

The potential health effects to coastal populations of the dumping of  
330,000 tons of radioactively contaminated mud on the coast of  
Wales, 2.8km from Cardiff, material originating from dredging near  
the British nuclear site at Hinkley Point, Somerset

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## **1. Introduction**

This report, which was commissioned by a number of individuals in Wales, addresses the proposal to dredge approximately 330,000 tons of radioactively contaminated sediment from the Hinkley Point Nuclear power station site and dump it at a site on the Welsh coast some 2.8km from the city of Cardiff. The question asked was: what are the potential health outcomes of such a process?

To begin, it must be understood that analysis of the health outcomes of exposures to internal radionuclides is an area where new evidence which has emerged after the Chernobyl accident has shown the current assessment of risk to be unsafe. This evidence, which switches scientific attention from cancer to genetic effects at birth, has been reported in more than 20 peer-reviewed studies from many countries in Europe and cannot be denied. Nevertheless, the authorities have refused so far to address the evidence in any way and continue to apply the unsafe radiation risk model of the International Commission on Radiological Protection (ICRP) [1] which is based on the inappropriate concept of absorbed dose. It is this radiation risk model which is the basis of the predicted doses to Welsh individuals given in the application from 2012 and on these figures the Welsh authorities issued the original licence in 2014. The predicted absorbed doses are meaningless when applied to the internal exposures to coastal populations which will result from inhalation of radioactive particles resuspended by Sea to Land transfer, the most relevant vector of exposure. Dose cannot be used for internal exposures [2-4].

## **2. The proposal**

Green Audit has carried out research since 2001 on both contamination [5,6] and health effects near Hinkley Point [7-10], on the effects of radioactive contamination of the river Blackwater [11], the Severn Estuary [12] and the Welsh coast of the Bristol Channel including Cardiff [13]. A summary study of the effects of exposures to Sea to Land transfer of contaminated sediment near Hinkley Point was published in the peer-review literature in 2015 [10]. It reported statistically significant excess risk of infant deaths which were related to proximity to the sea. It also reported the excess breast cancer risk associated with living near the intertidal sediment. Although attacked by Dr Julia Verne of the South West Cancer Agency, the paper was reviewed by Dr Derek Pheby, an epidemiologist and ex-Director of the Cancer registry, who wrote that the study results were clearly correct and we copy these in Appendix 1. Thus, there is already persuasive data to show that the effects of intertidal sediment contamination near Hinkley Point have caused the deaths of adults and babies on the Somerset side of the Severn Estuary/ Bristol Channel. The results of the studies are obviously relevant to the proposal to dredge the material and move it close to Cardiff.

The positions of the dredging and the location of the dumping are shown in Figure 1. The distance from the dump site:

- to Cardiff is 2.8km,
- to the holiday beach at Weston-Super-Mare coast is 13km and
- to the origin at Hinkley Point is 24km.

**Fig 1.** Map of the dump site and origin of the radioactive material. The dump site is defined by a polygon drawn between CG1 to CG4. The line from CG3 to CG4 parallels the Cardiff coast at a distance of 2.8km. There is a breast cancer and infant mortality cluster at Burnham on Sea downwind of Hinkley Point and adjacent to the contaminated sediment.



It is of singular interest that the permission document of 2014 states that no dumping may take place south of latitude  $51^{\circ} 25' 48''$  N. This is a West-East line from Lavernock Point west of Cardiff to Sand Point south of Clevedon and reduces the likelihood of contamination finding its way to the beaches in Somerset and the further contamination of the River Parrett estuary where local populations have already been shown to have excess cancer and infant mortality risk which it was argued was due to exposure to aerosolized intertidal sediment. The logic of dumping close to Cardiff may relate to historical decisions, but these in turn may also have been predicated on a requirement to keep contaminating material from the Somerset beaches. Tidal velocity for mixing could have as easily been provided by many positions on the English side of the Bristol Channel sandbanks, another important consideration for the issue.

### **3. The fate of the dredged material**

The strong tidal currents in the Severn Estuary produce a rather unique system where most of the sediment/ particulate material is permanently in suspension. The Physical Science Report for the pre-application refers to sediment levels in the estuary having been measured at between 100mg and 2g per litre of seawater, kept more or less permanently in suspension, with the higher levels occurring close to the bottom. It is further conceded that any sediment dumping will result in a quantitative increase in suspended sediment load in the whole estuary. Nevertheless, there are two important aspects of this which relate to human health effects:

1. It is clear that the new suspended radioactive and contaminated sediment will drop out and will add to the mud banks and muddy intertidal material in areas of low tidal energy at slack water, that is in Cardiff Bay, and in estuaries of the Usk and Parrett. This is likely to be most effective in Cardiff Bay.
2. Whilst it is accepted that the shallow water in the Severn Estuary coupled with the strong currents produces conditions for breaking waves and white water over most of the area, no consideration has been made of the Sea-To-Land transfer of fine particles resulting from the well-described surface tension effects discovered by Harwell scientists in the 1980s to account for the very high levels of radioactive particles measured on the Cumbrian coast resuspended from historic Sellafield releases. A search of the documents associated with the application reveals no discussion of Sea-To-Land transfer.
3. Aerosolised radioactive particulates produced by waves and Sea-To-Land transfer represents a vector through inhalation for radioactive contamination in populations living within 2km of the coast, as will be further discussed below.

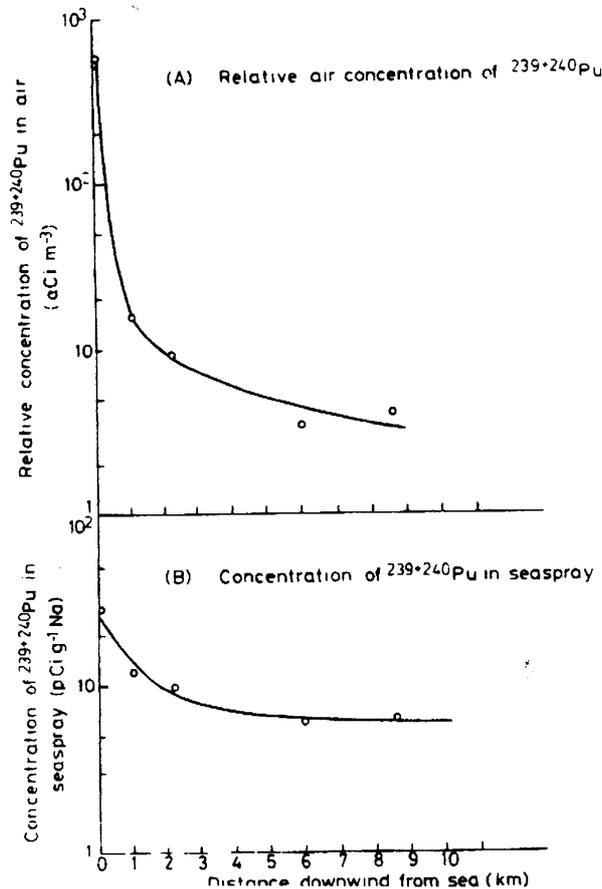
### **4. Sea-To-Land Transfer and its effects**

The phenomenon of Sea to Land Transfer was both discovered and explained by studies carried out in the 1980s by scientists from the National Radiological Protection Board and the Atomic Energy Research Establishment, Harwell. The process itself was shown to occur for plutonium which had been released to the Irish Sea by pipeline but was clearly finding its way back to land, contrary to the predictions of the environmental impact statement of those pumping the radioactive waste through the Sellafield pipelines [14-16].

The process of aerosolization is one where fine particles in suspension in seawater or in intertidal sediment near the coast become attached to air bubbles produced by wave action. These are the air bubbles that cause “white horses” in shallow water and when waves break on beaches. In the case of the 1984 study by Eakins and Lally [14], the white horses picked up radioactive particles of Plutonium from Sellafield which were then measured in the muslin screens Eakins and Lally deployed. The issue is discussed in my book *Wolves of Water* 2006 [17] in connection with the sea coast effect on cancer in Wales and in Somerset, South Wales and the Severn Estuary wards. When the bubbles, with their skin surface load of radioactive particles, reach the surface they turn inside out and project the particle into the air, at the same time giving the particle an electrostatic charge which keeps it airborne. The particles then are blown ashore in the air and slowly drop out at a rate dependent on their size and mass. People living in the high concentration area, up to 1 or 2km, inhale these particles

which are then transferred from the lungs to the lymphatic system, from which they can reach any part of the body and cause genetic damage and cancer and other illnesses. Fig 2 shows the results for Plutonium published by Eakins and Lally in 1984 with the trend in air concentration of Plutonium by distance from the coast.

**Fig 2** Trend in Plutonium by distance from the Sea in Cumbria [14].



Evidence of health effects is to be found in studies of cancer and leukemia in people living near the sea coast in areas where intertidal zones are likely to be contaminated with radioactivity. Green Audit studies have already been mentioned. Figures 3 to 6 are risk maps taken from some of these studies. Fig 3 is from a study commissioned by Michael Holmes MEP and shows lung cancer mortality in wards along the Severn Estuary. Note the high risk in wards adjacent to the contaminated sediment at the mouth of the estuary. Figures 4, 5 and 6 are taken from a study I carried out in 2001 for the Low Level Radiation Campaign and the late Hugh Richards. It looked at effects of pollution from the Nycomed Amersham radionuclide production facility on the River Taff near Cardiff (location shown on map Fig 4). Together with the releases from the nuclear sites in the region, discharges from Nycomed Amersham created significantly high levels of Tritium in surface seawater and in biota. The sea coast effect is clear. Fig 4 gives lung cancer mortality (women). Fig 5 gives all malignancies mortality (men). Fig 6 is lung cancer mortality (men). I'm sorry about the quality of figures 5 and 6; I only have this study on an old computer and at the moment I

don't have the means of transferring it to a modern machine so I had to take screen shots on my mobile. Figure 4 is reproduced in *Wolves of Water* so Richard Bramhall was able to scan it for this paper.

What is fairly clear is that lung cancer mortality risk is elevated along the coastal wards of the Severn Estuary, which is plausible if the effects are due to inhalation of radioactive material suspended in the seawater and tidal flows and aerosolized by well described processes. The discovery of this sea coast effect on cancer emerged from the study of cancer in small areas in the whole of Wales carried out for the Irish State in connection with a court case against British Nuclear Fuels. The case involved analysing the database of the Welsh Cancer Registry from 1974 to 1989; the results showed a very significant sea coast effect on cancer incidence for most cancer sites - an effect which was greatest in areas of greatest contamination of the coastal sediment by material from Sellafield. Results were published in *Wolves of Water* [17] and will be published in the peer review literature in the next 6 months.

**Fig 3** Map of lung cancer risk in wards near the Severn Estuary, contaminated with material from the nuclear sites at Hinkley Point, Berkeley and Oldbury (shown as red dots). Note the higher risk along the coastal strips.

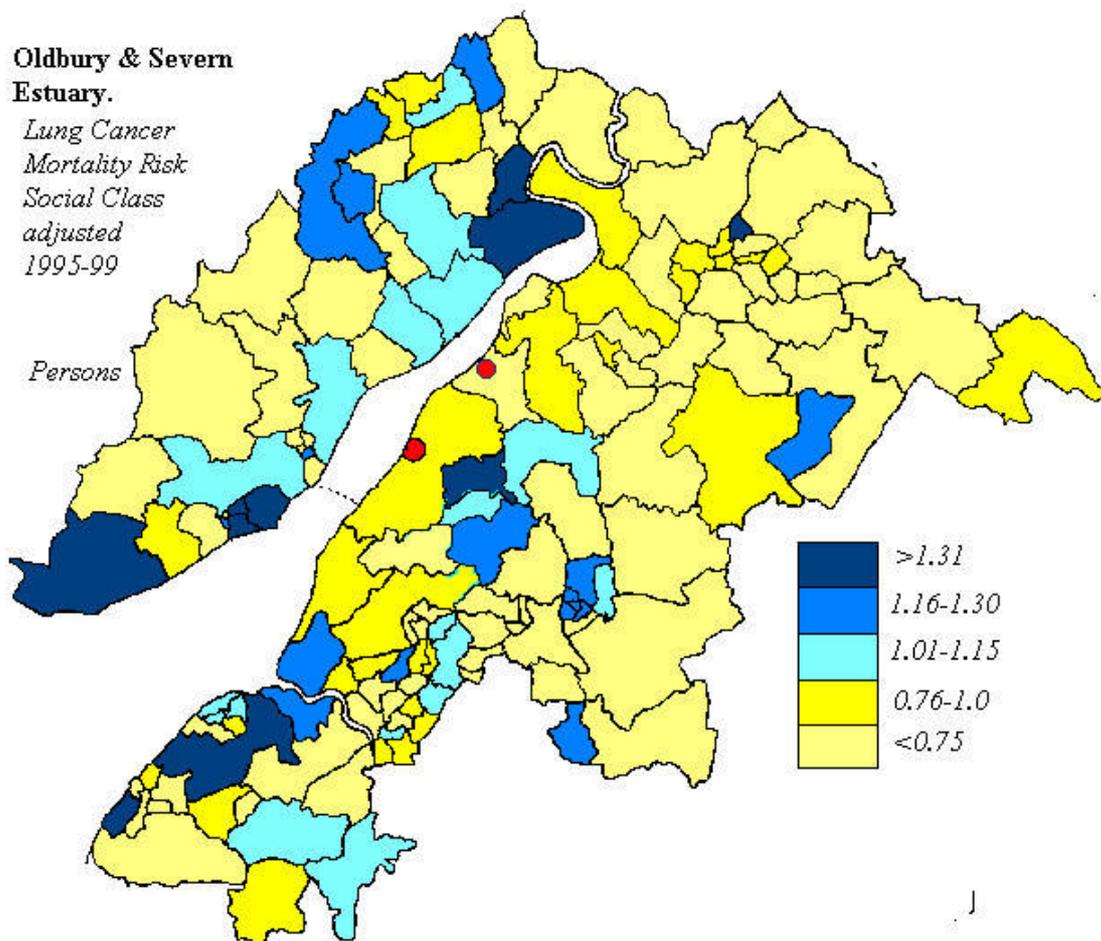
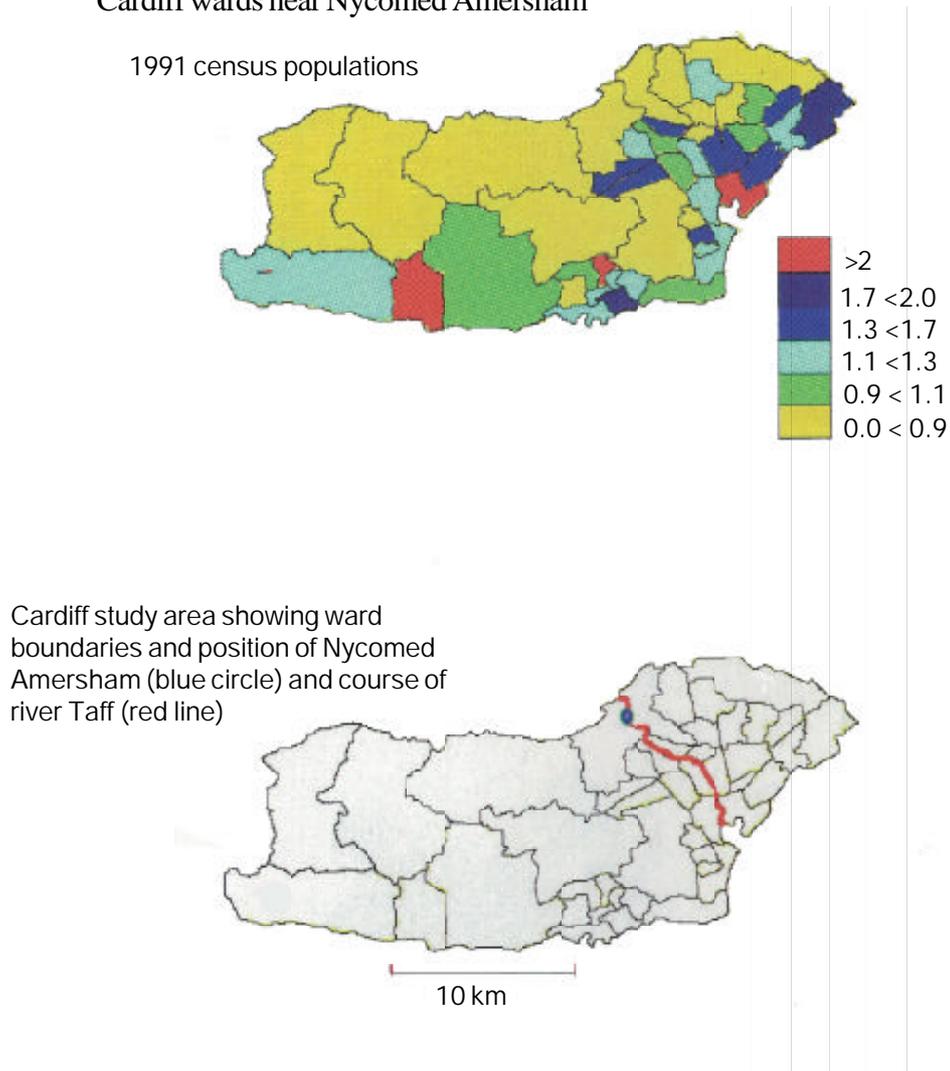


Fig 4: Female lung cancer mortality risk 1995 - 2000  
Cardiff wards near Nycomed Amersham



## 5. The Hinkley Point dredging

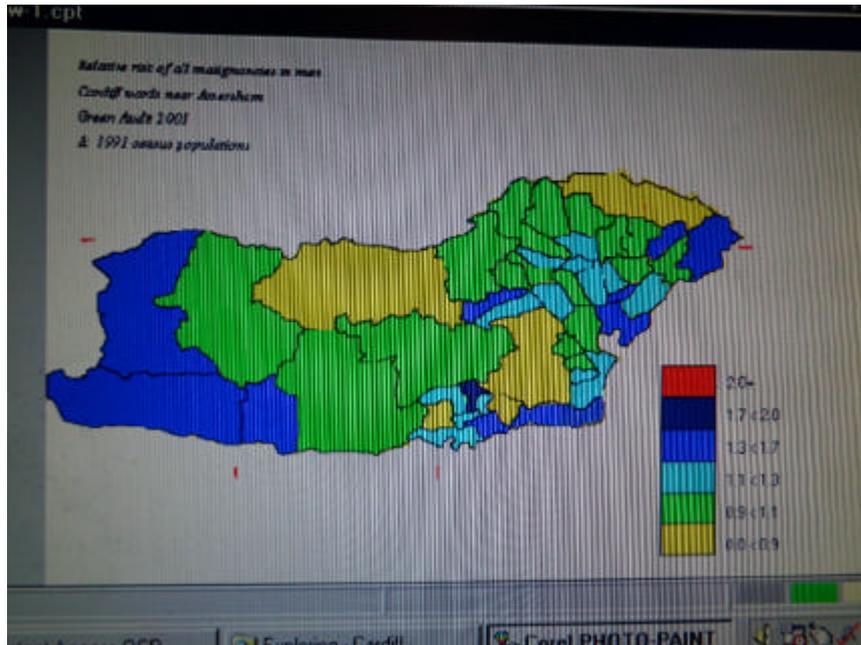
The foregoing discussion gives rise to this question: *What effect on the coastal population of Wales will this dredged material have?* First, it should be realized that historical discharges from Hinkley Point and the major radioactive contribution of atomic weapons testing fallout to the offshore mud remains in the sediment at various depths within the mud. This can be seen by the autoradiograph of a mud core obtained in the Irish Sea and shown in Fig 7 below. It can be argued that the safest course is to leave these strata undisturbed. Deep dredging of the contaminated sediments as proposed would release very large quantities of radioactive material into the Severn Estuary. This particulate material would appear in the marine environment very close to the city of Cardiff and would certainly precipitate out in low tidal areas as well as contributing to the levels of radioactivity in the air through the mechanisms discussed above. This would, as can be seen by the studies carried out by Green Audit, increase the levels of all types of cancer in the area

## 6. Other effects

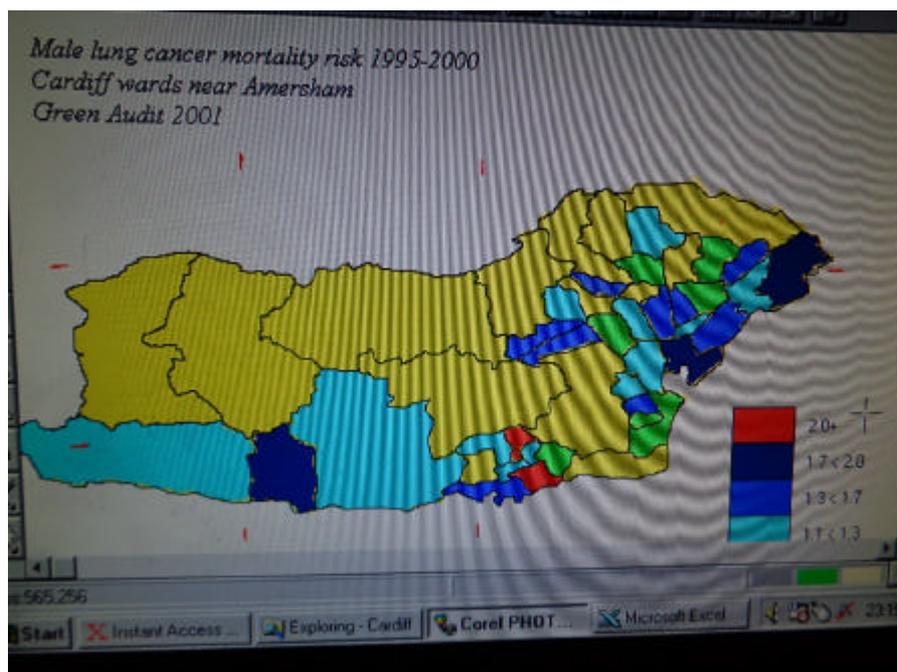
It is clear that insufficient attention has been paid to the effects of the recirculating contaminated material on marine life. However, this brief report is aimed at drawing attention to the evidence for the effects of sea to land transfer and inhalation on cancer which would follow permission for the proposals. Recent criticisms by Green Audit of the proposals to release radioactive material from Bradwell resulted in the decision not to pursue the Magnox Fuel

Element Dissolution and dispersion processes there. One of the factors in that decision was the failure to justify releasing material to the marine environment. A similar argument can be developed in this case.

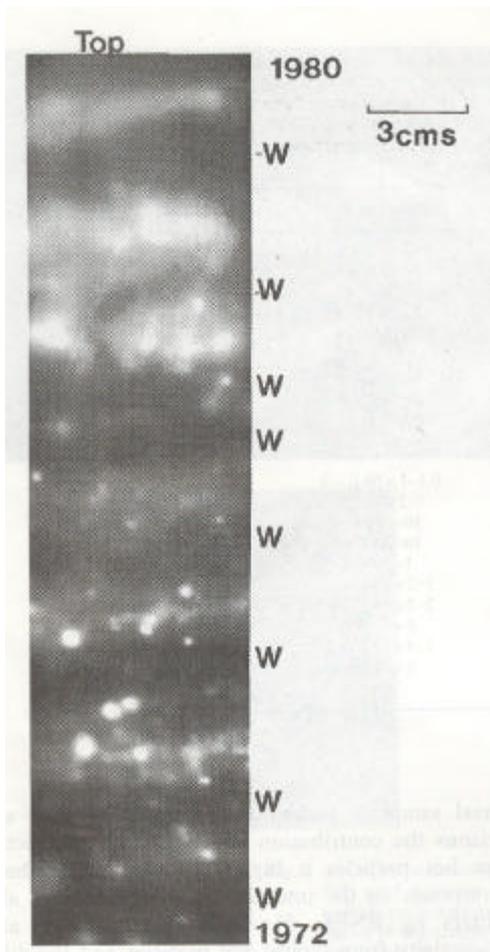
**Fig 5** All cancer mortality in men in Cardiff Wards; note coastal effect.



**Fig 6** Male lung cancer mortality risk, Cardiff Wards



**Fig 7.** Mud core from Ravenglass near Sellafield showing radioactive particles at different depths beneath the mud surface ( courtesy of the late D.S.Popplewell, ex NRPB).



## **7. Conclusions and recommendations**

Exposure to radioactive material which has a quantifiable probability of causing harm to health must be justified in relation to benefits to balance the harm. In this case, no benefits would accrue to Welsh populations; indeed, the people living near the estuaries would suffer significant harm. It is therefore recommended that the Welsh Assembly oppose the dumping of this material close to the city of Cardiff and indeed close to any part of the Welsh coast.

## References

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4. Busby Christopher (2013). Aspects of DNA Damage from Internal Radionuclides, New Research Directions in DNA Repair, Prof. Clark Chen (Ed.), ISBN: 978-953-51-1114-6, InTech, DOI: 10.5772/53942. Available from: <http://www.intechopen.com/books/new-research-directions-in-dna-repair/aspects-of-dna-damage-from-internal-radionuclides>
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8. Busby C, Dorfman P, Rowe H (2000) Cancer Mortality and Proximity to Hinkley Point Nuclear Power Station in Somerset: Part II Prostate Cancer. Occasional Paper 2000/3 Aberystwyth: Green Audit
9. Busby C, Dorfman P, Rowe H (2000) Cancer Mortality and Proximity to Hinkley Point Nuclear Power Station in Somerset: Part III All malignancies, lung and stomach cancer. Summary Occasional Paper 2000/4 Aberystwyth: Green Audit
10. Busby Christopher, de Messieres Mireille and Morgan Saiorse (2015) Infant and perinatal mortality and stillbirths near Hinkley Point nuclear power station in Somerset, 1993-2005; an epidemiological investigation of causation. *JJ Epidemiol. Prevent.* 2015 1(2) 013
11. Busby Christopher (2015) Breast Cancer Mortality in Estuary Wards near Bradwell Nuclear Power Station, Essex, UK 2001-1995 . *Jacobs Journal of Epidemiology and Preventive Medicine* 1(1)- 06; <http://epidemiology.jacobspublishers.com/index.php/j-j-epidemiol-prevent-1-1-005>
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## Appendix 1

Correspondence between "M\*\*\*\*" a journalist, Jim Duffy Coordinator of the Stop Hinkley organisation at the time, and the late Derek Pheby an epidemiologist and ex-Director of the South West Cancer Intelligence Unit.

Jim, Sent in confidence. Derek said I could share it with you. M\*\*\*\*

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**From:** F PHEBY [mailto:derekpheby@btinternet.com]

**Sent:** 09 December 2008 15:44

**To:** M\*\*\*

**Subject:** Re: Burnham breast cancer INCIDENCE figures released! 50% higher than average

**rom:** F PHEBY [mailto:derekpheby@btinternet.com]

**Sent:** 07 December 2008 20:31

**To:** M\*\*\*

**Subject:** Re: Burnham breast cancer INCIDENCE figures released! 50% higher than average

Dear M\*\*\*,

Thank you very much for asking me to review this paper. The first point that I would like to make is that it is outrageous that the 'Stop Hinkley' campaign had to invoke the Freedom of Information Act, backed by a judgment in the House of Lords, to obtain incidence data from the South West Cancer Intelligence Service.

This is exactly the position I found myself in over osteosarcoma in young people in Helston, where the SWCIS insisted (on the basis of no research) that there were no environmental risk factors operating, and refused absolutely our request for cooperation and for incidence data. In fact we obtained our data by other means, and demonstrated a very strong link between domestic radon and osteosarcoma.

In our case, I wondered if the motivation for this was financial, because the cost of effective anti-radon measures in all houses in high radon areas would be immense, and I wonder whether similar considerations are involved in the Burnham breast cancer situation.

This was certainly not the situation when I was Director of the South-Western Regional Cancer Registry. I took the view that the principal purpose of a cancer registry was to support research into the causes and distribution of cancer, and into the outcomes of interventions, both preventive and therapeutic. For that reason I worked very hard to introduce modern technology into the process, and to improve the quality of the data so as to make it fit for purpose. I had no problem whatsoever releasing incidence data to *bona fide* researchers, subject of course to their acceptance of our

protocol which ensured conformity to the Data Protection Act and protection for the confidentiality of data subjects.

I have not always agreed with Chris Busby in the past. I remember, some years ago, crossing swords with him on 'You and Yours' about the La Hague reprocessing plant, which was a most interesting discussion. He is, however, a respected scientist of considerable repute, whose views are challenging and who needs to be taken seriously. He, and the Stop Hinkley campaign with whom he has been working, deserve better than to be treated so contemptuously by the SWCIS, particularly in view of the public importance of the issues in which they are engaged.

I am at a loss to understand for what purpose the SWCIS considers it collects data, unless it is to enable scientific investigation by *bona fide* researchers of important questions of public concern. It should not be deploying considerable sums of public money in order that the data it collects should disappear into a black hole.

Turning to the paper itself, I have repeated Professor Busby's calculations, and come to a very similar conclusion. Taking both Burnham wards together, over the whole study period, I calculated a chi-squared value for the association between incidence of breast cancer and residence in Burnham, in comparison with England and Wales as a whole. The figure I calculated was 25.526. In other words, the increased incidence of breast cancer in Burnham was very unlikely to have arisen by chance. The probability of this being so was 0.00000044, i.e. the odds against this association arising by chance were more than two million to one.

What we cannot know from the data made available is what this means, and how it has arisen. We need to know, for example, the precise distribution of the cases within Burnham, which would enable us to model with some degree of accuracy levels of exposure to environmental hazards that may be causal factors in the development of these cancers. We also need to know more detail of the nature of these cancers, because breast cancer is not a single disease, but there are several different sorts, with different risk factors involved in each.

All this makes the attitude of the SWCIS all the more incomprehensible. I can understand that they would have difficulty releasing data with all the detail outlined above which is necessary for a comprehensive study of the issue, because such detail could make individual data subjects identifiable to third parties, which could compromise their entitlement to confidentiality. There is all the more reason, therefore, why in such cases, both in Burnham and in the instance I previously cited at Helston in which I was involved, they should be undertaking the research themselves, in collaboration with independent investigators such as Professor Busby and myself. They should not be dismissing out of hand the conclusions of respected scientists, while behaving as proprietors of the cancer registry database, and treating it as their own private fiefdom. Rather, they should see themselves as custodians of what should be an immensely valuable public asset, which should be used in ways that contribute to the public good.

I hope very much that the SWCIS can be persuaded to see the light, and start cooperating with other investigators over matters of serious public concern such as this. I am afraid, though, as I found when I was Director of the cancer registry, you get no medals for being off-message, and the culture of concealment is probably now so deeply ingrained as to be very difficult to change.

With best wishes,

Derek.

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**From:** M\*\*\* <M\*\*\*@\*\*\*\*\*>  
**To:** derekpheby@btinternet.com  
**Sent:** Thursday, 27 November, 2008 2:30:22 PM  
**Subject:** FW: Burnham breast cancer INCIDENCE figures released! 50% higher than average

Many thanks Derek for looking at this . Best Wishes M\*\*\*

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**From:** Stophinkley@aol.com [mailto:Stophinkley@aol.com]  
**Sent:** 01 October 2008 13:07  
**To:** M\*\*\*  
**Subject:** Burnham breast cancer INCIDENCE figures released! 50% higher than average

Hi M\*\*\*

This is what I was phoning you about: it follows a new Lords' ruling that frees up incidence data.

Best wishes

Jim

## **New study shows 54 extra women got breast cancer in Burnham in 11 years**

**A new study of breast cancer registrations in Burnham North and South shows a 50 percent excess above national figures.**

The eleven year study by Professor Chris Busby uses data obtained since a landmark House of Lords ruling in July that allowed 'incidence' data to be made available to independent researchers. Previously just 'mortality' data was available. Incidence data is more helpful in defining environmental links to health effects.

Stop Hinkley applied straight away for the new statistics which the South West Public Health Observatory was now required to supply under the Freedom of Information Act. We asked Prof (formerly Dr) Busby to analyse the figures.

Over the eleven year period 1994 to 2004 113 women would have been expected to contract breast cancer. In fact 167 women were diagnosed: a rate fifty percent higher than normal. The statistical chance of this occurrence over the two wards is one in 200,000. The statistics allow for any age differences from the norm.

The alarming figures back up several previous studies by Prof Busby including last year's infant mortality study, highlighted on BBC West, that found a three-fold excess in estuary wards near Hinkley, including Burnham (1).

Earlier studies from 2000 onwards have shown excess of breast cancer mortality (Busby) (2) and incidence (PCAH (3) and SW Cancer Intelligence Service). SWCIS has always denied the link to Hinkley Point.

Three Somerset Health Authority studies in 1983, 85 and 87 showed excess child leukaemia in wards near Hinkley but did not look at Burnham. A German government-sponsored study this year found a doubling of leukaemia in children living upto 5 kilometres from all 16 nuclear power stations with an observable effect upto 10 kilometres (6 miles) (4).

Chris Busby made the headlines in **New Scientist** (9<sup>th</sup> September) with a joint study showing uranium to be much more radioactive than thought due to its absorption of gamma rays (5).

Jim Duffy

Stop Hinkley Coordinator

1. Study on infant deaths near Hinkley: <http://www.stophinkley.org/PressReleases/pr080229.htm>

2. Breast cancer & proximity to Hinkley Point, 2000: apply to LLRC via [lowradcampaign@gmail.com](mailto:lowradcampaign@gmail.com)

3. PCAH Citizens Epidemiology: apply to LLRC via [lowradcampaign@gmail.com](mailto:lowradcampaign@gmail.com)

4. New Scientist on leukaemia clustering near all 16 German nuclear reactors: <http://www.newscientist.com/channel/health/cancer/mg19726423.500-do-nuclear-plants-boost-leukaemia-risk.html>

5. New Scientist on risks from uranium: <http://www.nuwinform.se/tickell20080903newscientist.html>