for the legacy  
420 waste that we have already, as well as any waste that would result from a  
421 new build programme. This is essential to deal with waste and spent fuel,  
422 even in the event of new reactor designs such as PRISM or Generation IV  
423 reactors. NDA has currently been analysing projections of spent fuel from  
424 PRISM reactors. Whilst burning plutonium in PRISM could reduce the  
425 quantity of plutonium by 50%, the requirement for plutonium to provided in  
426 the form of a metal confers some additional challenges, when compared to  
427 an oxide form. It is clear that new technologies will help to optimise the  
428 system and the waste produced, but these technologies will not eliminate  
429 the need for geological disposal.

430 **JOHN STEVENSON MP:** I would like to ask a practical question in relation to  
431 the decision. As I understand it, we are accepting that Cumbria is not a  
432 perfect solution, but nevertheless some of you have said that it could be  
433 a solution, and moving to Stage Four of the process is an issue of finding  
434 out more to see whether it is feasible or not. I understand this to be the  
435 decision that Cumbria will make in deciding whether to move to Stage Four.  
436 My question is: how much will this cost?

437 **BRUCE MCKIRDY:** We estimate that Stage Four activities will cost about  
438 £10 million per year for four to five years. My total budget is of the  
439 order of £20 million per year. The remaining budget funds continued work

440 doing generic research into materials and the behaviour of these  
441 materials, and also funds our ongoing work on packaging of existing  
442 nuclear material.

443 **JOHN STEVENSON MP:** Assuming that this goes ahead to Stage Four, how  
444 confident are you that this process will result in sufficient evidence to  
445 give a definitive answer as to whether or not to proceed beyond Stage  
446 Four?

447 **PROFESSOR BRUCE YARDLEY:** I believe that the process will result in enough  
448 information to allow a well-informed decision to be made at the end of the  
449 process. There is still going to be an extent to which this process  
450 results in answers such as “there is X amount of fluid flow, can you live  
451 with it?” The next stage of the process is not intended to find an exact  
452 spot, which would be the equivalent of locating the needle in the  
453 haystack. Instead, it is a process of identifying those areas within the  
454 region where groundwater flow is sufficiently low and the chemical  
455 environment sufficiently good. Assuming that the budget is spent  
456 intelligently, and that Stage Four is conducted by smart people with  
457 relevant international experience from overseas projects, it should be  
458 feasible to identify sites and characterise them well enough to make a  
459 decision. In doing so, it is important not to turn the land mass into a  
460 sieve: when searching for copper or coal deposits, it is relatively easy  
461 to drill lots of holes to look for the material. If looking for areas of  
462 water impermeability, by definition we don’t want to drill too much and  
463 increase the permeability of the rock. I believe that if the expenditure  
464 was focused on individual areas, rather than spread across all areas of  
465 the region, the process can deliver the level of certainty. It is  
466 important to note that this may either result in a clear signal that we  
467 have two orders of magnitude more safety than needed—and the process can  
468 proceed to later stages—or that the safety is two orders of magnitude too  
469 low, and the process cannot proceed. Either way this should be clear by  
470 the end of Stage Four.

471 **PROF STUART HASZELDINE:** What I am failing to see from the NDA is  
472 information on where the candidate regions in West Cumbria would be. If  
473 Councils decide to go forward, what would be the hypothesis for the  
474 further testing? How would the NDA demonstrate success or failure in Stage  
475 Four of the process? Clear criteria for site selection are notably absent  
476 from the information that has been provided by the NDA.

477 **BRUCE MCKIRDY:** The NDA is clear that we have not identified sites yet.  
478 This is the first element of Stage Four of the MRWS process – this work  
479 would not be undertaken alone, but would be conducted with community  
480 involvement. Around six months ago, DECC published, following  
481 consultation, a document about the framework within which that site  
482 identification and assessment process will be conducted, including  
483 criteria. This is the first step of Stage Four, which will make use of all

484 the available data, and will ensure this is thoroughly examined and used  
485 properly.

486 **PROF STUART HASZELDINE:** How is it possible to say that there is promising  
487 geology within the region if there is no idea of where sites would be  
488 sited? This is a clear contradiction.

489 **BRUCE MCKIRDY:** I believe that there are reasonable prospects for this,  
490 based on the evidence that is available at the moment. We know that 75% of  
491 the area has been left after the BGS study, and we have a reasonable idea  
492 of the underlying geology. We have data from the Nirex investigations  
493 during the 1990s, and on that basis we believe there is a reasonable  
494 prospect. We don't know that there is definitely somewhere suitable, but  
495 that is the purpose of Stage Four – to work with communities to establish  
496 this.

497 **PROF STUART HASZELDINE:** Is the National Park not excluded from the regions  
498 that would be considered?

499 **BRUCE MCKIRDY:** The National Park may be excluded based on the site-  
500 selection criteria for housing the above-ground elements of a GDF.  
501 Criteria for areas suitable for surface facilities and those suitable for  
502 underground facilities would be considered independently, and the surface  
503 criteria may rule out the National Park. The output of this process will  
504 produce a picture of the areas suitable for surface and underground  
505 operations, and there will be an attempt to match the two together, to  
506 find an area of overall suitability for both surface and subsurface  
507 facilities. These facilities may be directly above each other, or up to  
508 10-15 km apart.

509 **PROF STUART HASZELDINE:** It is noteworthy that NDA has retained ownership  
510 of the Longlands Farm site near Sellafield, and has also retained mining  
511 rights to the area. We know that areas of granite rock are located around  
512 10-15 km away from this site in Ennerdale. This raises the issue of  
513 whether it would be possible to build a tunnel from the Longlands Farm  
514 site 5-10 km sideways, to beneath the National Park.

515 **BRUCE MCKIRDY:** It should be noted that ownership of the Longlands Farm  
516 site transferred to NDA naturally from BNFL [British Nuclear Fuels  
517 Limited]. NDA has not sold this land since acquiring it, but there are  
518 other areas of land that were transferred to NDA from BNFL that have also  
519 not been sold.

520 **PROF STUART HASZELDINE:** To summarise what I believe has been said, you  
521 claim that the search for a site would not look at the National Park, but  
522 could feasibly look beneath it. I want to be clear about spending  
523 £10 million assessing existing information: I have considered the existing  
524 information in great detail and it is unclear to me how you can analyse  
525 this existing information to identify a single site. It is not clear that

526 it would be possible to establish this without invasive work drilling from  
527 the surface.

528 **PROFESSOR BRUCE YARDLEY:** I hope this is not going to be a case of spending  
529 £10 million per year reassessing existing information. If so, I would find  
530 myself on Professor Haszeldine's side of the argument on this point. The  
531 new work conducted under Nirex 97 was published, and this shows what  
532 investigations can feasibly be conducted. This underlines the extent of  
533 what can be demonstrated with borehole testing to characterise the flow of  
534 the region – we can certainly make reasonable progress. I am not very  
535 happy looking at the slides that Professor Haszeldine and Professor Smythe  
536 have previously made public and the claims they make about the coverage of  
537 past analysis. To take an excerpt from Professor Smythe's written  
538 submission, he claims that "my analysis of the modelling used to predict  
539 the water flow shows that the effect of the faults cutting the rocks has  
540 been ignored." In fact, the 2003 Nirex paper in question has as the first  
541 three words of its title "fracture-dominated flows", suggesting that  
542 Professor Smythe's analysis was not very thorough. Of course this aspect  
543 has been studied in the past. I am very incensed that misleading phrases  
544 have been bandied around regarding analyses of published work; in  
545 contrast, the published work to date covers exactly those questions that  
546 Professor Smythe says must be addressed.

547 **JOHN STEVENSON MP:** To be clear, at the end of the desktop survey, can we  
548 expect to have a decent analysis of the situation to make a decision?

549 **PROFESSOR BRUCE YARDLEY:** I want to see more than desktop survey: a desktop  
550 survey would be the very first part of Stage Four of the MRWS process, but  
551 the next stage would be to identify several contrasting types of geology  
552 and identify the potential of these rocks. In the event that one of these  
553 types of geology were considered to have appropriate potential, the next  
554 step would be to look more widely for other sites in the region with  
555 similar geology. In this way, the process would start with range of  
556 potential sites, identify which of these is likely to work, then apply  
557 this learning more broadly to other similar square kilometres of the  
558 region. I will not be responsible for handling the process, but if I were  
559 in charge, that's how I would do it.

560 **JOHN STEVENSON MP:** And you would expect this to throw up whether some  
561 geologies are suitable or none?

562 **PROF BRUCE YARDLEY:** Yes.

563 **RORY STEWART MP:** From the point of view of my constituents and the public  
564 more generally it is reasonable to ask, if we spent up to £50 million on  
565 this process, what are the criteria under which you or they assess the  
566 outputs of the research. For example - what is the amount of fluid flow  
567 that is acceptable, what is an acceptable rate of return to the biosphere,  
568 and can we live with it? Is someone going to define publically the

569 criteria for success or failure? Will someone say “these are our  
570 assumptions made about what can be done by engineering and these are the  
571 minimum standard required from geology that would need to be  
572 demonstrated”?

573 **PROF BRUCE YARDLEY:** It would be possible to define criteria in that way -  
574 but it should be noted that the two members of this panel could each  
575 provide a different set of criteria and requirements to ensure that the  
576 process resulted in the outcome they desired. These would be subject to  
577 interpretation.

578 **RORY STEWART MP:** Can I push harder on this point? Recognising that, is  
579 there any way to get clarity for the public? It is clearly not reassuring  
580 for the public to consider that the criteria for safety may depend on an  
581 individual’s perspective.

582 **PROF BRUCE YARDLEY:** Yes, but this is complex. For example, does one look  
583 at the velocity of fluid flows, or the volume of the fluid? There are  
584 clearly different ways to look at this.

585 **RORY STEWART MP:** I agree it is complicated but surely the idea of this  
586 five year £50 million research is to get an answer at the end. There must  
587 be a hypothesis that can be tested and proven or not, which implies there  
588 must be criteria to work with.

589 **PROF BRUCE YARDLEY:** Yes, that is possible - but I want to be clear that we  
590 need to give this careful thought so that those wanting an answer do not  
591 set the criteria in a way that they get the answer they want. As long as  
592 the criteria could be properly thought through, I agree we do need these.

593 **RORY STEWART MP:** And these would need to be defined before the process  
594 could begin, surely, so we know what we are assessing?

595 **PROF BRUCE YARDLEY:** I am not an expert in this specific matter, but the  
596 international guidelines from the IAEA [International Atomic Energy  
597 Agency] could be expected to form a starting point. These guidelines are  
598 already more extensive now than they were in the in mid 1990s and I would  
599 expect these to be able to lay out the very basic needs for a repository,  
600 which could be followed.

601 **PROF STUART HASZELDINE:** The international requirements for suitable  
602 geology are already clear: the geology should have predictable  
603 characteristics, low flow of groundwater, and preferably small volumes of  
604 flow as well as having the correct geochemistry. It is worth noting that  
605 no other country has gone into this type of rock when building a  
606 repository. No other country has sited a repository next to a huge drive  
607 of water flow, or in an area that is so fractured and complex with a great  
608 deal of water flows underground. Effectively we have a roundabout of  
609 factors combining in this region, which make the region very difficult to

610 predict. This would mean that in the event of siting a repository in West  
611 Cumbria, we would need to place huge faith in our ability to engineer  
612 barriers to contain the waste. The process we are faced with resembles a  
613 clearly premature rush into accepting the first community to volunteer,  
614 when in fact there are other communities that would be more suitable. For  
615 UK as a whole, I consider that we would be better advised to park this  
616 process, to look at other sites and to cultivate volunteerism as the  
617 original CORWM report intended. This requires the Government to actively  
618 cultivate voluntarism around the UK. This has never been carried out.

619 **BRUCE MCKIRDY:** The IAEA does have guidelines for siting a repository but  
620 they specifically do not set out any prescriptive criteria – and these  
621 guidelines are applied in a way such that account is taken of all these  
622 guidelines on the whole system. That is because no one factor can be  
623 considered in isolation and it is required to be able to look in  
624 combination at the factors altogether. It should be noted that no other  
625 countries have specific numerical criteria for geology that need to be  
626 met. In every case, what is paramount is the need to demonstrate that  
627 barriers work together. In a scenario where the geology is not so  
628 favourable, then the challenge is to engineer the system differently. NDA  
629 would never go forward in a scenario that required us to rely 100% on an  
630 engineered barrier indefinitely into the future and no other engineers  
631 would do this. However, there aren't specific numerical requirements –  
632 these are general guidelines that must be considered in combination.

633 **JAMIE REED MP:** I understand that Stage Four should answer many of these  
634 questions and address the uncertainties we have discussed. My question is:  
635 what is to be lost in proceeding to Stage Four?

636 **PROF STUART HASZELDINE:** I have not heard a clear response from NDA on what  
637 they actually want to do in Stage Four.

638 **JAMIE REED MP:** Can you answer that specific question?

639 **PROF STUART HASZELDINE:** I hold significant amounts of information from  
640 archives, and so-called legacy information. Reanalysis of that information  
641 can be done. However, that level of geological information does not exist  
642 at all for sites inside the National Park, which requires generic  
643 assumptions to be made in those areas. We now know enough about these  
644 areas to know that the area around Silloth is an aquifer. It is really not  
645 clear what new certainty will be generated by further NDA analysis,  
646 without conducting invasive drilling from the surface. Nirex 95 and 97  
647 investigations are both good examples of this point. In addition both of  
648 these examples show that this repository siting fails in the area. All  
649 that is different now is the potential inclusion of high-level waste and  
650 spent fuel within the inventory for disposal. It should be noted that this  
651 high-level waste produces extra heat, and this heat can accelerate  
652 groundwater movement by a factor of 10. Where groundwater may originally



653 have been expected to return to the surface in many thousands of years,  
654 the presence of heat could mean this becomes hundreds of years. The  
655 circulation clearly accelerates in this scenario. All of this work can be  
656 done in principle, and it has already been done in principle: it shows  
657 that the process in West Cumbria is a cul-de-sac which represents overall  
658 bad value. Proceeding at this stage merely sets us up for the prospect of  
659 failure at the start of MRWS Stage Six, just as the Nirex investigation  
660 failed at the equivalent point.

661 **JAMIE REED MP:** Is it right that you have worked for Greenpeace within this  
662 context?

663 **PROF STUART HASZELDINE:** No, that is not correct. I was keen to undertake  
664 further research and accepted an un-tethered research grant from the  
665 Greenpeace Trust to allow me to conduct research, which was later  
666 published. I later separately gave evidence on behalf of Greenpeace at the  
667 Nirex planning inquiry, using outputs of my earlier research to do so, and  
668 was cross examined on that. There is a disconnect between my appearance at  
669 the inquiry and the earlier research.

670 **JAMIE REED MP:** It is just that in your 1996 book with Professor Smythe,  
671 you cite yourself as being for Greenpeace in the appendix.

672 **PROF STUART HASZELDINE:** I was a witness in support of Greenpeace. I should  
673 note that this is just as you yourself were employed by Nirex at time of  
674 the inquiry.

675 **JAMIE REED MP:** I was and I don't seek to hide that. Thank you for making  
676 that explicitly clear. To return to my original question – I am surprised  
677 you have forgotten it – a given your concerns, and that Stage Four is  
678 designed to investigate these concerns, where is the danger or problem  
679 with proceeding?

680 **PROF STUART HASZELDINE:** The problem is if there is no new information to  
681 be acquired. We have the existing information and known that the areas  
682 North and South of Sellafield, including Longlands Farm, fail the  
683 criteria. We also know that existing information from other sites is  
684 sufficient to conclude that those sites are also not right and suitable.  
685 Proceeding in West Cumbria diverts time and money from finding a more  
686 suitable site elsewhere.

687 **JAMIE REED MP:** I should also note that I was the MP that successfully got  
688 rid of Nirex. That was one of my first, most successful and happiest days  
689 in my life as an MP.

690 **PROF BRUCE YARDLEY:** I wish to make an analogy. Visiting a children's  
691 bookshop, one can no doubt find a good book that has an excellent cut out  
692 picture showing just how a nuclear reactor works – this doesn't mean,  
693 however, that the picture would be much use to someone wishing to build a

694 reactor! The information used in the Nirex appeal process was a broad-  
695 brush picture of water flows. I consider that picture to be around the  
696 level of detail as the cutaway drawing: to be able to actually build  
697 something usable, one would need much higher resolution. The modelling  
698 conducted at the time was perfectly good for what was available then - it  
699 used a code designed for assessing regional flows and gave a good picture  
700 of the overview but failed on the detail required. How these  
701 investigations must work is to start with a model, add more detail, re-  
702 model, and so on. I do not agree that the original information and  
703 modelling solves the problem we are now facing.

704 **BRUCE MCKIRDY:** It is not our intention that £10 million per year would be  
705 spent merely on analysing the same data. The intention would be to use  
706 existing data to undertake feasibility studies, working with different  
707 communities at specific sites. The Nirex work focused on the suitability  
708 of a single specific site. We do want to peer review the Nirex work and  
709 get it more thoroughly examined. However, it is important to note that the  
710 context of the Nirex work was very different. During the Nirex  
711 investigation there was no locus for regulatory engagement; that meant it  
712 was possible to reach the end of the equivalent to Stage Five and then  
713 abandon the process. Formal regulatory involvement was only required at  
714 the point that an operator wanted to dispose of waste. Now we have a  
715 process that includes early regulatory involvement - the plans and work  
716 can be scrutinised now. It is vital to note that if we cannot get  
717 regulatory buy in at each stage of the process, we cannot proceed. There  
718 is certainly a lot that we don't currently know that we would be able to  
719 know if we proceeded to Stage Four.

720 **JAMIE REED MP:** I understand that in addition to technical work, Stage Four  
721 is the opportunity for the local community to discuss the benefits package  
722 and what support may be available to the community on a *quid pro quo* basis  
723 and the investment that may come forward. This is clearly intrinsic to the  
724 principle of volunteerism, which is the key principle on which the process  
725 is proceeding.

726 **BRUCE MCKIRDY:** Yes, that is correct.

727 **TIM FARRON MP:** I would like to pick up on Professor Yardley's point about  
728 allowing long-term access to a repository and the view that a repository  
729 should be sealed off. It has been put out there by some people that if in  
730 future, society were to find a new and wonderful approach to handling this  
731 waste, it would be useful to be able to get at the waste to implement this  
732 new and wonderful solution. I am keen to understand your views on the  
733 benefits and disbenefits of allowing access to continue and what current  
734 thinking is. What then are the implications for the kind of site you may  
735 choose geologically or otherwise, and whether there are implications in  
736 terms of being able to allow some or no access?

737 **PROF STUART HASZELDINE:** If we are trying to dispose of the waste safely,  
738 we clearly want to minimise water flow and return pathways for gas or  
739 water to the surface. This is fundamentally the opposite to creating a  
740 human- or machine-sized pathway to the site and the complex network of  
741 tunnels housing the waste. It would certainly be very hard to do that  
742 without compromising the performance of the repository: you may judge this  
743 to be acceptable or unacceptable when weighed against the perceived  
744 benefits of retaining access. Crystalline rock may be more challenging in  
745 this context than mud or clay rocks which have the capacity to be self-  
746 sealing. In a UK context, it should also be noted that gas accumulation in  
747 a repository is a relevant issue and it has been widely accepted that  
748 radioactive gases would be expected to accumulate in the repository  
749 itself. If one were to maintain an entry tunnel, this clearly becomes the  
750 most logical exit pathway for those gases. While the benefits should be  
751 weighed against this, there is a likelihood of weighing up a lot of clear  
752 problems against potential benefits in the future that are poorly known or  
753 understood.

754 **BRUCE MCKIRDY:** I consider that once a repository is closed and sealed, it  
755 should be passively safe, and not rely on future intervention. A key  
756 component and benefit of this waste management solution is that it does  
757 not rely on further intervention to remain safe. Once a repository would  
758 be built, we would expect the process of filling the repository with waste  
759 to last around 50 - 100 years, then there is the possibility to leave it  
760 open slightly longer. So for up to 100 years the waste would be expected  
761 to be retrievable by the same routes used to put it in. Within the French  
762 programme there has been discussion of a period of retrievability post-  
763 emplacement and prior to closure. To summarise, we would expect the waste  
764 to be accessible only for 50-100 years while emplacing, and potentially  
765 for a short time afterwards, during which time in effect the repository  
766 would be acting as an underground store.

767 **PROF BRUCE YARDLEY:** I agree - once the repository is full, close it up.

768 **TIM FARRON MP:** What are the long-term risks to the communities into the  
769 fairly distant future of burying the waste in west Cumbria, taking account  
770 both the geology of the region, but also the general long-term risks that  
771 may result?

772 **PROF BRUCE YARDLEY:** You should also evaluate the long and short-term risks  
773 of not burying the waste to these communities.

774 **SIR TONY CUNNINGHAM MP:** There are clearly risks of doing nothing.

775 **PROF BRUCE YARDLEY:** But recognising that, I interpret the question as,  
776 once buried, what do risks start to be? The key risk is the return of  
777 radioactive material to the surface in some concentrated form: the  
778 thresholds people usually talk about in this context are relative to  
779 average background radiation levels. I am not a professional repository

780 designer – and this would clearly be a matter for designers to deal with  
781 when designing a repository. Issues include the fact that one or two  
782 radionuclides are quite soluble in water and these would be an issue,  
783 however these would be short lived, so as long as they can be captured by  
784 the engineered barriers this should be okay. Longer term, the question is  
785 what happens when water eventually gets at the waste being stored in a  
786 repository. In the worst case, oxidised water enters the vault and reacts  
787 with alkaline concrete but without being reduced. If surface water reacts  
788 with cement in a deep environment, it may result in an issue of uranium  
789 solubility. It is important, however, to question the extent to which  
790 oxygen would be present. A useful analogy is the school experiment of a  
791 nail in a bottle – if nails are placed into two bottles, one of which is  
792 sealed, the bottle with oxygen present results in quicker rust. Only when  
793 oxygen is present will the nail rust.<sup>5</sup> The extent to which ground water  
794 would be oxidised within a repository could be expected to be low. In the  
795 case of having huge fluxes in oxygen—for example if vessels had been  
796 damaged on the surface—as a result, we would expect the uranium to  
797 dissolve in the water. I would expect, however, an arrangement where water  
798 moves in and out of a vault becoming alkaline and neutralised, but where  
799 radionuclides would precipitate out at the point at which water moves into  
800 the rock surrounding the repository and becomes neutralised. In the event  
801 of a catastrophic failure with very fast fluid flows, there would clearly  
802 be a serious problem but I do not judge this to be very likely. That is  
803 more likely to happen in surface storage. These rocks don't randomly have  
804 large amounts of flow.

805 **PROF STUART HASZELDINE:** The key point to note about the static bottle  
806 experiment is that it is static, whereas this question is about fluid and  
807 flows. In the school experiment, the bottle with water flowing through it  
808 would result in rust being produced most quickly of all. We should be  
809 clear that we are making an unnatural concentration of uranium in an area  
810 with intense water flow: this is essentially engineering an unnatural  
811 scenario against the intentions of nature. I would also contest the issue  
812 that the relevant soluble isotopes are limited to hundreds of years in  
813 their half lives: Carbon-14 in gaseous form has a half life of thousands  
814 of years, and iodine also has a long half life; both are very metabolise-  
815 able to humans. There are well known retention issues in Sweden with the  
816 poor performance of copper canisters and at present the KBS3 engineering  
817 proposed by NDA does not work. I consider that there is very solid  
818 evidence for oxidising water permeating through the fractures of rocks in  
819 this environment – it was measured in boreholes. Where there is evidence  
820 of the last minerals to precipitate in many of these faults, there is  
821 evidence of oxidising characteristics and glacial water has manifestly

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<sup>5</sup> Professor Yardley has clarified that the point he intended to convey was that even if there is a lot of oxidised water and a small nail, the solubility of oxygen in water is so low that it is used up with little effect. Likewise a buried repository would have to be exposed to an enormous quantity of oxidised water to have much effect.

822 gone through these sites to the great depths in question. I consider that  
823 Professor Yardley proposes a spurious and “children-cartoonish” painting  
824 of the expected water flows within this type of repository. We should  
825 remember that if we seal the site up and found we have made a mistake, it  
826 would be very difficult to go back.

827 **PROF BRUCE YARDLEY:** It is clear that we two experts can see the different  
828 assumptions that we are each making and it is not appropriate to argue  
829 about it in this context. I consider that Professor Haszeldine has taken  
830 an extreme case in his work by showing uranium solubility in strongly  
831 alkaline water, which has reacted with cement, but at the same time  
832 considering an oxidation state derived from the atmosphere.

833 **BRUCE MCKIRDY:** Let us remember that we are not deciding to build a  
834 repository right now. Before that stage could be reached, the scenarios  
835 that Bruce and Stuart have described would need to be defined in a single  
836 safety case that would be openly published and would most likely need to  
837 be subject to international review. We need to take all the data we have,  
838 as we have discussed in the context of these questions, and to put this  
839 information into the context of a full safety case and ensure that this  
840 case is properly reviewed by those people who have the expertise to deal  
841 with this information.

842 **RORY STEWART MP:** If siting a repository in different geologies does not  
843 present an issue or risk, why have French teams gone to such efforts to  
844 site their repository in clay rather than crystalline rocks if the risks  
845 are so low? You seem to be suggesting that the risks are so minimal – why  
846 would the French bother to bury this in clay?

847 **PROF BRUCE YARDLEY:** I do think the work Professor Haszeldine has carried  
848 out about uranium solubility takes the worst possible combination of  
849 circumstances, beyond what is reasonable to consider.

850 **RORY STEWART MP:** And why have the French made their efforts to site this  
851 in clay?

852 **PROF BRUCE YARDLEY:** I am certainly not saying that it is a good thing to  
853 have water flowing over the waste and we clearly want to minimise this.  
854 But at the end of the day, a tiny amount of radiation returning to surface  
855 is not a catastrophe for the entire planet or entire Cumbria. In contrast,  
856 a container being breached at Sellafield at the point in time when a  
857 strong wind is blowing towards Manchester clearly is a problem. I feel we  
858 should not be forced into extremes of saying that this is either a  
859 disaster or completely okay – we must be able to nuance this and find an  
860 area in the middle. I do feel that the risk is overhyped and not  
861 accurately represented.

862 **TIM FARRON MP:** It seems that there is a reasonable likelihood that further  
863 geological investigations in West Cumbria will not leave us with a good  
864 chance of being able to proceed - what happens then?

865 **BRUCE MCKIRDY:** The waste is currently stored safely on the surface and we  
866 currently package the waste so that it is both safe for storage and  
867 suitable to be housed in a repository. There is no issue with continuing  
868 to do so. The MRWS process is also still open to other parts of country to  
869 volunteer. We hope to receive more information from Treasury about the  
870 size and nature of the benefits packages, which we consider will present a  
871 clear opportunity for other sites in the UK.

872 **JOHN WOODCOCK MP:** Is this an accurate assessment of the evidence that you  
873 have given: none of you are saying that West Cumbria is necessarily  
874 completely unsuitable, and therefore it becomes an argument about what the  
875 best sequencing of events ought to be - whether Cumbria ought to go  
876 forward into Stage Four of the process now, or whether there ought to be  
877 an examination of other sites. But from what I have heard, there is not a  
878 question that Cumbria is *de facto* unsuitable at this stage?

879 **PROF STUART HASZELDINE:** No - I am saying that West Cumbria is *de facto*  
880 unsuitable. We have heard both from Dr Dearlove, geological advisor to the  
881 West Cumbrian MRWS Partnership, and in March 2012 from both the Inspector  
882 and the technical assessor of the original Nirex inquiry, that in their  
883 terms, "the prospects of finding a suitable site in Cumbria are low".

884 **JOHN WOODCOCK MP:** Can I check this, as I may have misunderstood. Clearly  
885 you have severe doubts and it has been helpful for me that you could spell  
886 out those doubts. I thought there was something of a consensus across the  
887 panel that the level of work required to test your thesis has not been  
888 done. I understood you were arguing that a better use of public money  
889 might be to put the money to use in other sites.

890 **PROF STUART HASZELDINE:** I would like to nuance that back to you as "we  
891 should now spend time and money looking for other sites as a Plan B and  
892 Plan C in case Cumbria fails". However, I am also saying that we do know  
893 enough to exclude Cumbria as Plan A, as the detailed geology of the  
894 coastal zone, deep water flow, and rock formation is known well enough to  
895 know this would place all the onus on engineering a solution.

896 **BRUCE MCKIRDY:** I disagree. I consider there is a reasonable prospect of  
897 finding a suitable site. I am not arguing that West Cumbria is definitely  
898 suitable, but it presents a sufficiently reasonable prospect to look  
899 further.

900 **PROF BRUCE YARDLEY:** I think the prospects are reasonable in Cumbria, but  
901 there could be better prospects elsewhere. However, I would like to see a  
902 stack of waste canisters left in the middle of Parliament Square to remind

903 you that we do already have this stuff - it exists now and we do need to  
904 do something about it!

905 **RORY STEWART MP:** Do you agree that as a fundamental part of our ability  
906 and the public's ability to assess the process there needs to be more  
907 transparency about the criteria against which the region will be assessed?  
908 This is not just IAEA guidelines but details of what kind of complexity of  
909 rock, what speed of water flow, what volume of water, we think would be a  
910 problem. As we have identified in this discussion, we cannot rely entirely  
911 on engineering; we know this will eventually collapse. The only way we can  
912 progress this is with clear criteria against which we can balance and  
913 assess the research conducted.

914 **BRUCE MCKIRDY:** I absolutely agree on the need for transparency and an open  
915 process. I think we need to avoid artificially-derived numerical criteria,  
916 although during the process we do need to be very clear and open about  
917 what research is being done, what conclusions have been drawn from this  
918 research, and why those conclusions were reached.

919 **PROF STUART HASZELDINE:** I agree that we need criteria. We also need a  
920 critical friend or critical voice<sup>6</sup> within the process: all my work and  
921 that of Professor Smythe to challenge the process has been self funded,  
922 which means there has been no real critical friend or independent voice to  
923 speak against and challenge proposals. There are very clearly better areas  
924 of geology, which could perform better in the UK. I consider that DECC as  
925 representing the UK public has not performed its duty in finding an  
926 adequate number of sites to consider.

927 **PROF BRUCE YARDLEY:** Yes: it will be difficult, but I do agree that the  
928 public needs to be told what the criteria are and how the investigations  
929 in West Cumbria are being benchmarked both against other hypothetical  
930 sites, and against the present risk that exists with the current surface  
931 storage of waste.

932 **JAMIE REED MP:** I believe that many of my constituents are actually  
933 insulted by the scaremongering that has gone on, which implies a grand  
934 conspiracy to implement the repository project. I consider that Section  
935 Six of Professor Haszeldine's submission contains a series of false  
936 assertions. You said that you can speak for Professor Smythe, who writes  
937 in his submission that he has direct experience as a BGS scientist of  
938 being forced to publish scientific papers that he didn't believe in, but  
939 that he was forced to do this by the Department of Energy. Do you actually  
940 believe this kind of thing is still going on? Do you believe that my  
941 constituents, trades unions, NDAs, and myself actually want to site the  
942 repository against our own best wishes in geologies we know to be

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<sup>6</sup> Professor Haszeldine has clarified that he considers such organisations which represent the public outside of the developer's control, are funded in France (CLIS) and in Sweden (MKG, Swedish Radiation Safety Authority) with several millions of pounds each year.

943 unsuitable? Do you believe that a British Government of any colour, the  
944 British State, would wish to site the repository in a region where it is  
945 fundamentally flawed?

946 **PROF STUART HASZELDINE:** I believe we have been able to explore that issue  
947 without the emotional terms you are using now. We clearly need a site, but  
948 we need to achieve good value for money for the UK as a whole. What we  
949 have now is the first two communities to volunteer, but we know that there  
950 are better sites in the UK. The UK Government should be actively working  
951 to encourage those communities to engage with the process, and in other  
952 countries this engagement has lasted for much longer – for many years. We  
953 need to make sure we have a good spectrum of choice. At the moment, by  
954 analogy, we are not sure which brands of soap powder we are choosing  
955 between, or even if we have a choice at all. This is not a satisfactory  
956 way of proceeding.

957 **BRUCE MCKIRDY:** We do not see these activities as mutually exclusive. We  
958 have been clear that we want to examine the West Cumbrian geology in more  
959 detail by entering Stage Four of the process, but in parallel DECC wants  
960 to look around the rest of the country. And that is the plan for  
961 proceeding.

962 **PROF BRUCE YARDLEY:** You will see that there is a remarkable amount of  
963 agreement here, despite our different positions. This highlights that we  
964 need more opportunities for people to sit face-to-face, or shoulder-to-  
965 shoulder, and discuss this to better understand our sticking points. Of  
966 course Government can be seen to be out to get us, but that is always the  
967 case!

968 **SIR TONY CUNNINGHAM MP:** Can I ask each panel member to briefly sum up  
969 their position please?

970 **PROF STUART HASZELDINE:** I would like to formally rebut Jamie Reed's  
971 assertion that Section Six of my submission is incorrect: I do consider  
972 this statement to be factual. I would note that the process today has  
973 surfaced many issues that the MRWS process did not manage to surface. I  
974 consider that the public should be informed and represented by impartial  
975 advisers on this issue – and it is not always clear who "the public" are,  
976 whether this is communities, councils or other groups. I believe we need  
977 to survey the whole of the UK to seek alternative regions in which to  
978 engage with the public. Much of this work has already been done in the  
979 1970s and 1980s and would require trivial additional work. The NDA say  
980 they are supportive of this work: therefore, why should we rush into  
981 spending £40 million when we could instead go to other communities to  
982 begin a dialogue on this issue? It is clear that West Cumbria is not a  
983 geologically suitable setting. It is clearly a setting that would rely  
984 heavily on engineering, and lead to the technical discussions that would  
985 arise from that – resulting in questions and issues of "my number or your



986 number?”. For example, we know that the height of the wall protecting  
987 Fukushima from a tsunami was judged to be adequate by engineers, but then  
988 this later failed. Relying purely on engineering in a repository puts us  
989 in that position again. I consider it would be premature and wrong to go  
990 to Stage Four of MRWS process in West Cumbria.

991 **BRUCE MCKIRDY:** I believe it is appropriate and entirely reasonable to  
992 proceed to the next stage. We know we have the information we need; let’s  
993 now look at it further. We should be able to look at Professor  
994 Haszeldine’s claims and also look at other claims. At the end of the day,  
995 the independent regulators will be the arbiters of this. We should  
996 remember that Stage Four is only about finding out more, and communities  
997 retain the ability to withdraw at any stage of the process if they so  
998 wish.

999 **PROF BRUCE YARDLEY:** There is a case that there could be suitable sites in  
1000 West Cumbria – but there also might not be. Given that uncertainty, there  
1001 remains a case to continue to look for suitable sites elsewhere. But I  
1002 consider there is a reasonable chance of finding a suitable site in West  
1003 Cumbria.

1004 **SIR TONY CUNNINGHAM MP:** Thank you all. My colleagues will know themselves  
1005 we meet regularly and it is often the case that when we meet, one or two  
1006 of the MPs is unable to attend, so for the six MPs here present to all  
1007 attend a meeting is a sign of our great engagement, and we are very  
1008 grateful. Thank you for taking the time and trouble to join us.

--Meeting ends--