Indicators for Land Contamination

Science Report SC030039/SR

ENVIRONMENT AGENCY

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ACRONYMS AND GLOSSARY

Attribute data   Data that describe the properties of geographic features. For each class of features, the data are usually contained in a table where a row represents the geographic feature and each column represents one attribute of a feature, with the same column representing the same attribute in each row.

CLO   Contaminated Land Officer

Data   A collection of facts, concepts or instructions in a formalised manner suitable for communication or processing by human beings or by computer (Walker, 1993).

Database   A collection of data organised according to a conceptual structure describing the characteristics of the data and the relationships among their corresponding entities, supporting applications areas. For example, a GIS database includes data about the position and characteristics of geographical features (Walker, 1993).

Database management system (DBMS)   A collection of software for organising the information in a database. Typically a DBMS contains routines for data input, verification, storage, retrieval and combination (Walker, 1993).

Defra   Department for Environment, Food and Rural Affairs

Disaggregation   The process of dividing (e.g. a dataset) into its constituent parts

Envirocheck™   A report produced by Landmark Information Group containing a summary of records on environmental issues surrounding a chosen location. Commonly supplied with copies of historic mapping for the same area.

ESRI   Provider of geographic information systems (ArcView and ArcGIS)

Excel™   Spreadsheet software published by Microsoft.

Geographic information system (GIS)   A computer system for capturing, storing, checking, integrating, manipulating, analysing and displaying data related to positions on the Earth's surface. Typically, a Geographical Information System (or Spatial Information System) is used for handling maps of one kind or another. These might be represented as several different layers where each layer holds data about a particular kind of feature. Each feature is linked to a position on the graphical image of a map.

Geo-reference   To establish the relationship between page co-ordinates on a planar map and known real-world co-ordinates.

Granularity   The size of the units under consideration in some context. The term generally refers to the level of detail used in a dataset – high granularity

corresponds to a high level of detail.

Groundwater	Refers to all subsurface water as distinct from surface water. Generally groundwater is considered to be that water which is below the zone of saturation and contained within porous soil or rock stratum (aquifer)
HLUD	Historic Land Use Database – a Landmark Information Group dataset of the locations of historic industrial activity as depicted on old Ordnance Survey maps at various scales.
HMRC	Her Majesty's Revenue and Customs (formed from HM Customs and Excise, and Inland Revenue)
Information	Intelligence resulting from the assembly, analysis or summary of data into a meaningful form (Walker, 1993).
IPC	Integrated Pollution Control
IPPC	Integrated Pollution Prevention and Control
Landmark	Landmark Information Group Limited
LLW	low-level waste (radioactive)
Metadata	Data about data and use aspects of it.
MoD	Ministry of Defence
mSv	millisievert
NHBC	National House Building Council
NIRS	National Incident Reporting System
NORM	naturally occurring radioactive material
NLUD	National Land Use Database
nSv	nanosievert
ODPM	Office for the Deputy Prime Minister
ONS	Office of National Statistics
OS	Ordnance Survey
Part IIA	Part IIA of the Environmental Protection Act 1990 which established the responsibility of local authorities for dealing with land contamination and contaminated land issues
PDL	previously developed land
Polygon	A closed plane figure bounded by straight sides
PPC	Pollution Prevention and Control
PPG	Planning Policy Guidance

Raster	Raster data is an abstraction of the real world where spatial data are expressed as a matrix of cells or pixels, with spatial position implicit in the ordering of the pixels. With the raster data model, spatial data are not continuous but divided into discrete units. Unlike vector data, however, there are no implicit topological relationships.
RDA	Regional Development Agency
Relational database	A database management system with the ability to access data organised in tabular files that can be related to each other by a common field (ESRI, 1996).
Resolution	In aerial photography, resolution is a factor of the height at which the photographs were originally taken and the resolution at which the photographs were scanned to create a digital image. The resolution is usually expressed as the on-the-ground size of each individual pixel that comprises the image. For example, '50 cm data' means that each pixel in the digital photograph covers 50 cm on the ground.
RSA	Radioactive Substances Act 1993
Scale	The ratio of the distance measured on a map to that measured on the ground between the same two points. In the UK, most map scales are now metric and are shown, for example, as 1:50,000, which represents a scale of 1 cm = 50,000 cm (or 500 metres)
Spatial data	Any information about the location and shape of, and relationships among, geographic features. This includes remotely sensed data as well as map data (ESRI, 1996).
µSv	microsievert
Vector data	Vector data consist of lines or arcs, defined by beginning and end points, which meet at nodes. The locations of these nodes and the topological structure are usually stored explicitly. Features are defined by their boundaries only and curved lines are represented as a series of connecting arcs. Vector storage involves the storage of explicit topology, which raises overheads; however, it only stores those points which define a feature and all space outside these features is 'non-existent'.
VLLW	very low-level waste (radioactive)
WAG	Welsh Assembly Government
WDA	Welsh Development Agency
WML	Waste Management Licensing Regulations 1994 (as amended)

EXECUTIVE SUMMARY

Four indicators have been developed to assist in the management of land contamination in England and Wales:

CS1   Extent of Industrial Land Use

CS2   Identification of Land Contamination

CS3   Remediation of Land Contamination

CS4   Newly Created Land Contamination

These definitions use a definition of land contamination that includes all land potentially affected by both chemical and radiological contamination. Any potentially contaminating land-use was included, irrespective of the hazard level of the contaminant or associated risks to receptors. Identified and remediated sites were those known to local and national agencies, either through the planning or Part IIA regimes, and where specific interventions were recorded.

This project derives estimates for the area and number of sites for these indicators for chemical and/or radiological contamination. Two main techniques were employed:

- extrapolation from surveys undertaken at 12 locations throughout England and Wales;

- examination of national data sources.

The 12 sample areas aimed to cover a representative cross-section of local authorities, on a regional basis, and on the basis of industrialisation as defined through the National Statistics Area Classification scheme. Sampling was restricted to urban areas only; factors were applied to incorporate rural land in the final totals.

The final answers for the indicators are expressed as a range of values obtained and are qualified by uncertainties generated by the different techniques. The mid-point of these ranges are:

CS1   300,000 ha   (325,000 sites)

CS1 (Radiological)   27,000 ha   (53,000 sites)

CS2	67,000 ha	(33,500 sites)
CS3	44,000 ha	(21,000 sites)
CS4	30 ha	(750 sites)

The radiological figures are covered in detail in Appendix A. This refines the results to consider the potential for significant radioactive contamination from particular activities and the risks associated with them.

From the information in the main report and Appendix A, it is concluded that there are somewhere between 100 and 1,000 sites (with the best estimate being 250) that **may** fall within the definition of radioactively contaminated land under the proposed Radioactively Contaminated Land Regulations. **However, only a fraction of these are actually likely to do so**. These are sites where some form of intervention to prevent possible or actual harm could be required. This compares markedly to the higher number of sites identified under CS1 (50,000) in the main report.

CS1 (radiological) is purely a measure of the number of sites were radioactive material has been used, stored, disposed of, or concentrated as a result of industrial activity. It does not equate to the presence of actual elevated levels of radioactivity, or risk or harm to human health or ecosystems resulting from it. There is no suggestion that these activities have resulted in contamination to any appreciable level at the vast majority of sites.

It is estimated that, of the sites potentially affected by radioactive contamination, roughly 0.5 per cent could be contaminated sufficiently to represent a risk of causing harm. It must be further noted that of this 0.5 per cent, there would have to be a combination of the nature and extent of the radioactivity, the land use and how persons inhabit or visit the site for actual harm to occur. So, while there may be roughly 250 sites that could cause harm, only a proportion of these will be doing so – though this fraction cannot be estimated at present.

The numbers produced by this report should be regarded as merely indicative. Particular caution is needed for the number of sites, as long histories of continuous but changing land use patterns defy capture as discrete site entities. Limitations in the methodology that emerged during the work include the potential distortions caused by extrapolation from inappropriate sample areas. Furthermore, many of the national datasets are inadequate and incompatible, as there are no commonly agreed definitions for land contamination and remediation and few established protocols for sharing data between government departments and different agencies. Specific recommendations on addressing both these concerns are included in the report.

1.   INTRODUCTION AND DEFINITIONS

BACKGROUND

1.1   The purpose of this report is to describe the methodologies used and the results of a project to populate proposed indicators for England and Wales for measuring progress with identifying land contamination (including land affected by radioactivity) and securing its remediation where necessary to protect human health and the environment.

1.2   Land contamination in England and Wales is identified and dealt with through a number of different regulatory processes. These include:

- Part IIA of the Environmental Protection Act 1990;

- Town and Country Planning Act 1991;

- Waste Management Licensing Regulations 1994 (as amended);

- Pollution Prevention and Control (England and Wales) Regulations 2000 (as amended);

- Water Resources Act 1991;

- Radioactive Substances Act 1993.

1.3   An explanation of the interaction of these regimes is contained in Annex 1 (paragraphs 45 to 71) of Department of the Environment, Transport and the Regions Circular 02/2000 (DETR 02/2000). The primary regulators for contaminated land in England and Wales are the local authorities under Part IIA of the Environment Protection Act 1990 – generally the district/borough/unitary tier of local government. They are also lead regulators for land contamination under the Town and Country Planning Act 1991 as local planning authorities. Part IIA defines 'contaminated land' and was enacted to deal specifically with land contamination through the identification and remediation of land posing unacceptable risk in its current use and

circumstances. However, it is through development of land subject to the grant of planning permission – under the Town and Country Planning Act – that the majority of land contamination is identified and remediated as laid down by Planning Policy Statement 23: Planning and Pollution Control (PPS23).

1.4   Part IIA presently excludes harm or pollution of controlled water attributable to radioactivity from the scope of that regime. However, the Department for Environment, Food and Rural Affairs (Defra) is drafting a public consultation including draft regulations on radioactively contaminated land. Early indications suggest that Defra will simply extend the existing Part IIA provisions to include radioactivity, with specific modifications to deal with technical and policy issues raised by radioactivity. This will include either an amendment of the definition of contaminated land or a new definition of 'radioactively contaminated land' so as to make clear to what the regime will apply to. Together with statutory and technical guidance, this would enable local authorities to determine land as 'contaminated land' on the basis of radioactivity. The draft will also probably provide that such contaminated land, once determined, must also be designated as a special site, the inspection and remediation of which would then be regulated by the Environment Agency.

1.5   Currently there is no statutory definition of radioactively contaminated land and, apart from the Nuclear Installation Act 1965 or under the planning regime, there is no legal regime under which characterisation and remediation can be compelled. Voluntary remediation can result in the need for disposal of radioactive wastes, such disposals being regulated under the Radioactive Substances Act 1993 (RSA93). An explanation of the current regulatory system pertaining to radioactively contaminated land and waste is given in an Environment Agency report (Environment Agency, 2002a). Nuclear licensed sites are potential special sites under the Part IIA regulations but purely for non-radiological contamination.

1.6   Existing estimates of the extent of land contamination in England and Wales vary, but there may be up to 100,000 sites affected to some degree (DLTR, 2003). It is also estimated that between 5 and 20 per cent of these may require action to ensure that unacceptable risks to human health and the environment are mitigated. However, there is no established basis by which the extent of land affected by contamination on a regional or a national level is determined.

1.7   In 2002, the Environment Agency published its first report under Part IIA on the state of contaminated land in England (Environment Agency, 2002b). This reported the progress with the Part IIA regime and presented data on:

*   Supplementary Credit Approval schemes;

*   Integrated Pollution Control (IPC) authorised sites;

- current and closed waste management sites;

- summaries of data from the National Land Use Database;

- data from Landmark Information Group Limited.

1.8   The report provided site-specific data on 33 sites formally determined as contaminated land under Part IIA. It did not come to any conclusions on the possible extent of land contamination and gave little attention to the wider efforts on land contamination undertaken through the planning regime or by voluntary action by site owners and operators. (It is not the role of the Environment Agency to monitor activity by local authorities under planning.)

1.9   Local authorities are required to inspect their areas for land falling within the Part IIA definition of contaminated land. Under the 1990 Act, local authorities are required to supply certain information to the Environment Agency for the purposes of compiling the regular state of contaminated land report (the next one is due in 2007). These requirements are set out in *Contaminated land inspection strategies: technical advice for local authorities* available on the Defra website (DETR/Environment Agency, 2001).

1.10   However, local authorities are not required to:

- report on sites that may potentially meet the definition of contaminated land;

- provide information about sites they may be considering for detailed inspection or which they may have inspected and decided not to determine as 'contaminated land' under the Environment Protection Act.

1.11   Local authorities are only required to:

- report on sites they have determined to be contaminated land;

- maintain public registers under the Act including information pertaining to remediation activities (e.g. remediation statements, declarations and notices, and special site designations).

1.12   The aim of this project was to employ a wider approach to the problem and to develop a more complete picture of the extent of land contamination in England and Wales and, in particular, to highlight the extent to which this is currently being dealt

with. Better estimates and data on the extent of land contamination in the UK are vital for informed decision-making.

- What is the true scale of the problem?

- What is the progress being made in dealing with it, particularly progress outside the Part IIA regime?

- What is the geographical spread of land contamination and how does it relate to land use?

- A market research report by Market & Business Development (MBD) estimated the investigation and remediation market in the UK to be £905 million in 2003 (MBD, 2004).

1.13   There is little knowledge at present about the scale of the problem of land contaminated by radioactivity in England and Wales. This lack of knowledge needs to be addressed and a baseline assessment of the total extent of such land in England and Wales developed in terms of area and number of possible affected sites. A research report on historic practices that have utilised radioactive materials (DETR, 2000) is currently being expanded to cover an additional set of profiles of land uses that may have been subject to radiological contamination.

INDICATORS FOR LAND CONTAMINATION

1.14   Research by the Environment Agency, Defra and the Welsh Assembly Government (WAG) (Environment Agency, 2001) identified a draft set of national indicators for measuring progress in dealing with land contamination in line with the Government's policy on sustainable development (DETR, 1999a,b). The research also identified a number of sources to provide baseline information and regular reporting of progress on the indicators.

1.15   For the purposes of this report, the definitions of the proposed indicators have been modified to take into account the fact that the contaminated land regime has been in force since April 2000 (July 2001 in Wales) and also to consider the forthcoming regulations for radioactively contaminated land. Further refinements to the indicators were developed during the project to take into account issues relating to data collection.

CS1   Extent of Industrial Land Use

A baseline assessment of the total extent of land that may potentially be affected by contamination, including radiological contamination, in England and Wales.

1.16   CS1 is taken to encompass the entirety of the 'potential' amount of land affected by contamination in England and Wales on the basis of records of the use made of the land. It does not include any assessment of the actual presence of contamination nor the level of risk posed were that contamination to exist, nor of land which may have been contaminated by unrecorded activity or natural phenomena.

1.17   An example could be a former chemical works. This would have used and produced substances with the potential to contaminate land, groundwater and surface water. However, for contamination actually to have occurred:

- those substances would have had to have been spilt or otherwise leaked/shed to ground;

- there would have to be pollutant linkages in order for the substances to adversely affect controlled waters or other defined receptors such as human beings, property, etc.

1.18   Not all such effects amount to 'unacceptable risk'. Therefore, CS1 identifies a site as having a use, either currently or in the past which, based upon the substances used or manufactured, could have given rise to land affected by contamination. It should not be taken to mean that the site actually has elevated levels of contaminants nor that the site is causing, or has the potential to cause, harm or pollution of controlled waters. CS1 can therefore be described as a worst case assessment of land quality in England and Wales.

1.19   The primary data source for CS1 is the distribution of historic industrial practices as revealed by old editions of Ordnance Survey maps, trade directories, etc. CS1 utilises a broad definition of historic industry and, in practice, includes any manufacturing, processing or extraction facility that appears in the records. No attempt has been made to rank the relative hazards of the different industry type or to estimate the fraction of any site that may have been contaminated.

1.20   Other CS1 sites include IPC and Integrated Pollution Prevention and Control (IPPC) operational sites, closed landfill sites, and Local Air Pollution Control (LAPC) licensed sites. Although sites licensed under these various regimes will in theory be free of contamination (as a results of the licence conditions), they are included because of the potential for historic contamination.

CS2   Identification of Land Contamination

The measurement of progress in the identification of land contamination requiring action, including radiological contamination.

1.21   Indicator CS2 includes all land that has been identified as being affected by land contamination through the following mechanisms:

- determination as contaminated land through Part IIA of the Environmental Protection Act 1990 or the equivalent radioactive land contamination legislation when introduced;

- land subject to other environmental legislation relating to pollution of controlled waters (sections 161 and 161A of the Water Resources Act 1989);

- land identified as being affected by contamination such that it requires some form of intervention or management action to ensure that it is suitable for use under the Town and Country Planning Act 1993; and/or

- identified voluntarily by a landowner as being affected by contamination such that it warrants some form of intervention to address risk, avoid regulatory action or to maximise market value.

1.22   The scope of control is different for the different regulatory regimes of planning and Part IIA. This indicator attempts to encompass both regimes. By the nature of the differences between the definitions for CS1 and CS2, CS2 will be a subset of CS1; it will always be smaller both in terms of number of sites and aerial extent. It should be noted that contamination can be discovered on or in land where there was no indication from the data available that any such contamination might be present (e.g. illegal unregistered waste disposal and leaks from domestic oil tanks).

1.23   The recording of site-specific data for CS2 generally falls to the local planning authority and the environmental health department of the local authority. Additional information may be available from the local or regional Environment Agency offices. At a national level, the register of special sites, and local Environment Agency records of local authority regulatory activity provide a running total of overall progress in Part IIA. However, the data represents only that information which has been received by the Environment Agency and may underestimate the total number of sites currently determined as contaminated by local authorities.

CS3   Remediation of Land Contamination

The measurement of progress in the remediation of land contamination, including radiological contamination.

1.24   Indicator CS3 represents land that has had some form of intervention to mitigate or prevent harm arising from the presence of land contamination, and is a subset of indicator CS2. For land that will be identified within CS2, some form of intervention is likely to be undertaken. In time, the figures for the number of sites and aerial extent of CS3 should tend towards those of CS2.

1.25   As with CS2, data on a site-specific basis for CS3 are generally recorded at the local authority level. At a national level, as well as the Environment Agency, a number of government departments/agencies fund or subsidise remediation activities, and are therefore collecting data relevant to CS3, e.g. Defra, Office of the Deputy Prime Minister (ODPM), Department of Trade and Industry (DTI), English Partnerships and the Land Restoration Trust (LRT). In the private sector and particularly among utility companies, the treatment of land contamination is regarded as a priority by a number of major landholders, e.g. the Coal Authority and SecondSite (working for National Grid Transco). Their activities may also involve voluntary remediation, which will increase the totals for CS3 obtained from regulatory/statutory processes.

CS4   Newly Created Land Contamination

The quantity of land contamination and radiological contamination caused since the introduction of the new contaminated land regime, and since its proposed extension to include radioactivity.

1.26   The sole data source for CS4 is the Environment Agency's National Incident Reporting System (NIRS), which represents a record of environmentally polluting (and potentially polluting) events. All events reported to the Environment Agency are recorded in this system, including those where the area of impact may be restricted to a site that is already regulated or controlled.

1.27   Indicator CS1 encompasses the entirety of the 'potential' amount of land affected by contamination. It is therefore speculative and a worst case scenario. The remaining three indicators record actual contamination. CS4 is therefore a record of actual additional contamination caused since the introduction of the contaminated land regime, rather than potential contamination simply as a result of the land having a potentially contaminative use.

1.28   The pollution potential of most industrial uses has fallen since the introduction of waste management licensing, IPC and Pollution Prevention and Control (PPC) permitting and the general take-up of environment management systems. While there is no room for complacency, land contamination is thankfully mainly a legacy of our industrial past.

Definitions of 'contaminated' and the standard of 'remediation'

1.29   As described above, land affected by contamination is dealt with through a variety of different regimes, each with its own scope and standards concerning remediation. The sections above detail which regimes were included in the collation of data for the proposed indicators. The range of situations and regimes that may apply can mean that a site may have been identified as being affected by contamination such that it scores under CS2 and that intervention may have occurred (CS3). However, it could nevertheless reappear under CS2 as a result of redevelopment warranting additional remediation.

1.30   For instance, a gasworks site could have been investigated and remediated in anticipation of use as a light industrial park. Introducing a new receptor through redevelopment (e.g. residents in domestic housing) could require further remediation to ensure it is suitable for that new use.

1.31   The project intended to record and collate data on what basis a site was recorded as being affected by contamination and to what standard it had been remediated. However, the data available to the project team did not allow the standard to which sites had been remediated to be determined on an area-wide, let alone a region-wide, basis. Suggestions for collating and collecting such data in the future are given in Section 6 of this report.

2. METHODOLOGY

CONCEPTUAL MODEL

2.1 Two approaches have been adopted for the estimation of the number of sites and areas for each of the indicators:

A. **Extrapolation from study areas.** The percentage of land that is potentially contaminated (CS1) and the percentage identified (CS2) and remediated (CS3) can be calculated from a survey of selected study areas . Regional and national totals can then be produced by extrapolation from these areas.

B. **National dataset totals.** A variety of datasets can be used to deduce totals for the indicators at a regional or national level. These include data holdings in the public and private sectors.

2.2 The comparison between the results from the different datasets and from the different approaches provides a guide to the bias and uncertainties in both approaches.

2.3 Both approaches were adopted for this study.

DATA ACQUISITION

2.4 Contact was established with potential information providers in the public and private sectors. Full details of the data sources used in the project are given in the results sections, but in summary the datasets represent:

- regulatory datasets related to pollution control, waste management and the contaminated land regime itself from the public sector at a national level;

- inventories of land holdings and their condition from regional/national development agencies;

- inventories of land holdings and their conditions from major industrial sectors;

- regulatory datasets on planning, pollution control and waste management maintained at a local authority level.

2.5   The emphasis was placed on approaching data providers that could supply data on at least a regional if not a national basis. These data should also ideally be comprehensive, i.e. cover an entire industry sector or activity type.

2.6   The criteria used to assess the potential for these datasets were:

- **availability** – many datasets were identified as commercially sensitive and their owners were unwilling to release them;

- **granularity** – datasets that revealed site-specific information are the most relevant for the project;

- **veracity** – the accuracy of the attributes of the data, e.g. a dataset of remediation action undertaken by a site owner is considered a better indicator than permits for mobile plant that might have been used for remediation at a site;

- **accuracy** – as applied to geographical resolution, locations and extents;

- **coverage** – both geographically and sectorally.

2.7   Twelve study areas were selected (see Appendix B), each comprising a 1-km radius of land in England and Wales. The 12 study areas used for the sampling exercise were selected using the Area Classification scheme developed by the Office for National Statistics as a way of segmenting local authorities by type.

2.8   An initial list of 14 authorities was identified and a dialogue was opened with both the environmental health and planning officers at each local authority. The officers were provided with a document outlining the project's data requirements and this document was used as the starting point for discussions on the availability and nature of data holdings relating to the different indicators.

2.9   In addition to obtaining data, local advice was sought to determine suitable locations for the position of the 1-km radius study areas. The concept was to choose an area that typified the historic and current land use patterns within the local authority such that it would not unduly bias the results in the scaling-up exercise.

2.10   Where possible, data were acquired in digital format for use with the ArcView Geographic Information System (GIS) software supplied by ESRI (UK). In addition, the study area research teams marked up paper maps showing high resolution (OS Landline) mapping for each area.

DESKTOP STUDY

2.11   Both methods of arriving at figures for the indicators were initiated with a desk-based examination of historic maps (at approximately 1:2500 and 1:10000 scale) and the datasets collected from local, regional and national bodies for the 12 study areas. Historic mapping was used in hard copy format, with the remainder of the datasets and information received being overlaid onto the recent base-mapping (Landline) from Ordnance Survey. The maps were then examined in detail to reveal:

- the location, number and type of sites where there was an indication of potentially contaminative activities;

- the nature of the site activities (historic and contemporary);

- overlaps between data sources;

- site extents, and allocations to the four indicators:

    - areas of potential contamination;

    - areas of redevelopment and/or remediation of previously contaminating land use;

    - areas of possible ongoing contamination.

Definition of a 'site' and calculation of areas: inter-indicator compatibility

2.12   Each area of interest on the historic or contemporary maps was manually captured by drawing a boundary line onto paper copies of the contemporary Ordnance Survey base-mapping. In many cases, the line drawn coincided with the boundary line of an existing site. In other cases, however, the line was derived from the boundaries of historic sites and thus did not relate precisely to contemporary map boundaries. Where a site varied in size and shape across different epochs of historic land use, the maximum site extent was taken. The lines drawn on the hard copy contemporary maps were then digitised into polygons using ESRI's ArcGIS 8.3 software. For sites represented as points, it was necessary to estimate an assumed area, which was digitised as a circle.

2.13   The boundary was drawn on the map to represent the total extent of the site and corresponded generally to a fence line or other physical demarcation in the historic or contemporary mapping. The resulting area did not, therefore, have regard to the distribution of buildings or activities within the site; neither did it consider the potential extent of contamination nor the location of pathways and receptors.

2.14   By ignoring the distribution of activities within the site, the site area is likely to be overestimating the potential area of contamination. This is offset, however, by situations in which the migration of contaminants may have led to contamination of a larger area than that demarcated by the site boundary (i.e. trans-boundary migration). In these cases, the use of the polygon area will be an underestimate of the site extent. On balance, it is felt that the former factor may have a slightly larger influence, but not so great that it renders the estimate invalid. The area as derived from the site boundary may therefore be considered a conservative estimate for the area of contamination.

2.15   For the identification and remediation of land contamination, the data provided by the local authorities and regional Environment Agency office in some cases revealed a more accurate picture of the affected area. For indicators CS2 and CS3, therefore, the area calculation may reflect a clearer picture of the actual area of contamination rather than an estimate based on the site boundary. Where the data are supplied to a higher level of precision, however, the relationship to the 'site' polygons that may have been used for CS1 becomes strained. Any one single instance of 'identified' or remediated land may cover part of a site, a larger extent than the site, or multiple sites in whole and/or in part.

2.16   The approach taken to this issue has been to disaggregate the data as far as possible, so that where a single larger CS1 site is divided into smaller parcels for CS2 and CS3, the CS1 count will increase to take into account the sub-divisions. One consequence of this disaggregation method, however, is that where a CS3 site extends beyond the boundaries of a CS1 site, the CS3 site will be sub-divided and will therefore be counted more than once.

2.17   This is illustrated in Figure 2.1 where the final total for the indicators will be two CS1 sites and two CS3 sites. (NB There are two CS2 sites in addition because anything remediated has also been previously identified). Although this approach may appear less intuitive than an assumption that there is simply one site for each indicator, it limits the number of potentially misleading assumptions required. In the example shown, it is possible that the remainder of the CS1 area may be the subject of a remedial exercise at some time in the future. This eventuality can be catered for by having two entries for this site in the data.

Figure 2.1 Differences between potentially contaminated and remediated areas

CS1 – Potential Contamination

CS3 - Remediated
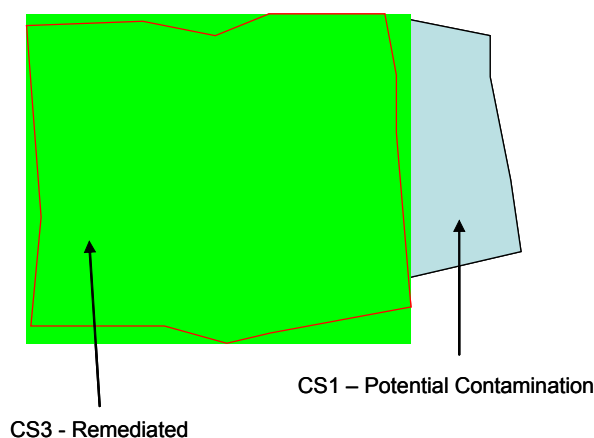
Definition of a 'site': relationship between digital datasets and intra-indicator compatibility

2.18   In many cases, data for a specific indicator were received in the form of pre-digitised boundaries ready for immediate use within the GIS. Though this removed the need to undertake manual capture of the boundaries, it posed additional problems in arriving at a final answer for the total number of sites for any one indicator. This problem was particularly acute for the digital records of historic land use from Landmark (for indicator CS1), where separate layers were supplied for each historical time period.

2.19   Where two layers of polygons come together and the boundaries of the sites do not precisely align, multiple additional polygons are generated that represent the areas of overlap or difference between the two. This is illustrated in Figure 2.2, where combining one polygon from one data source with three polygons from a second data sources generates nine separate polygons. The number of polygons created rises in an exponential fashion with each layer of data added, so with five or six different data sources, it is possible to have many hundreds of polygons over a relatively small area.

2.20   The treatment developed was to merge the data from the different layers in such a way that the fewest polygons resulted and that no two polygons overlapped. In this way, it was possible to arrive at an accurate figure for the overall area.

2.21   Deciding on the number of sites, however, was a less precise process, requiring the use of a size filter to determine which polygons should count as genuine 'sites' and which were processing artefacts. Where a study area is characterised by a small number of relatively large sites, then there is likely to be good agreement between a manual determination of the number of sites and the result arrived at through this filtering process. Where there are a larger number of relatively small sites, then the

cut-off in the filtering process has to be set at a smaller site size such that significant areas of contamination are not excluded. In this situation, therefore, the number of sites is likely to be exaggerated.

Figure 2.2 Combining site boundary data from two data sources
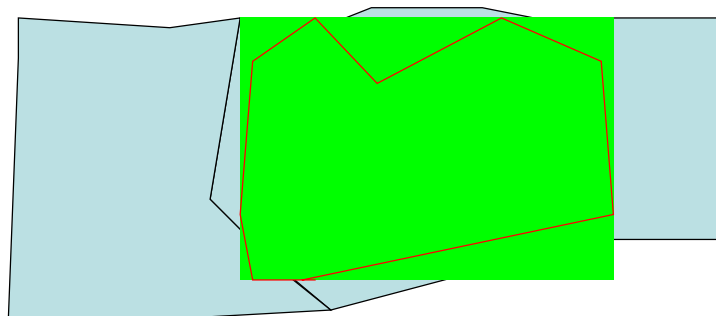
2.22   One feature of the treatment, however, is that the area calculation remains true to the extents of the merged polygons. The problems associated with using site boundaries notwithstanding, the overall area figures produced are therefore more reliable than those for the number of sites.

Site definition: summary

2.23   Taking into account both of the factors identified above, the results from the process need to be examined with the following in mind:

- areas for the indicators are based on site boundaries, which are considered a conservative (but reasonable) estimate of the area of contamination;

- the area figures have been calculated exactly from the boundary data, except where a point location only was available and an assumed area has been taken;

- site numbers may be influenced by the relationship between potentially different boundaries for the same site within an indicator (i.e. at different historical time periods) and between different indicators.

2.24   Although figures for the number and area of sites are quoted in the results, the figure for the area is the more reliable and robust.

Trade directories

2.25   The records from trade directories were not immediately available in a geographical format. It was expected that these documents would provide a general characterisation of the area (identifying potential conflicts, inconsistencies and oversights) and reveal more detail on specific use-types. The trade directories were also thought likely to be particularly useful in the case of radiological contamination and to reveal detail on potentially contaminative land use types that might not be available from the other datasets.

2.26   Attempts were made at an early stage of the work to take advantage of the British Library which, as a copyright library, holds all the trade directories for the entire country. However, the finding and retrieval system in the British Library was not compatible with the requirement to be able quickly to scan through a large number of different volumes; it can take many hours to locate a document and there is a limit on the number of documents that may be held by any one researcher.

2.27   This was in contrast to using a local library or records office, where all the directories are found together in a publicly accessible area. But using these more local repositories presented additional challenges. It was not always clear which library held the directories for a specific area, the directories were often not a complete set, and there were frequently restrictions on the number of pages that could be photocopied for further reference.

2.28   Having located the directories for the right area, there were further difficulties in abstracting the information. The most common problem was the lack of a full address for entries – the best given in many cases was a street name, and often it was just an area or town. Even if street names were quoted, it was impossible to match up the contemporary configuration and naming of streets for older directory entries. Finally, where an accurate address was given, further problems were encountered in locating this to a specific set of premises such that the area of the site could be recorded.

2.29   Most of the significant entries found through the trade directory searches had already been identified through alternative sources. The remaining entries were very small in nature, and added very little to the overall picture in terms of additional potentially contaminative sites. This aspect of the methodology was not therefore considered a cost-effective way of contributing to the development of the indicators.

2.30   Anecdotal evidence and experience from previous studies indicates that collecting trade directory data across a whole local authority may take several staff weeks of time, and that less than half of the data collected in such studies can be geographically referenced to a specific site.

RADIOLOGICAL CONTAMINATION

2.31   The majority of results in relation to the indicators for radiological contamination were obtained by identifying relevant sites from those identified during the search for all potential contaminative activities. For instance, a premise identified as a former landfill site (and therefore a potentially contaminated area contributing to the CS1 figure) could also be identified as an area potentially contaminated with radioactive materials.

2.32   This approach was supplemented by examining the RSA permitted activities within the study areas (current and historic) and by trade directory searches for specific radiological activities. The latter search technique was based on a list of 40 trade categories that relate to common uses of radioactive materials, e.g. radium luminising, radiography and the manufacture of thorium gas mantles. Searches were also conducted for businesses relating to the import and handling of radioactive material. These trade directory searches encountered the same problems as previously discussed.

Hazard indicator

2.33   Each of the sites identified was assigned to one of the 67 categories of industrial land use as used by Landmark Information Group in its Historic Land Use Database. This assignment was based on the detail shown on the historic maps and confirmed where possible by a field survey or information from the local authority or trade directories.

Refinement to site area calculations for CS1 radioactive contamination

2.34   A refinement to calculated site areas for CS1 for RAS sites was undertaken. This refinement was carried out to allow for the major difference (in general) between chemical and radiological contamination. Chemical contamination is likely to be widespread over an area, with approximately equivalent concentrations of pollutant in that area. Radiological contamination is more likely to be localised within a site.

2.35   Taking as a starting point the gross CS1 figure (potential contamination – entire area of premises), the following percentages were elicited by expert judgement (see Appendix A). These figures are likely to represent upper bounds. They are shown, with supporting argument, in Table 2.1.

Table 2.1 Refinement to CS1 (percentage contamination by elicitation) for radioactive contamination for various site-types

Site type	Percentage contamination	Rationale
Scrap metal merchants	5	Radioactive scrap materials, mainly illegally disposed sources, have been accumulated in the past over small areas of scrap recycling premises.
Ironworks/ foundries	80	Metal processing can lead to concentrations of naturally occurring radionuclides in slags. Slag heaps on open ground are widespread on such sites and could occupy the majority of the total area of a works.
Waste disposal site (closed)	100	Most landfill sites closed before 1990 will have received radioactive wastes in the very low-level waste (VLLW) category. Some landfills will have received waste in higher categories. The entire site must be considered to be contaminated. NB Only 5 per cent of closed landfills are likely to be legally classified as radiologically contaminated.
Miscellaneous laboratories/RSA permitted sites	5	Authorisations for the disposal of radioactive wastes to the environment can be associated with spills to ground due to poor controls. Such spills will have been confined to small areas associated with handling radioactive materials at laboratory benches or in waste disposal areas.
Gasworks	5	De-scaling pipework and creating spoil heaps over (small) areas of gasworks and gas transfer premises is a feature of historical industrial practices. Such spoils can contain elevated levels of naturally occurring radioactive materials (NORM).
Cemeteries	0.1	Plutonium-fuelled pacemakers are known to have been buried with cadavers in the USA. With respect to the number of persons fitted with these devices, the area of contamination is likely to be extremely low.
Radium luminising shops	10	The potential for spillage arises for the same reason as in 'miscellaneous laboratories/RSA permitted sites' above. Historically, however, radium luminising has been shown to be a more extensive issue with respect to spillages and spread of contamination.
Hospitals	5	Waste management practices at old (and mainly closed) hospitals were not as rigorous as in contemporary operations. Waste storage in open areas can lead to contamination, albeit over a very small area of the premises.
Former Royal Navy college	1	This site contained a research reactor, recently decommissioned under modern regulatory arrangements. It is highly unlikely that any significant area remains contaminated.

FIELD SURVEY

2.36   For most areas, the results from the desktop study were verified by visits to particular sites within the study area. The concept of these site visits was to double-check the

desk study, and the visits explicitly did not involve intrusive surveys (i.e. sampling and analysis) or site reconnaissance on privately owned land.

2.37   The typical parameters collected during the inspection process informed the uncertainties and assumptions identified in the desk study. They included:

- visual evidence to support historic or ongoing land uses;

- obvious errors in site extents not revealed by the desk studies;

- refined estimates of the extent of contamination within a site.

2.38   Where possible, the results from the desk study were discussed with an officer from the local authority environmental health department. Their local knowledge was considered potentially useful in supplementing the results and improving their accuracy.

FINAL CALCULATION

Methodology A: extrapolation from study area findings

Selection of a classification scheme

2.39   The premise of the extrapolation approach is that the final totals arrived at for the study areas are broadly representative of the country as a whole, and that the results can therefore be extrapolated to produce national totals. Rather than extrapolating directly from a study area to the national total, one refinement is to divide the country into different regions, to undertake the extrapolation separately for each region, and then add the figures for the regions to obtain a national result. The assumption is that the study areas are more likely to be representative of a region than they are for the whole country, and therefore the extrapolation will be more accurate.

2.40   As there is not necessarily a regional pattern of land contamination, a further refinement is to divide the country into zones of land contamination potential (industrial, rural, urban, etc.), which are independent of geographical location. Distributing the study areas evenly across these different zones would further improve the extrapolation accuracy.

2.41   As no such classification exists, a search was undertaken for the most appropriate existing scheme. The scheme chosen as the basis for the project was the Area Classification from the Office for National Statistics (ONS). Based on the 42 parameters from the 2001 census, ONS has assigned each UK local authority to one

of 24 area classifications. These classifications reflect the diversity of population demographics, social and ethnic groupings, and crucially for this project, employment by different industry sector.

2.42   For this project, these 24 classes were then allocated to nine categories to reflect the regional and population density diversity required for this project (e.g. all the London classes were grouped, as were the coast and countryside groups). The classification scheme, together with the relative area of the country represented, is shown in Table 2.2.

Table 2.2 Local authority area classification scheme: proportion of national land cover

Category	Total area (ha)	Percentage of total land area
Centres with industry	321,460	2.13
Coastal and countryside	4,781,509	31.67
Industrial hinterlands - A	588,320	3.90
Industrial hinterlands - B	8,239	0.05
London and suburbs	156,570	1.04
Manufacturing towns	794,847	5.26
New and growing towns	312,055	2.07
Prospering small town and/or Southern	7,870,980	52.13
Regional centres	263,509	1.75
Total	**15,097,489**	**100.00**

2.43   For future work of this type, it may be appropriate to develop a bespoke classification scheme that represents the estimated distribution of land contamination more closely. This is the subject of one of the recommendations outlined later in the report.

Selection of the local authorities

2.44   Within each of these categories, the two local authorities closest to the national average for employment levels in mining, quarrying and construction, and the two closest to the national average for employment in manufacturing were selected. Of the 42 parameters used in the classification scheme, it was felt that these two categories would correlate most strongly with the presence of land contamination. The selection of authorities that were the closest to the national average for these two parameters was designed so that they would be more broadly representative as well as within their group.

2.45   This long list of candidates was then supplemented with additional authorities with significance for radiological contamination and a number of substitutions were made to increase the geographical diversity. As far as possible, these latter substitutions were made using the ONS local authority similarity index, which uses the same 42 parameters as the Area Classification scheme to group together similar authorities.

2.46   From this long list, a selection of 14 areas was chosen to reflect a spread of urban area population size and regions. In addition to the 12 required for the project, two were added to list as alternatives in case of problems. This list of 14 areas is shown in Table 2.3.

Table 2.3 Selected local authorities

Local authority	Category	Population in 2001	Population category	Government Region
A	Industrial hinterlands – B	191,659	Major city	North East
B	Centres with industry	261,037	Large town*	North West
C	Industrial hinterlands – A	150,459	Major city	North West
D	Manufacturing towns	315,172	Large town*	Yorkshire and Humberside
E	Centres with industry	253,499	Large town*	West Midlands
F	New and growing towns	117,069	Small town**	East
G	Prospering small and/or Southern	130,108	Rural	East
H	London and suburbs	214,403	Major city	London
I	London and suburbs	119,067	Small town**	South East
J	Coastal and countryside	35,075	Rural	South West
K	Prospering small and/or Southern	84,885	Rural	Wales
L	Regional centres	305,353	Major city	Wales
M	Regional centres	513,234	Major city	Yorkshire and Humberside
N	Coastal and countryside	130,447	Rural	East Midlands

* >250,000
**<100,000

2.47   The data acquisition process was initiated with all 14 areas. After exploratory discussions, 'M' was removed from the process because of difficulties in obtaining data and 'N' due to a lack of appropriate urban zones on which to centre a study area.

Calculations

2.48   The starting point for the extrapolation is the total area for each of the indicators (CS1–4) within each study area, expressed as a percentage of land cover. These percentages were then applied to the total land area for their local authority category, and these combined in turn to produce national aggregate figures. The calculations were also repeated using regional groupings of authorities.

2.49   To restrict the degree of extrapolation required, the study areas were chosen to lie either wholly, or as much as possible, only within urban (built-up) areas. The extrapolation was therefore applied only to the urban land area of each group – on average 20 per cent of the total area.

2.50   Although this approach obviously excludes large sections of the country, the density of sites with land contamination in rural areas is significantly lower than in urban areas. If a similar exercise were undertaken for rural areas, the study areas would need to be larger than the 1-km radius area used in this project.

Methodology B: verification of national datasets

2.51   Systematic examination of the data for the study areas enables conclusions to be drawn on the relative accuracy for the different datasets and how such data are partitioned between the different indicators. For example, IPPC sites from the national register found within the study areas can be examined for any linkage with historic industrial practices, or for their relationship with areas identified and remediated.

2.52   These relationships can be used to develop accuracy figures and to help allocate the national totals for the data to the different indicators. This provides an alternative approach to the scaling-up from the local surveys.

2.53   This is dependent, however, on the national datasets being adequately represented within the study areas, which in practice turned out not to be the case. Although some examples from the national data (e.g. IPPC sites) were present in the study areas, the numbers were too small compared with the overall size of the datasets for any meaningful conclusions to be drawn.

2.54   For the majority of datasets, therefore, the treatment of the national totals was restricted to:

•   allocation to indicators;

- estimates of the areas and extents by different geographical regions;

- discussions over the internal relationships between them.

2.55 One national dataset where there was detail available for the study areas, however, was the Historic Land Use Database (HLUD) from Landmark Information Group Limited (Landmark). Within each study area, it was possible to overlay the findings from the desk study with the HLUD data. Although some study areas had taken advantage of the HLUD data as provided by the local authority, in most areas the desktop study had been conducted independently and the degree of overlap and agreement could therefore be calculated.

2.56 One important aspect of the national dataset examination was that the data covered both rural and urban areas. Examining some of the datasets allowed conclusions to be drawn on the relative distributions of the indicator sites, and to confirm that the location of study areas within urban locations was an appropriate decision.

3.   STUDY AREAS: OUTPUTS AND DISCUSSION

3.1   Appendix B contains summaries of the results for each of the local authorities and study areas. The local authorities have purposely not been identified and details for the study areas have been generalised.

3.2   The 12 study areas have each been characterised using the Land Cover Map 2000 from the Centre for Ecology and Hydrology (CEH, 2000). Broad habitat or land cover type definitions have been allocated on a 25-metre grid, representing different classes of built environment, arable, grassland, woodland and bare ground. These classes represent at least 90 per cent of the land area in each case. The remaining 10 per cent comprises mostly water and coastal features.

COMBINED RESULTS

3.3   To compare the results between the study areas, the estimates for each indicator are presented as a percentage of the study area for non-radiological sites in Table 3.1.

Table 3.1 Study area total results

Area	Classification	Region	Percentage area		
			CS1	CS2	CS3
A	Industrial hinterlands - B	North East	44.1	7.3	7.3
L	Regional centres	Wales	38.3	11.5	11.5
C	Industrial hinterlands - A	North West	35.1	10.5	0.0
B	Centres with industry	North West	27.8	4.1	2.4
D	Manufacturing towns	Yorkshire and Humberside	27.2	2.0	0.8
E	Centres with industry	Midlands	26.2	5.9	5.9
I	London and suburbs	South East	24.4	9.0	8.3
F	New and growing towns	East	16.9	6.3	0.0
H	London and suburbs	London	15.9	5.8	3.6
K	Prospering small and/or Southern	Wales	13.6	0.0	0.0
G	Prospering small and/or Southern	East	11.3	0.5	0.0
J	Coastal and countryside	South West	3.4	0.0	0.0

3.4   The distribution of CS1 is broadly in line with the expected level of industrialisation for each area based on the classification. Generally, the top half of Table 3.1 contains the industrial, manufacturing and regional centre categories, and the bottom half contains the more rural types of authorities.

3.5   The regional distribution of CS1 reinforces the intuitive expectation that industry has historically been a feature of the northern areas of the country, with some pockets in Wales. Where there are two sites from a region, there is conflicting evidence. The result from the East and North West regions suggest consistency, whereas the result from Wales indicates a degree of variation.

3.6   The pattern for CS2 is not necessarily linked to the distribution of CS1 sites and is difficult to characterise by local authority classification or by region. CS3 in all cases but one is strongly linked to CS2. The situation in Study Area C, however, is possibly anomalous: while there was considerable evidence of redevelopment, there was a lack of corroborating and definitive evidence to confirm this finding.

3.7   The results for the sites with potential radiological contamination are presented in Table 3.2. As only one site across the 12 areas was found to have been remediated on radiological grounds, these figures have not been presented. Only those sites with the potential for historical contamination (CS1) are presented.

3.8   The main difference between the total and the radiological contamination is in Study Area K. This is due to the presence of a large hospital site. As discussed in Section 2, the methodology for radiological contamination has been further refined using scaling-down factors which reflect the different nature of radiological contamination; i.e. isolated and concentrated rather than more widespread across a site.

3.9   To calculate the overall figures from these results, it is necessary to combine them with data collected from different national datasets. These are presented in Section 4, followed by the final calculations in Section 5.

Table 3.2 Study area radiological results

Area	Classification	CS1 (per cent)
L	Regional centres	1.21
A	Industrial hinterlands - B	7.16
E	Centres with industry	2.60
K	Prospering small and/or Southern	0.20
I	London and suburbs	2.17
C	Industrial hinterlands - A	2.47
F	New and growing towns	6.64
G	Prospering small and/or Southern	5.01
B	Centres with industry	0.22
D	Manufacturing towns	0.45
H	London and suburbs	0.12
J	Coastal and countryside	0.00

Comments on study area methodology

Selection of local authorities

3.10   The final 12 local authorities were selected primarily on the basis of their representation of different regions and types of local authorities. However, the final list, although covering all the local authority classifications, does not include a representative of the East Midlands region. Both the East and West Midlands regional figures are therefore based on Study Area E results.

3.11   A better approach might have been to start off with a much longer list of authorities, and to establish initial contact with them to determine the degree of likely co-operation and data availability. At that point, the final selection could have been made to ensure appropriate representation from the different regions.

Choice of study area

3.12   The concept was to choose study areas that were broadly 'representative' of the local authority. Examination of the results shows that, on the whole, this policy has been successful in that the trend follows the local authority typology for the most part. However, one of the comments most frequently received during the data collection exercise was that, if the study area were moved slightly in either direction, it would change the nature of the results.

3.13   The selection of the area was made on the basis of current land uses and discussions with local authority officers with a variable range of knowledge bases. The use of current mapping may have been misleading, in that historical practices may not be evident. It may have been more appropriate to wait until historical map data had been received before refining the area selection. In this way, a truly 'average' 1-km radius area could be selected.

Planning data records

3.14   The availability of records from local planning authorities was not consistent, and the methods of recording, archiving and retrieval of data varied considerably between authorities. Compounding the availability issue is the fact that, where planning conditions are recorded, they are often expressed purely as a condition to undertake an investigation on a site. There are no subsequent records on the outcome of that investigation or if remediation was undertaken. The policy of attaching such a condition is not consistent between authorities; thus, more sites will be 'identified' through having such a condition in authorities that adopt a more conservative and pro-active approach.

3.15   There is no easy solution for this problem. Realistically, the resolution lies in the completion of the inspection process under Part IIA or more consistent recording of contamination identified and remediated through the planning process, e.g. through Best Value Performance Indicators (see Section 6).

3.16   A very broad interpretation of potential radiological contamination was employed and hence a relatively large number of the sites in CS1 feature in this list. Thus, a considerable number of sites are included where the potential for radiological contamination is likely to be extremely low. Similarly, the trade directory searches for a number of areas provided a long list of potential sites when taking a very broad definition of potential contamination.

3.17   It is also the case is that some relatively large sites have been identified where the area of potentially impacted land is a very small proportion of the overall site. As we are recording only site extents, this further exaggerates the results. For this reason, qualifying factors (scaling down) have been employed as described in Section 2.

3.18   General experience on radiological contamination suggests that:

- the majority of such sites may not actually represent a significant radiological hazard;

- and are likely to be below any potential threshold level for harm.

4. NATIONAL DATA SOURCES: OUTPUTS AND DISCUSSION

4.1   This section presents the results of the analysis of the different national or regional datasets received. It includes a discussion of the supporting datasets and the evidence used to generate the indicators directly.

NATIONAL STATISTICS AREAS AND CLASSIFICATIONS, ODPM URBAN AREAS

4.2   Underlying the production of results are the key statistics for local authorities compiled by ONS based on the 2001 Census (ONS, online). This source gives population, demographic and, crucially, area data for each local authority. These key statistics have been used to classify the local authorities (the Area Classification scheme), and this classification has guided the selection of the study areas.

4.3   As the study is restricted in scope to 'urban' areas, some time was spent in researching an appropriate definition. The one used in the project underpins analysis of the Census data and is that developed by ODPM (ODPM, 2001):

> *"... areas with a land use that is irreversibly urban in character. For urban land to qualify as an Urban Settlement it must extend for 20 hectares or more and have a population of at least 1,000."*

4.4   Data were supplied by ODPM for 1991 and 2001 but only the 2001 data were used. ODPM recommends that population sizes should be attributed to such areas and that a threshold size of 10,000 is used for strict definitions of 'urban'. At the time of the analysis, population attributes from the 2001 Census had not been assigned, so this project uses the full extent of the area in the dataset. Breakdowns of these areas by region and by the local authority classification used in this project are given Tables 4.1 and 4.2, respectively.

Table 4.1 Total area and urban Area in England and Wales by region, 2001

Region	Total area (ha)	Area as percentage of England and Wales	Urban area (ha)	Urban area as percentage of total urban area in England and Wales
North East	857,320	5.7	62,643	4.84
North West	1,410,642	9.3	163,015	12.59
Yorkshire and Humberside	1,540,762	10.2	126,743	9.79
West Midlands	1,299,834	8.6	134,483	10.39
East Midlands	1,560,652	10.3	111,170	8.59
East	1,910,985	12.7	149,168	11.52
London	155,061	1.0	128,878	9.95
South East	1,906,949	12.6	216,430	16.72
South West	2,382,076	15.8	129,158	9.98
Wales	2,073,208	13.7	72,968	5.64
Total	15,097,489	100.0	1,294,657	100.0

4.5   Table 4.1 indicates that although the distribution of overall land is comparable between the regions, the distribution of urban land is less constant on a regional basis. For example, Wales occupies 13.7 per cent of the total land area of England and Wales, but has only 5.64 per cent of the urban area. The biggest proportion of urban area (16.72 per cent) is found in the South East, which is only the third largest region. This result is intuitive – urban areas are not evenly distributed. If there is a strong correlation between urban areas and contaminated land, then this result needs to be considered during the extrapolation process and each region considered independently, rather than using a blanket average.

Table 4.2 Total area and urban area by local authority classification, 2001

Local authority classification	Total area (ha)	Area as percentage of England and Wales	Urban area (ha)	Urban area as percentage of total urban area in England and Wales
Centres with industry	321,460	2.13	137,920	10.65
Coastal and countryside	4,781,509	31.67	122,575	9.47
Industrial hinterlands - A	588,320	3.90	112,662	8.70
Industrial hinterlands - B	8,239	0.05	4,589	0.35
London and suburbs	156,570	1.04	136,051	10.51
Manufacturing towns	794,847	5.26	126,684	9.79
New and growing towns	312,055	2.07	80,815	6.24
Prospering small and/or Southern	7,870,980	52.13	458,251	35.40
Regional centres	263,509	1.75	115,108	8.89
Total	15,097,489	100.00	1,294,657	100

4.6   The local authority classification scheme, however, gives a different picture. Despite the wide variation in the percentage of total land cover, the distribution of urban areas between the classes is much more constant once the two outliers (Industrial hinterlands - B and Prospering small and/or Southern) are removed. The study areas are focussed on urban areas and there is evidence below to suggest that there is a concentration of land contamination within urban areas. The more evenly distributed the urban land is between the categories, the more even the potential distribution of land contamination and the greater confidence can be attached to the sampling regime. However, the two outliers are of concern – particularly the large urban area in Prospering small and/or Southern. The small area of Industrial hinterlands - B is unlikely to have a large distorting impact on the results, but the relatively large outlier will amplify any errors in the study areas for those categories.

LAND COVER MAP 2000

4.7   The figures for land cover type (CEH, 2000) are summarised in Table 4.3, which indicates the proportion of:

- land in the suburban/rural development and continuous urban category, i.e. 'built-up' land;

- bare ground – a potential indication of derelict and undeveloped industrial land. Table 4.3 also reports the proportions for all urban areas within that classification.

Table 4.3 Land cover in the study areas by local authority classification

Classification	Average/ Study area	Percentage developed	Percentage bare ground
Coastal and countryside	All urban	64.35	1.53
	J	63.44	0.00
Prospering small and/or Southern	All urban	70.20	0.99
	K	53.29	1.63
	G	38.04	0.38
Industrial hinterlands - A	All urban	72.78	2.23
	C	56.07	2.83
Manufacturing towns	All urban	77.50	1.13
	D	80.53	1.63
Industrial hinterlands - B	All urban	76.55	3.65
	A	83.22	11.90
Regional centres	All urban	78.45	1.54
	L	82.25	12.68
Centres with industry	All urban	78.14	2.49
	E	84.20	9.39
	B	81.43	1.27
New and growing towns	All urban	71.14	0.95
	F	64.95	0.00
London and suburbs	All urban	76.88	0.46
	H	72.05	0.00
	I	87.86	0.00

4.8   The biggest discrepancy between the land cover in the study area and the average for that type of authority is in the Prospering small and/or Southern category. Both the study areas (K and G) were focussed on small towns where the 1-km radius study area extended beyond the boundaries of the urban area, leading to the inclusion of more rural land. This will have reduced the amount of built-up land compared with the average for that class. Study area C also features less built-up land than the average for urban area in its class. On the assumption that rural areas have a lower density of land contamination, these areas may be expected to feature lower totals for the indicators than might be anticipated had they included more

developed land. The extrapolation from these study areas may therefore under-represent the totals for these classes.

4.9 The percentage of bare ground is considerably higher than the class average for study areas A, L and E. In all three cases, these areas had relatively high scores for CS1 and were areas where a large number of industrial sites had ceased operation. Although the class averages for bare ground for these areas are the highest and therefore a high CS1 score may be expected, the discrepancy between the study area and the overall average suggests that the study areas may be amplifying the totals for these classes.

Table 4.4 Land cover in the study areas by region

Region	Average / Study area	Percentage developed	Percentage bare ground
East	All urban	71.3	0.47
	F	64.9	0.00
	G	38.0	0.38
London	All urban	76.5	0.50
	H	72.1	0.00
Midlands	All urban	75.4	1.77
	E	84.2	9.39
North East	All urban	74.1	2.27
	A	83.2	11.90
North West	All urban	74.0	1.11
	C	56.1	2.83
	B	81.4	1.27
South East	All urban	72.0	0.75
	I	87.9	0.00
South West	All urban	70.1	1.85
	J	63.4	0.00
Wales	All urban	64.8	3.47
	K	53.3	1.63
	L	82.2	12.68
Yorkshire and Humberside	All urban	73.6	1.27
	D	80.5	1.63

4.10 The pattern of anomalies is repeated in the regional distribution of land cover (Table 4.4), with the same outliers for both the percentage developed and

percentage bare ground. Study Area K is slightly less of an outlier compared with the total for Wales.

4.11   These outliers apart, the regional and area classification land cover are consistent with those in the study areas.

NATIONAL SURVEY OF CONTAMINATED LAND IN WALES

4.12   The National Survey of Contaminated Land for Wales was undertaken in 1988 by the Environmental Advisory Unit of the University of Liverpool on behalf of the then Welsh Office and the Welsh Development Agency (Welsh Office, 1988). The aim of the original survey in 1984/85 and the 1987/88 update was to help to identify contaminated sites before they were redeveloped, thereby avoiding the financial costs and risks to which developers and eventual occupiers of the site might be exposed. The survey identified 752 sites covering 3,721 ha. Table 4.5 shows the distribution of those results between urban and non-urban areas of Wales. It also categorises the sites using a hazard factor on a scale of 1 to 5.

4.13   One important factor that can be determined from the identified location of the sites is the distribution of sites between urban and rural locations. Urban locations were defined using the official ODPM 2001 boundaries, plus an additional 500-metre buffer in all directions. This buffer was applied to account for the fact that the site locations were identified as points only, and that a point within 500 metres of an urban area may in fact represent an industrial site that was part of that urban area.

Table 4.5 Results from the National Survey of Contaminated Land for Wales, 1988

Hazard factor	Data	Urban	Non-urban	Total
1	Area (ha)	857.4	378.1	1235.5
	Sites	158	71	229
2	Area (ha)	1085	705.4	1790.4
	Sites	263	134	397
3	Area (ha)	126.3	215.4	341.7
	Sites	56	24	80
4	Area (ha)	62.7	184.8	247.5
	Sites	24	10	34
5	Area (ha)	41.5	64.3	105.8
	Sites	7	5	12
Total area (ha)		2172.9	1548	3720.9
Total sites		508	244	752

4.14   The results of this survey indicate that the majority of contaminated sites are found in urban areas. However, application of an analysis of variance (ANOVA) test to the distribution of site areas reveals a statistically significant difference ($P = 0.003$) between the mean site area for urban locations (3.25 ha) and for non-urban locations (5.60 ha).

4.15   Using the urban area calculations outlined above, urban areas represent 3.52 per cent of Wales' total area of 2.073 million hectares, i.e. 72,968 ha. This gives the following percentage land contamination figures in Wales:

- Urban: 2.98 per cent

- Non-urban: 0.07 per cent

4.16   Applying these figures to the whole of England and Wales gives a total area of land contamination (**CS1**) as **48,243 ha**, split between:

- Urban: 38,581 ha (12,000 sites)

- Non-urban: 9,662 ha (1,725 sites).

NATIONAL LAND USE DATABASE: PREVIOUSLY DEVELOPED LAND

4.17   The English Derelict Land and Vacant Land Surveys have now been combined into the Previously Developed Land (PDL) section of the National Land Use Database (NLUD) (see http://www.nlud.org.uk). The NLUD-PDL project is run jointly by ODPM and English Partnerships. The definition for previously developed land used is:

> *"... land is that which is or was occupied by a permanent structure (excluding agricultural or forestry buildings), and associated fixed surface infrastructure. …. Previously developed land may occur in both built-up and rural settings. The definition includes defence buildings and land used for mineral extraction and waste disposal where provision for restoration has not been made through development control procedure."*

4.18   NLUD-PDL data are collected by local authorities annually. At the time of the project, the most complete results were for 2002. Of 354 local planning authorities in England, good data were received from 311 (88 per cent). Partially complete or missing records were estimated during a grossing-up exercise, so in the final land totals there is an approximately 70:30 split between known and estimated data.

4.19   The main report on the NLUD-PDL database for each year specifically does not make any representation on the likely presence of contamination. However, some categorisation by the requirement for 'treatment' is included, with the definition of treatment including 'demolition, clearing of fixed structures of foundations and levelling.' This treatment criterion is referred to in two of the six categories in the NLUD-PDL primary classification scheme. These categories are:

- 'Previously Developed Vacant Land' does not require treatment (but testing for presence of contamination is assumed to be required);

- 'Derelict Land and Buildings' does require treatment.

4.20   There are no comments made in the report with regard to treatment for land or buildings currently in use but at various stages of redevelopment – of which a considerable proportion could require remediation.

4.21   In 2002, the total area for 'Previously Developed Vacant Land' for the whole of England was an estimated 16,000 hectares and that for 'Derelict Land and Buildings' (where treatment is definitely required) was estimated at 20,000 hectares (NLUD, 2003). These numbers explicitly exclude land and buildings currently in use and thus could be viewed as an underestimate. However, they do not consider remediation for

land contamination but the more general 'treatment'. This may suggest that a figure of 20,000 hectares is an overestimate.

4.22 An alternative analysis of the data with respect to the potential land contamination implications is possible through the classification applied to the former use on the site. By selecting the use categories most likely to lead to contamination (i.e. excluding offices, retailing, car parks and roads) and looking at all the different land classes, a total of 24,000 hectares is obtained from the database of NLUD sites. Extrapolating from this to take into account the incomplete or missing data (using the 70:30 rule) produces an estimate of **33,500 ha;** for the purposes of this study, this has been assigned to **CS1**. Breakdowns of these figures by region and by local authority classification are given in Tables 4.6 and 4.7, respectively. These numbers have been similarly extrapolated using the 70:30 rule.

Table 4.6 Previously developed land (hectares) grouped by former use and local authority classification, 2002

Local authority classification	Industrial and commercial			Minerals and landfill		Transport			Total	Total (per cent)
	Industry	Warehouse	Utilities	Landfill	Minerals	Airports	Dock	Rail		
Industrial hinterlands - A	2,339	150	51	398	619	67	330	223	4,177	12
Centres with industry	2,126	167	334	198	423	1	8	355	3,612	11
London and suburbs	810	379	155	5	0	0	14	70	1,434	4
New and growing towns	2,066	68	14	99	506	1	0	104	2,858	9
Prospering small and/or Southern	4,055	914	592	870	1,567	852	39	545	9,434	28
Regional centres	1,458	297	323	157	534	192	51	299	3,311	10
Manufacturing towns	1,505	172	157	644	2,604	323	28	447	5,881	18
Coastal and countryside	672	136	60	70	620	924	65	164	2,711	8
Total	15,032	2,284	1,686	2,441	6,872	2,360	536	2,207	33,420	100
Percentage	45	7	5	7	21	7	2	7	100	

Table 4.7 Previously developed land (hectares) grouped by former use and region, 2002

Region	Industrial and commercial			Minerals and landfill		Transport			Total	Total (per cent)
	Industry	Warehouse	Utilities	Landfill	Minerals	Airports	Docks	Rail		
East Midlands	1,202	236	228	178	1,101	144	0	376	3,464	10
East of England	723	196	36	18	84	0	11	158	1,227	4
London	1,059	403	187	17	58	0	14	66	1,803	5
North East	1,858	94	19	431	255	61	122	128	2,967	9
North West	3,199	280	241	1,007	1,119	626	203	578	7,254	22
South East	2,985	309	224	156	1,373	555	95	69	5,764	17
South West	985	170	59	72	390	339	4	137	2,156	6
West Midlands	1,675	230	290	207	740	75	1	106	3,323	10
Yorkshire and Humberside	1,346	366	402	357	1,753	561	86	590	5,462	16
Total	15,032	2,284	1,686	2,441	6,872	2,360	536	2,207	33,420	100

4.23   The biggest area of sites is found in the Prospering small and/or Southern class of
        local authorities, while the South East accounts for the second largest regional total.
        As Table 4.88 reveals, however, this may be more attributable to the fact that
        Prospering small and/or Southern accounts for the biggest proportion of England.
        When examined as a percentage of total land area, Regional centres is the category
        that features most prominently; Centres with industry and Industrial hinterlands -A
        are also greater than 1 per cent of land area.

Table 4.8 Percentage of previously developed land grouped by local authority classification

Local authority classification	PDL (per cent)
Regional centres	1.33
Centres with industry	1.12
Industrial hinterlands - A	1.09
London and suburbs	0.92
New and growing towns	0.92
Manufacturing towns	0.87
All England	0.26
Prospering small and/or Southern	0.12
Coastal and countryside	0.09

NATIONAL LAND USE DATABASE BASELINE

4.24   This second component of NLUD was not available to the project team. To date,
        information on only a small area of England has been collected in detail and is
        subject to further development before being released. This dataset could, however,
        be an important component of future iterations of this project.

ENVIRONMENT AGENCY

Part IIA Inspection Strategies, Part IIA Public Registers, Part IIA Reports to the Environment Agency

4.25   Information at a national level was received from the Environment Agency on the
        status of the Part IIA regime as of February 2004. Table 4.9 shows the distribution of
        the 70 sites that had been statutorily determined, classified by their size. This list
        includes the 18 sites designated as 'special sites'. It is important to note that this
        represents information provided to the Environment Agency at that time. It may not
        fully represent the total number of sites determined as contaminated land by local

authorities. The latest figures, although not used within the study are available from Defra at: www.defra.gov.uk/environment/land/contaminated/faq.htm.

Table 4.9 Part IIA determined sites as at 11 February 2004

Environment Agency Region	Approximate site area					Total
	0–5 ha	5–10 ha	10–15 ha	15–20 ha	>20 ha	
Anglian	8	2			1	11
Midlands	3	1				4
North East	6	2	1		2	11
North West	5	1			1	7
Southern	5	1				6
South West	13					13
Thames	11				1	12
Wales	4	1		1		6
Total	55	8	1	1	5	70

4.26   At present, too little data have been collected to inform any conclusions except that the number of sites and total area recorded are clearly below those achieved by previous surveys and the indicators developed in this project. The information, however, has never previously been assessed in terms of sites where contamination has been proved to exist in excess of statutory criteria (DETR Circular 02/2000). *[JAH: Not clear which Regulations. Is reference to circular OK? If not, please insert name and SI number of the Regulations here and not in References.]* All previous data may have done is estimate those sites which may be potentially contaminated or where contamination exists – not that the contamination fulfils the criteria of significant harm required under Part IIA and that it has been determined as such. This highlights several factors:

- The Part IIA legislation has only recently been enacted and much of the work remains to be completed. As of February 2004, records had been received from 49 out of 374 authorities in England and Wales.

- Redevelopment and appropriate remediation through the planning process remains the first choice of the Government for dealing with the legacy of land contamination rather than the Part IIA regime.

4.27   To produce an overall statistic from this source, assumed site sizes at the mid-point of the band (and arbitrarily assigning 50 ha to the >20 ha category) produces an overall estimated extent of **500 ha** for indicator **CS2**.

Environment Agency National Incident Recording System (NIRS)

4.28   The Environment Agency records and characterises pollution incidents based upon their impact to air, water and land. All incidents have a score assigned for their impact to air, water and land – with 1 being the most severe and 4 being no impact. Thus, those incidents with a score of 4 for land will have had an impact to either air or water (score 1 to 3) to bring it to the attention of the Environment Agency. Table 4.10 presents data from 2001 and 2002 based on information obtained from the Environment Agency website (http://www.environment-agency.gov.uk).

Table 4.10 NIRS number of incidents falling into the different land impact scores for 2001 and 2002

Category of impact	2001	2002
1	22	31
2	484	458
3	9510	11,401
4	23,702	17,986
Total	33,718	29,876

4.29   Category 4 impacts are those with no impact and Category 1 incidents are those with the most severe, characterised by persistent and extensive effects on land quality. However, the data provided do not allow quantification of the area impacted on. It is also not possible to identify the degree of overlap with sites which may have already been identified as contaminated. Given that they may frequently arise from industrial operations where the site is operating under one or more permitting regimes, it is likely that any estimate of area of contamination would be double-counting areas estimated using these permitting records or based on land use.

4.30   Although these incidents are obviously of high significance at a local level, they are relatively small in comparison with the national number and extent of potentially contaminated sites. If only category 1 and 2 sites are taken, a figure of 500 sites per year can be allocated to CS4 Ongoing Land Contamination.

4.31   A review of 177 incidents over an 11-month period undertaken by the Environment Agency indicated that approximately 50 per cent actually had an impact rather than merely the potential for impact. Examining these incidents in closer detail suggested that a reasonable average impact size is 0.04 ha (400 m^2).

4.32   Assuming that the incidents are all occurring on previously unidentified land and that the number does not vary significantly from year to year, the sites and areas for **CS4**

since the introduction of the Part IIA Contaminated Land Regime (i.e. from 2001 onward) are:

- Number: 250 sites per year for 3 years = **750 sites**

- Area: at an average of 0.04 ha per site = **30 ha**

Pollution Inventory

4.33   The Pollution Inventory has been developed by the Environment Agency to provide information on annual mass releases of specified substances to air, water, land or produced as waste which arise from any large industrial sites, i.e. those authorised by the Environment Agency under IPC, IPPC, the Radioactive Substances Act 1993 (RSA) and the Waste Management Licensing (WML) regime.

4.34   The reporting requirements for the Pollution Inventory encompass emissions from the whole of the IPC authorisation. These include:

- point sources, e.g. chimneys;

- non-point sources;

- fugitive emissions, e.g. leaks or spillage.

4.35   Operators are also required to indicate to which discharge route they have been released to (e.g. air, land, water, waste, or one of their subdivisions). This dataset therefore represents a 'superset' of industrial activities subject to Environment Agency regulation.

4.36   Because these sites are regulated under a variety of different permitting regimes, any land contamination issues should, in theory, be addressed by the operator as soon as possible after they occur. These sites may represent areas of historical contamination caused by prior activities on the site and therefore represent a contribution to CS1. An analysis of the spatial distribution of the sites also helps to inform a general pattern of the distribution of industry, both in terms of urban/rural and the local authority classification scheme.

4.37   Table 4.11 summaries Pollution Inventory data published for 2002 on the Environment Agency website.

Table 4.11 Pollution Inventory sources classified by industry sector, 2002

Industry sector	Total
Fuel and power production and associated processes	303
Metal production and processing	129
Mineral industries	59
Other industry	118
RSA authorised sites	541
Chemical industry	897
Waste disposal and recycling	650
Water	486
Total	3183

4.38   It is possible to take these figures further by applying data supplied by the Landmark Information Group. These data include a specific categorisation of the number and areas of sites digitised from the most recent epoch of mapping (Epoch 6, post-1970). By using these sites as a guide, it is possible to develop an average site area for different classifications of industry. This therefore allows an estimate of the total area. The results of this exercise are presented in Table 4.12.

Table 4.12 Estimated site and contamination areas from Pollution Inventory, 2002

Process category	Landmark category	No.	Average area Epoch 6 (ha)	Total area (ha)
Carbonisation and associated processes	Factory or works - use not specified	18	3.49	62.80
Combustion processes	Factory or works - use not specified	188	3.49	655.95
Gasification and associated processes	Factory or works - use not specified	26	3.49	90.72
Petroleum processes	Oil, petroleum, gas, refining and storage	48	5.70	273.53
Unknown process(es) in fuel and power sector	Factory or works - use not specified	23	3.49	80.25
Iron and steel	Metal casting/foundries	21	12.83	269.34
Non-ferrous metals	Metal casting/foundries	67	12.83	859.33
Unknown process(es) in metals sector	Metal casting/foundries	41	12.83	525.86
Cement/lime manufacture and associated processes	Cement, lime and plaster products (manufacture)	27	1.10	29.62
Ceramic production	Tableware and other ceramics (manufacture)	3	0.76	2.28
Glass manufacture and production	Glass and glass products excluding flat glass (manufacture)	4	19.70	78.78

Process category	Landmark category	No.	Average area Epoch 6 (ha)	Total area (ha)
Other mineral fibres	Factory or works - use not specified	12	3.49	41.87
Processes involving asbestos	Factory or works - use not specified	5	3.49	17.45
Unknown process(es) in minerals sector	Factory or works - use not specified	8	3.49	27.91
Coating processes and printing	Printing: miscellaneous excluding newspapers	14	1.59	22.24
Di-isocyanate processes	Factory or works - use not specified	36	3.49	125.61
Paper and pulp manufacturing processes	Pulp, commodity grade paper and paperboard manufacture	7	6.65	46.55
Tar and bitumen processes	Factory or works - use not specified	6	3.49	20.93
Timber processes	Saw milling, planing and impregnation ((i.e. treatment of timber)	5	0.97	4.87
Treatment/processing of animal or vegetable matter	Food processing - major	4	1.39	5.57
Unknown process(es) in other industries sector	Factory or works - use not specified	46	3.49	160.50
Radioactive substance sites - non-nuclear	Factory or works - use not specified	520	3.49	1814.34
Radioactive substance sites - nuclear	Factory or works - use not specified	21	3.49	73.27
Acid processes	Chemical manufacturing general	61	7.61	464.36
Chemical fertiliser production	Chemical manufacturing general	13	7.61	98.96
Inorganic chemical processes	Chemical manufacturing general	188	7.61	1431.13
Manufacture and use of organic chemicals	Chemical manufacturing general	460	7.61	3501.70
Pesticide production	Chemical manufacturing general	9	7.61	68.51
Petrochemical processes	Oil, petroleum, gas, refining and storage	36	5.70	205.15
Pharmaceutical production	Chemical manufacturing general	1	7.61	7.61
Processes involving halogens	Chemical manufacturing general	106	7.61	806.91
Unknown process(es) in chemicals sector	Chemical manufacturing general	23	7.61	175.08
Incineration	Refuse disposal	54	3.11	167.73
Landfill sites and waste transfer stations	Refuse disposal	552	3.11	1714.58
Production of fuel from waste	Refuse disposal	2	3.11	6.21
Recovery processes	Refuse disposal	37	3.11	114.93
Unknown process(es) in waste sector	Refuse disposal	5	3.11	15.53
Sewage treatment works	Sewage	486	1.44	701.35
Total				**14769.32**

4.39   The results suggest a contribution of **15,000 ha** to **CS1** on the basis of currently
        operational industrial sites.

4.40   However, the alignment is not always perfect between the industrial sectors in the
        Pollution Inventory and those used by Landmark. Out of 38 categories, 12 have been
        assigned to the generic Landmark 'factory or works' category. Similarly, it has not
        been possible to distinguish between the different types of chemical works. It is
        possible that the match and estimate of average site size could be refined further
        using sector-specific knowledge.

4.41   Examining the radiological aspects of this data, there are 541 entries with records of
        radiological emissions. As there are no specific categories for these in the Landmark
        data, they have been assigned to the generic factory or works group to give a total
        site size of 1,887 ha. In the absence of a breakdown of this figure according to site
        classification, this figure has not been modified by the qualifying factors as discussed
        in Section 2.

4.42   Of the records in the Pollution Inventory, 2,550 (80%) can be assigned to a
        geographical location on the basis of their postcode. This allows subdivision by
        region, as shown in Table 4.13. Some of these records represent multiple permits for
        a single operational site. Removing these duplicates leaves approximately 2,000
        unique sites.

Table 4.13 Distribution of Pollution Inventory sites by region, 2002

Region	Number of sites	Total site area (ha)	Percentage total area
East	197	891	10.3
East Midlands	200	855	9.9
London	126	553	6.4
North East	117	628	7.2
North West	275	1399	16.1
South East	245	951	11.0
South West	160	601	6.9
Wales	138	775	8.9
West Midlands	189	878	10.1
Yorkshire and Humberside	245	1146	13.2
Total	1892	8677	100.00

4.43   A further useful distribution pattern is the split between urban and rural areas
        (Table 4.14). This has been calculated using the same technique as for Previously

Developed Land, i.e. taking a 500-metre buffer around the built-up areas defined by ODPM.

4.44   The findings reinforce the decision to restrict the sampling activity to urban areas only, as this is where the bulk of the sites are located.

Table 4.14 Distribution of Pollution Inventory sites by urban/rural setting, 2002

Setting	Percentage of sites	Total Site Area (per cent)
Rural	15	11
Urban	85	89

PPC Records

4.45   Very few PPC sites were found within the 12 study areas examined. This low number makes it impossible to extrapolate any national figures on the consequences of PPC activity with any degree of confidence. Data from these PPC sites, however, feature within the Pollution Inventory database (see above).

4.46   National level data contain 1,765 PPC records expressed as point locations. Although some estimates can be made regarding the size and extent of such sites, the nature of the permitting system and the complexity of the relationship between permits, operations and site areas would undermine such estimates.

4.47   Similarly, changes to the permitting system and particularly the introduction of a revised national database will, in the future, allow easier capture of the numbers and types of activities, which can in turn be assigned to risk categories. In addition, one of the features of the IPPC regime is the control of emissions to all media, including land. A recent project undertaken by WS Atkins Environment on behalf of the Environment Agency to consolidate a number of PPC records, however, suggested that the number of emissions to land being permitted was extremely small - in fact a sample of permits in March 2003 revealed no such emissions.

4.48   In examining the use of these data, it is also necessary to consider that the nature of the permitting regime. In theory, land contamination resulting from the operation of a permitted site should be addressed by the operator once discovered, or at the surrender of the permit. Any contamination resulting from activities before the granting of a permit would have to be dealt with through a different regulatory regime.

Abstraction licences, discharge consents and test pump consents

4.49   These data sources were found to be of only peripheral use. In a small number of instances, discharge consents were related to certain remediation techniques and were used to confirm historical clean-up activities. In the national dataset, however, it is not possible to specifically identify where discharges are specifically related to land remediation activities. These data cannot therefore be used to populate the CS3 indicator for remediation.

4.50   Although an activity requiring a discharge consent may in some cases be linked to a potential CS1 site, it is also possible that the activity will be benign in this regard. More data and analysis are needed in connection with the activity before any conclusions can be established.

Water quality monitoring including GQA Chemistry, GQA Biology, and Dangerous Substances Directive water quality monitoring

4.51   Various datasets have been supplied to the project team showing the location and results of monitoring water quality. Although it is possible to use these data to indicate where pollution of watercourses may be occurring, there is no necessary causal link between this pollution and land contamination. These data did not therefore reveal any useful information for this study.

Landfill sites, REGIS points dataset

4.52   Details of the locations of existing (permitted) landfill and waste management licences were supplied by the Environment Agency to the project team, together with point locations and landfill site polygons. As these sites are controlled under separate legislation and do not fall under the definition of land contamination for the purposes of this project, these data were not examined in detail. In summary form, however, the area of registered landfill (during 2003/04) is 28,000 hectares, spread between different regions of England and Wales as indicated in Table 4.15. *[JAH: date of data? Need dates of data for landfill sites. Also need to be clear whether data cover current and/or closed landfills.] [How were regions defined? These are not (all) Environment Agency regions.]*

Table 4.15 Numbers and extent of permitted landfill sites in England and Wales

Region	Total landfill area (ha)	Number of sites	Percentage of national total
Eastern	3,655	254	13.1
London	884	37	3.2
Midlands	5,717	487	20.5
North East	1,739	129	6.2
North West	2,825	272	10.1
South East	5,315	380	19.0
South West	2,407	309	8.6
Unassigned	190	11	0.7
Wales	1,635	186	5.9
Yorkshire and Humberside	3,535	323	12.7
Total	27,903	2,388	100.0

4.53 An ongoing Environment Agency project to compile a definitive resource of closed landfill sites has produced preliminary estimates of around **20,000 sites**, covering **62,000 ha** of which contributes to **CS1**. This dataset may feature some duplication, and the exact relationship between these areas and those for operational landfills is not clear. This result is of greater significance than the operational landfill site area in that historic, closed landfill sites are higher risk sites for land contamination issues (CS1), although by no means all such sites will be in a condition such as to come within the definition of 'contaminated land' in Part IIA.

4.54 Before the Environment Agency was set up in 1996, the waste industry was regulated and licensed on a local authority level. This led to different methods being employed to collect and store waste data. When the Environment Agency was formed, several different methods for recording waste management site licence data therefore existed within each of its Regions. The need for a national waste licensing database was identified and the REGIS (Regulation Information System) database of licensed sites for waste was introduced to fulfil this requirement.

4.55 The REGIS dataset contains information on licence holder and site address, correspondence address, dates of licence issue and National Grid References. The size field within the dataset gives an indication of the maximum quantity of waste permitted at the site per year derived from the charge code. This classifies the site into small (<25,000 tonnes per annum), medium (25,000–75,000 tonnes per annum) and large (>75,000 tonnes per annum). The distribution of sites geographically and by size is given in Table 4.16.

Table 4.16 Distribution of REGIS licences by size and Environment Agency region,

Region	Large	Medium	Small	Zero	(blank)	Total	Percentage of sites
Anglian	227	149	763	3	61	1,203	12.3
Midlands	398	189	828		215	1,630	16.7
North East	335	194	1015	2	548	2,094	21.4
North West	231	199	708	1	63	1,202	12.3
South West	157	165	586	3	256	1,167	11.9
Southern	174	118	379	4	38	713	7.3
Thames	381	158	495	4	73	1,111	11.4
Wales	126	113	374		50	663	6.8
Total	**2,029**	**1,285**	**5,148**	**17**	**1,304**	**9,783**	**100.10**

4.56 Of these 9,783 licences, approximately 1,700 (16 per cent) have been surrendered, revoked, suspended or cancelled. Using the codes supplied for the licence, 2,304 of the active permits relate to landfill operations. Because these sites are operating under strict licensing regimes, they should not in theory be contributing to the overall stock of land contamination. The numbers of the sites, however, does help to inform the scale and scope of the figures for other activities.

Mobile plant licence returns and working plans

4.57 Plant used for remediation is licensed by the Environment Agency and each use of the equipment requires a site-specific working plan. The records associated with this regime would, in theory, would reveal the extent and location of remediation. Further work is required to obtain this information from the Environment Agency records.

COAL AUTHORITY

4.58 Coal Authority data were not available to the project team in a form that could easily be used. There are potential data processing problems that would prevent aggregation of information. The Coal Authority's record-keeping is directed toward meeting a large number of data requests during property transaction process. The data holdings are therefore geared toward extracting information at specific points on a map and not to producing the aggregated statistics required by the project team.

REGIONAL DEVELOPMENT AGENCIES AND WELSH DEVELOPMENT AGENCY

4.59   Although the Regional Development Agencies (RDAs) and the Welsh Development Agency (WDA) share a common agenda to stimulate economic development within their region, their approach to implementation varies. Furthermore, the focus of RDA activity is principally all brownfield sites, and not just those with particular contamination issues. Data relating specifically to contamination are therefore unlikely to have been collected in a systematic way, which would allow extrapolation to a national level and comparison between different regions.

4.60   In terms of identifying brownfield sites, the RDAs rely heavily on the Previously Developed Land component on the National Land Use Database. Hence, the analysis of these data undertaken by the project team represents a useful insight into the information held at a regional level.

4.61   Various localised initiatives have been recently undertaken by the RDAs to characterise the different brownfield sites more accurately. This is consistent with the practice of developing Brownfield Land Action Plans (BLAPs), for which identification of contamination issues is a major component. It is recommended that the Government works with the RDAs to develop a consistent standard of classification and data collection in these schemes so that future estimates of the indicators can take advantage of such projects.

NATIONAL HOUSE BUILDING COUNCIL

4.62   The National House Building Council (NHBC) registers about 90 per cent of all new and newly converted homes in the UK, and provides a warranty and insurance for those registered. As part of its register, the NHBC requests basic data from the builder on the presence of contamination prior to building work and the remediation undertaken on the site. In addition, the NHBC itself supplements these data with its own estimates of contamination and remediation, as determined from the historical land uses for the sites.

4.63   Data on remediation for house building were provided by the NHBC for sites registered in 2003 but developed during 2002 (Table 4.17). These relate to sites requiring some form of 'action' to the land or the building with respect to contamination before it is considered for homes to be built and lived in on the site. Sites are considered areas of land developed by one builder, and are further divided into individual plots. An average plot size of 341 m^2 was used, as given by the ODPM English House Condition Survey 2001 for post-1980 house construction (ODPM, 2003).

4.64   Many small builders developing smaller sites may be slower at declaring to the NHBC the likelihood of their sites being affected by contamination. Some under-reporting of small sites where remediation has or should have taken place is therefore probable.

Table 4.17 Remediation for house building, 2002

Site size	No. of sites	Total number of plots	Estimated area (ha)
>100 plots	259	46,828	1,597
>50 plots	377	26,374	899
>10 plots	934	22,097	754
<10 plots	698	2,981	102
Total	**2268**	**98,280**	**3,351**

4.65   Adding an additional 10 per cent to the number given in table 4.17 to take into account those properties that do not register with the NHBC gives an estimate of **3700 ha** for **CS3** for 2002.

4.66   This year was the first for which these statistics have been compiled by the NHBC, so it is not possible to examine trends in these data with any certainty or to develop cumulative totals. As data for each year become available, it would helpful for the NHBC to review trends in these data.

LANDFILL TAX EXEMPTIONS

4.67   HM Revenue and Customs (HMRC) operates a scheme whereby Landfill Tax exemptions can be claimed for the remediation of contaminated land provided that remediation involves disposal of material from a site to landfill. Full details of the eligibility criteria are set out Notice LFT2 (HMCE, 2003). In summary, the conditions are fairly broad in scope, and relate both to redevelopment activity and general clean-up. The removal of material undertaken under a works notice or a remediation notice under section 78 of Environmental Protection Act 1990 is excluded, unless being undertaken by a local authority/RDA or another public body.

4.68   The information collected by HMRC to process claims for exemption includes valuable information on the site being remediated and the nature of the action being undertaken (HMRC, 2000).

4.69   Contact established with the then HM Customs and Excise in the early stages of the project provided anecdotal information that over 1,000 applications for exemptions alone were processed in 2003. More detailed information was not available to the

project team, mainly due to the fragmented nature of the data holdings and the effort required to compile the necessary statistics. It is recommended that the Government and HMRC collaborate to ensure a better flow of information, which would have benefits for both parties.

4.70   There is a discrepancy between the figure of 1,000 applications for Landfill Tax exemption during 2003 and the 2,300 house building sites where land contamination was recorded by the NHBC in 2002. This has a number of potential causes:

- the Landfill Tax exemption is not always being claimed where it could be;

- removal and disposal to landfill of material from a site comprises only a percentage of remediation activities (see below);

- much of 'action' and 'contamination' as recognised by the NHBC falls outside the scope of that deemed eligible by HMRC, e.g. work being undertaken under a statutory order. However, given the number of sites under Part IIA this is not a major contribution to the discrepancy.

4.71   In 2000, research on behalf of the Environment Agency established that 80–90 per cent of clean-up activity utilised excavation and disposal compared with *in situ* remediation (Environment Agency, 2000). This finding increases the likelihood that the discrepancy is attributable to the first and third of the factors identified above, and suggests that the HMRC data may not be quite as comprehensive as initial exploration suggested.

4.72   Further work is required to ensure that an appropriate flow of data is achieved and that the proportion of sites being remediated and which qualify for the exemption is fully characterised.

4.73   For the purposes of contributing to a national total, an arbitrary site area of 3.5 ha has been chosen on the basis of the average size of sites in the 'Factory or works – use not specified' category in the Landmark HLUD. Using this number produces an estimate of **3,500 ha** of land remediated in 2002/03 and which qualifies as **CS3**.

Landfill Tax

4.74   A register of landfill operators that pay landfill tax can be downloaded from the HMRC website (http://www.hmrc.gov.uk/). This gives the registration number, operator name and address of some 1,300 registered sites throughout the UK, but does not disclose the types of waste accepted.

LANDFILL TAX CREDITS

4.75   The Landfill Tax Credit Scheme (LTCS) (http://www.ltcs.org.uk) is designed to help mitigate the impact of landfill on local communities by channelling landfill tax into environmental projects. The scheme is regulated by Entrust. Due to their size, very few contaminated land projects are funded by the LTCS, and thus this source was not considered a viable source of data for this project.

CL:AIRE

4.76   Contaminated Land: Applications in Real Environments (CL:AIRE) (http://www.claire.co.uk/) is a not-for-profit organisation that provides a vehicle for the practical demonstration of cost-effective remediation technologies to real sites. The results of the demonstrations are available to contaminated land owners who can utilise this information to:

- extend the clean-up options available to them;

- reduce the technical risks;

- provide realistic cost estimates for full scale remediation.

4.77   However, the scope of this project is outside CL:AIRE's core activities and it was unable to provide any pertinent data.

WATER COMPANIES

4.78   All the water and sewage undertakers under the regulation of OFWAT were contacted by the project team to obtain areas, location and types of landholdings in their ownership. These data were not available due to incomplete records and security issues.

ENGLISH PARTNERSHIPS

4.79   As a funding body for the remediation and redevelopment of contaminated and disused sites, English Partnerships has a number of relevant data holdings. Historically, its efforts have been targeted at specific regions or development zones (e.g. Telford, Merseyside) and, for these areas, there are very good records relating to the level of contamination on its land holdings. Outside these areas, the data are likely to be patchier but may still provide useful information.

4.80   Initial contact with English Partnerships determined that its main source of information on sites on a national basis is the NLUD-PDL (see above).

MAJOR LANDOWNERS

4.81   Landowners such as Defence Estates, Atomic Weapons Establishment, SecondSite, Transco, British Airports Authority, Associated British Ports, National Power, Network Rail and London Underground, were contacted in the hope of gaining information about the extent of land holdings, their location and information with regard to land contamination and remediation. Response rates from these sources were low, principally due to a reluctance to release commercially sensitive data that could affect the value of their estate.

4.82   This channel of information is considered unlikely to yield future data without high-level agreement between the participants and the Environment Agency. But even with such agreements in place, it will be difficult to characterise any land holdings accurately in relation to potential contamination.

4.83   Some information was available from these organisations and a few examples are given in Table 4.18. These examples are not intended to be exhaustive, but are indicative of the scale of total land holdings, and the extent of ongoing remediation activities.

Table 4.18 Examples of information from major landowners

Organisation	Information
SecondSite Property[1]	£290 million spent on reclaiming over 600 ha
RWE npower[2]	Total area of non-operational land covers 918 ha, of which 726 ha is demolition or development site land
Network Rail[3]	Total estate portfolio is approximately 56,000 hectares and 16,000 route km
Defence Estates[4]	240,000 ha total UK land holding (4,000 sites). Built estate comprises 80,000 ha, and the remaining land is rural and generally undeveloped.

Sources

1 http://www.SecondSite-property.com/what_we_do/mn_construction.html [Accessed 25 July 2005]

2 Mark Jones. Environmental Programme Manager, RWE npower

3 http://www.networkrail.co.uk/Documents/PR03009.doc [Accessed 25 July 2005]

4 http://www.defence-estates.MoD.uk/about_estate/index.htm [Accessed 25 July 2005]

NRPB

4.84 The National Radiological Protection Board was consulted by the project team in order to obtain a register of radioactive sites where it had carried out contaminated land assessment. This appears to be a relatively low number of sites (<10) but, for reasons of client confidentiality, no useful data for these were released. Site-specific information contained in NRPB assessment reports may be a source of useful information in classifying the extent of potential radiological hazard.

HISTORIC RSA PERMITS AND REPORTS

4.85 Approximately 20,000 historical files relating to regulatory matters under the Radioactive Substances Act 1993 (and its predecessors) are held by Defra and/or the Environment Agency. The titles and reference numbers of these reports have been collated in a Microsoft Access database, which was supplied to the project team.

4.86 Of the 20,000 records, approximately half (~10,600) relate to site-specific matters outside nuclear licensed sites. These site-specific files are summarised in Table 4.19, which has been constructed by eliminating all non site-specific files and all files relating to nuclear licensed sites. Ministry of Defence (MoD) files are not present on the list because the MoD was, at the time of file archiving, exempt from formal regulation. Therefore, the analysis does not include MoD property.

Table 4.19 Site-specific files relating to historic RSA permits and reports

Ref.	File identifier	Title	No. of files
1	RW/RAD	Registrations and authorisations for overseas registered companies	28
2	RW/RAL RW/RAW	Registrations and authorisations for hospitals and hospices	628
3	RW/RAM RW/RG RW/RBA	Registrations and authorisations for industrial and commercial premises	7,811
4	RW/RAN	Registrations and authorisations for universities and medical schools	222
5	RW/RAP	Registrations and authorisations for nationalised industries	455
6	RW/RBG	Registrations and authorisations for churches	17
7	RW/RAU	Registrations and authorisations for the agricultural research council	21
8	RW/RAX	Registrations and authorisations for police stations and scenes of crime	3
9	RW/RAQ	Registrations and authorisations for local authority	417

Ref.	File identifier	Title	No. of files
	RW/RK	departments	
10	RW/RAR	Registrations and authorisations for schools and colleges	284
11	RW/RAS RW/RE RW/RBJ	Registrations and authorisations for government departments and crown property	332
12	RW/RBH	Registrations and authorisations for community and sports centres	63
13	RW/RBI	Registrations and authorisations for social clubs	71
14	RW/RBJ	Registrations and authorisations for quarries	4
15	RW/RAT	Registrations and authorisations for the medical research council	61
16	RW/RAV	Registrations and authorisations for the natural environmental research council	16
17	RW/RAY	Registrations and authorisations for public research institutions	12
18	RW/RY	Environmental studies	177

4.87 A number of gross assumptions can be made in order to derive an upper estimate figure for the contribution of these sites to indicator **CL1**. These assumptions are as follows:

- The files relate to both registrations for the keeping and use of radioactive materials, and authorisations for the disposal of radioactive wastes. For the purposes of identifying possible radioactively contaminated land, registrations can be excluded. (Some registrations are for 'open' sources; i.e. chemicals containing radionuclides. There is a consequent risk of spillage and therefore ground contamination. However, the potential is very low and, in any case, it is extremely rare for a site to hold a registration for keeping open sources unless it is accompanied by an authorisation for disposal). Based on a previous examination of a sample (~500) of the archived files, the ratio of registrations to authorisations issued by the Environment Agency and its predecessors is approximately 5:1. This means that 2,000 of the above site-specific files relate to authorisations.

- The files relate to historical archived information. There are current operational regulatory files under RSA93, but very few new sites coming under it. That is to say, the current operational files are mainly continuations of filed data for sites already in the historical record. The assumption here is that there are no more than 2,000 authorised sites.

- The proportion of authorised sites that could have radioactively contaminated land is likely to be no more than 10 per cent. This is an extreme upper limit, based on the consideration that the vast majority of authorisations are for discharges of radioactive wastes to air and water. It is extremely rare (with the exception of some nuclear licensed sites) for an authorisation to permit disposal to land: no such authorisations have been granted in the past 10 years. Furthermore, before authorisations are surrendered, it is common practice to require a demonstration that the site is clear.

- Two site-specific examples from the south of England were used to determine the maximum extent of radioactive contamination at a typical site; this is 0.2 hectares. This is an extreme upper bound; most known radioactively contaminated sites (e.g. those associated with luminising workshops or burning grounds at airfields) have an area of contamination of a few tens of square metres.

- A number of sites covered by the above analysis are known to have been remediated. The gross assumption for derivation of a maximum figure is that no site has been remediated.

4.88 Based on these data, an upper bound for radioactively contaminated land (excluding landfill sites, nuclear licensed sites and MoD property) is therefore:

10,600 (no. of site specific files) x
0.2 (proportion of authorisations) x
0.1 (upper figure for the proportion of authorised sites which could have contamination issues) x
0.2 ha (assumed area of contamination)

= **42 ha** for inclusion in **CS1**, equating to around 210 sites.

LANDMARK INFORMATION GROUP

Historic Land Use Database (HLUD)

4.89 This information is key to the project in that it forms a readily available and systematically collected dataset on the potential sites for contamination. The basis for the data are historical Ordnance Survey maps at 1:10,000 (or 1:10560) scale.

4.90 A systematic data capture process using on-screen digitisation was used to generate polygons, points and lines of historic land uses as displayed on the maps. The digitising process was repeated for six different time 'epochs' (Table 4.20).

Table 4.20 HLUD epochs

Epoch	Time period (approximate dates)
1	1843–1893
2	1891–1912
3	1904–1939
4	1919–1943
5	1945–1970
6	1970–1996

4.91   Each epoch is represented in a separate digitised 'layer' for use within a GIS system. The land use associated with each site is assigned to one of 66 different categories. Some of these are quite specific (e.g. hospitals), as they can clearly be distinguished from a map. There are, however, a number of generic categories, e.g. 'Heap', unknown constituents' or 'Factory or works - use not specified'.

4.92   The main data analysed are the site polygons. These are derived from those processes whose boundaries were clearly indicated on the mapping, and are greater than 100 x 100m (or 1 ha) in extent. An important feature of the HLUD data, which influences the analysis, is that where a site is in continuous use across multiple epochs, it is assigned the same ID number. The extent of the site may be different across each epoch; each of these extents is provided, but they are linked by a common ID number. Where there is a recognisable change of use on the site or the site becomes divided between multiple uses, then new ID numbers are assigned. Potentially, therefore, the same site could appear six different times, with six different ID numbers.

4.93   The HLUD data were supplied to the project team in two formats:

• Full digital data was supplied for the polygons, points and lines in the six epochs covering the 1-km radius study areas (see Appendix B).

• Aggregated statistics were supplied for each of the 66 land use categories for the English regions and for Wales. These aggregated statistics covered all epochs, and epoch 6 separately.

4.94   The aggregation technique took the largest site extent for every unique ID in the database. As a consequence:

- where there are multiple uses on the same site over time, the site area will be repeated for each of these new uses;

- where adjoining site boundaries expand or contract between epochs, site maximum areas could therefore feature a considerable degree of overlap.

4.95 The figures therefore are most likely to represent an overestimate of the site extents, which in turn are an overestimate of the potential extent of contamination. Using this raw data, including the overlap, gives an aggregated figure of approximately 600,000 ha in total for the dataset.

4.96 To remove this overlap, calculations have been made using the polygons supplied for the 12 study areas. In these 12 areas, the total area generated using the same method as applied by Landmark gives a figure of 1,100 ha. Taking the same maximum polygons and removing any area of overlap reduced the total area by 29 per cent to 780 ha.

4.97 Applying this 29 per cent reduction to the aggregated totals gives the estimates shown in Figure 4.1 and Table 4.21.

Figure 4.1 Landmark HLUD polygon areas by region
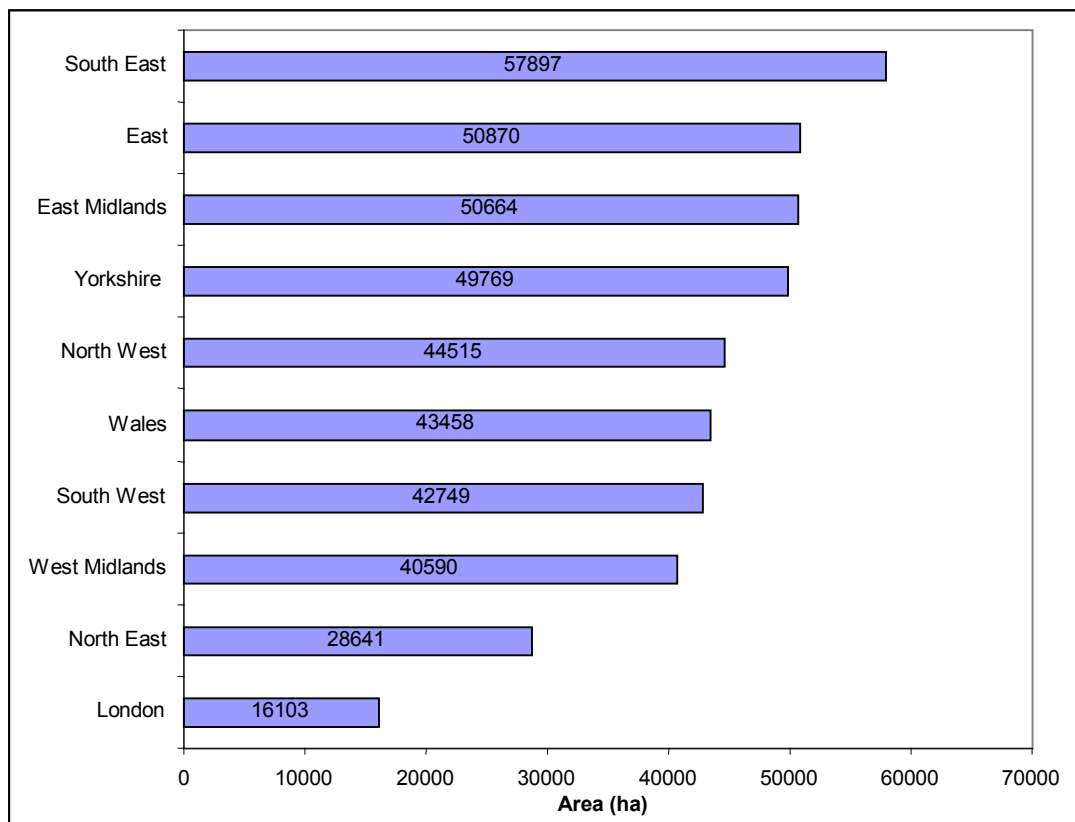
Table 4.21 Landmark HLUD polygon numbers and areas by region

Region	Sites	Area (ha)	Percentage of total sites	Percentage of total polygon area
East	25,919	50,870	7.5	12.0
East Midlands	26,956	50,664	7.8	11.9
London	6,913	16,103	2.0	3.8
North East	25,267	28,641	7.3	6.7
North West	44,109	44,515	12.7	10.5
South East	38,620	57,897	11.1	13.6
South West	49,322	42,749	14.2	10.1
Wales	50,836	43,458	14.6	10.2
West Midlands	32,717	40,590	9.4	9.5
Yorkshire	46,607	49,769	13.4	11.7
Total	**347,266**	**425,255**	**100.00**	**100.00**

EnviroCheck reports

4.98   Landmark's EnviroCheck reports contain much of the data previously discussed – in particular records from PPC and pollution incidents databases. The data used in EnviroCheck have, however, undergone a process of 'cleaning' – in particular the correction of geographical co-ordinates. For the study areas, therefore, the use of these data was preferable to the use of the 'raw' data. This information was used extensively in the study area reports.

Historical Tank and Engine Facilities (HTEF)

4.99   Also based on the historic mapping, these data show the sites where fuel storage is indicated on the historic maps. HTEF data were not purchased from Landmark for the study.

SiteScope data

4.100 Landmark acquired SiteScope in 2003 and is in the process of absorbing the SiteScope data into its own systems. The SiteScope data are grouped into over 4,000 categories of historic land use rather than the 66 used by Landmark. Although some of these details may simply represent different names for the same activities, a number of these categories have been identified as being of interest in relation to radiological contamination. For future studies, it may be beneficial to work with this information.

CONTAMINATED LAND TAX CREDIT

4.101 Accelerated payable tax credit for costs incurred by companies in cleaning up contaminated land sites are available from the HM Revenue and Customs (http://www.hmrc.gov.uk/manuals/cirdmanual/CIRD60000.htm). Unlike the HMRC scheme for relief on Landfill Tax (see above), there are no specific forms to be completed and companies claiming the tax credit submit the claim as part of their annual returns to HMRC.

4.102 The most recent figures available indicate that £75 million were claimed in 2002/03. The remediation costs cited by SecondSite Property (see Table 4.18) are approximately £0.5 million per hectare. If SecondSite Property activity reflects an average cost of remediation, then this would imply that the HMRC scheme funded the remediation of **150 ha** (**CS2** and **CS3**) in 2002/03.

4.103 Contact with HMRC was established and a request submitted to enable the release of further information. There could be an opportunity to encourage government departments/agencies such as HMRC to refine and enhance data capture, and to work with others to ensure that information is shared to allow accurate decisions to be cross-referenced. There could also be a role for ONS or another organisation to co-ordinate and deliver the data.

5.   FINAL CALCULATIONS AND SUMMARY OF RESULTS

INDICATOR RESULTS: CS1, CS2 AND CS3 EXTRAPOLATED FROM THE STUDY AREAS

5.1   The results from the study areas have been extrapolated to produce national totals using the following methodology:

- Take the study area results to represent the likely number and area percentage for that indicator within urban areas for that grouping of local authorities. Where more than one study area is present, take an average.

- Apply the percentage figure to the total area of urban land for that group and factor up the site numbers by the same amount. By summing these results, this gives an overall figure for the indicators within urban areas.

- Evidence from the other data sources indicates that 85 per cent of industrial sites and 89 per cent of industrial site areas are within urban areas. Applying these percentages to the urban totals, the overall national totals can be calculated.

- From the national totals, allocate the rural fraction to the different local authority groups on the basis of how much rural land they contain.

5.2   These steps have been completed for the three indicators CS1, CS2 and CS3 on the basis of the local authority classification and the geographical region.

5.3   The calculations are illustrated in Tables 5.1–5.6 for the area of the indicators. The number of sites is given by national total only.

Extrapolated by local authority classification

5.4   The national totals produced by extrapolation on the basis of local authority classification are:

- CS1   330,000 sites   292,000 ha

- CS2   30,000 sites   57,000 ha
- CS3   18,000 sites   32,000 ha

5.5   Tables 5.1–5.3 present the calculations and sub-totals for each local authority classification.

Table 5.1 CS1 national totals (local authority classification)

Classification	Study area	Percentage of study area	Urban (ha)	Rural (ha)	Total (ha)
Centres with industry	E, B	27.0	37,255	427	37,682
Coastal and countryside	J	3.4	4,192	10,822	15,014
Industrial hinterlands - A	C	35.1	39,555	1,106	40,661
Industrial hinterlands - B	A	44.1	2,026	8	2,034
London and suburbs	H, I	20.1	27,400	48	27,448
Manufacturing towns	D	27.2	34,435	1,553	35,988
New and growing towns	F	16.9	13,619	537	14,156
Prospering small and/or Southern	G, K	12.4	56,918	17,229	74,147
Regional centres	L	38.3	44,035	345	44,380
Total (ha)			259,436	32,075	291,511

Table 5.2 CS2 national totals (local authority classification)

Classification	Study area	Percentage of study area	Urban (ha)	Rural (ha)	Total (ha)
Centres with industry	E, B	5.0	6,927	84	7,011
Coastal and countryside	J	0.0	0	2,130	2,130
Industrial hinterlands - A	C	10.5	11,778	218	11,996
Industrial hinterlands - B	A	7.3	336	2	338
London and suburbs	H, I	7.4	10,091	9	10,100
Manufacturing towns	D	2.0	2,532	306	2,838
New and growing towns	F	6.3	5,051	106	5,157
Prospering small and/or Southern	G, K	0.2	1,109	3,391	4,499
Regional centres	L	11.5	13,234	68	13,302
Total (ha)			51,059	6,313	57,371

Table 5.3 CS3 national totals (local authority classification)

Classification	Study area	Percentage of study area	Urban (ha)	Rural (ha)	Total (ha)
Centres with industry	E, B	4.2	5,762	47	5,809
Coastal and countryside	J	0.0	0	1,187	1,187
Industrial hinterlands - A	C	0.0	0	121	121
Industrial hinterlands - B	A	7.3	336	1	337
London and suburbs	H, I	5.9	8,075	5	8,080
Manufacturing towns	D	0.8	1,058	170	1,229
New and growing towns	F	0.0	0	59	59
Prospering small and/or Southern	G, K	0.0	0	1,890	1,890
Regional centres	L	11.5	13,234	38	13,272
TOTAL (ha)			28,466	3,519	31,986

Extrapolated by region

5.6 The national totals produced by extrapolation on a regional basis are:

- CS1 (Industrial lnd use) 322,000 sites 332,000 ha
- CS2 (identified sites) 37,000 sites 78,000 ha
- CS3 (remediated sites) 24,000 sites 55,000 ha

5.7 Tables 5.4–5.6 present the calculations and sub-totals for each region.

Table 5.4 CS1 national totals (region)

Region	Study area	Percentage of study area	Urban (ha)	Rural (ha)	Total (ha)
East	F, G	14.1	20,973	4,661	25,634
London	H	15.9	20,454	69	20,523
Midlands	E	26.2	64,379	6,917	71,297
North East	A	44.1	27,657	2,102	29,759
North West	B, C	31.5	51,290	3,301	54,591
South East	I	24.4	52,827	4,472	57,300
South West	J	3.4	4,417	5,960	10,377
Wales	K, L	25.9	18,909	5,292	24,200
Yorkshire and Humberside	D	27.2	34,451	3,741	38,192

Region	Study area	Percentage of study area	Urban (ha)	Rural (ha)	Total (ha)
Total (ha)			295,358	36,515	331,872

Table 5.5 CS2 national totals (region)

Class	Study area	Percentage of study area	Urban (ha)	Rural (ha)	Total (ha)
East	F, G	3.4	5,022	1,102	6,125
London	H	5.8	7,466	16	7,483
Midlands	E	5.9	14,603	1,636	16,239
North East	A	7.3	4,589	497	5,086
North West	B, C	7.3	11,863	780	12,644
South East	I	9.0	19,567	1,057	20,624
South West	J	0.0	0	1,409	1,409
Wales	K, L	5.7	4,195	1,251	5,446
Yorkshire and Humberside	D	2.0	2,533	885	3,418
Total (ha)			69,839	8,634	78,473

Table 5.6 CS3 national totals (region)

Class	Study area	Percentage of study area	Urban (ha)	Rural (ha)	Total (ha)
East	F, G	0.0	0	773	773
London	H	3.6	4,603	11	4,614
Midlands	E	5.9	14,603	1,147	15,750
North East	A	7.3	4,589	349	4,937
North West	B, C	1.2	1,965	547	2,512
South East	I	8.3	17,962	742	18,704
South West	J	0.0	0	988	988
Wales	K, L	5.7	4,195	877	5,072
Yorkshire and Humberside	D	0.8	1,059	620	1,679
Total (ha)			48,976	6,055	55,030

INDICATOR RESULTS: CS4

5.8 Using the records in the National Incident Reporting System, the totals for CS4 (newly created sites) are:

- 250 sites per year since 2000   **750 sites**

- at an average 0.04 ha per site   **30 ha**

COMPARISON WITH LANDMARK HISTORIC LAND USE DATABASE

Comparison of regional totals and sensitivity estimates

5.9 Examining the Landmark Historic Land Use Database figures and comparing the results for the study areas and the national totals with those calculated for CS1 can help inform the project in two ways:

- It provides some confidence in the work undertaken in the study areas and a degree of corroboration or quality control checks for the desktop studies.

- The availability of the HLUD data at both a local level and the regional/national level allows the method of extrapolation applied to CS1 to be examined in detail. If the extrapolation technique is correct, then the local HLUD data should scale up to approximate the national totals. By exploring the factors behind any discrepancies, it is possible to reveal where the sensitivities lie in the final results.

5.10 Table 5.7 examines the overlap between CS1 as estimated by the project and the Landmark HLUD polygons.

Table 5.7 CS1/Landmark HLUD overlap and differences

Study area	Percentage CS1 overlap with Landmark	Percentage Landmark overlap with CS1	CS1 total as percentage of Landmark total
A	86	99	115
B	77	84	109
C	96	70	72
D	40	60	145
E	83	83	97
F	32	76	222
G	42	90	216
H	46	67	143
I	49	89	180
J	61	63	100
K	81	73	85
L	90	93	99
Average	65.2	79.0	132

5.11   In general, the results from Table 5.7 indicate that the area estimated by the project is on average 32 per cent higher than that estimated by the Landmark HLUD. On an absolute basis, however, this amounts to an average difference of 7.85 ha per study area – 2.5 per cent of the 314 ha. On average, 79 per cent of the Landmark polygon areas were identified as CS1, which suggests good agreement. The lower figure for the amount of CS1 which is also Landmark HLUD (65 per cent) is related to the generally larger extent of CS1.

5.12   Therefore, the figures for CS1 should be expected to be higher than those for Landmark at a national level – possibly by as much as 30 per cent. This is not the case, however, with the figures for CS1 suggesting 292,000 or 333,000 ha depending on the extrapolation method, and that for Landmark predicting 425,000 ha – the reverse of the anticipated situation. A number of factors may be causing this discrepancy:

A   The extrapolation of CS1 assumes that 90 per cent of land contamination is found within urban areas. This number may be too high, and therefore the numbers and areas of sites in rural England and Wales are under-represented in the overall total. The data received from Landmark enumerates both urban and rural areas, and represent a precise count of the areas found in each.

B   The sample areas did not adequately represent the distribution and pattern of land contamination, and were biased in favour of local authorities and areas within the selected authorities with lower than average land contamination.

C   The degree of overlap in the national total for the Landmark polygons was underestimated and the 425,000 ha include significant duplicate areas.

5.13   The relative weight to be applied to these factors, and some good evidence for the overall accuracy of the indicators (or for CS1 at least) can be determined from Table 5.8, which gives the national totals for CS1 by region. The CS1 estimate is based on the work from the study areas. The Landmark estimate is based on the HLUD information received for the study areas, processed to remove overlapping areas and extrapolated using the same method used in CS1. The Landmark aggregate column reproduces the data from Section 4 and shows the distribution of the aggregated totals received from Landmark Information Group, processed to remove the estimated overlap. These data are reproduced in Figure 4.1.

Table 5.8 Distribution of CS1 by region and data source (hectares)

Region	Landmark aggregate	Landmark estimate	CS1 estim
East	50,870	15,046	25,634
London	16,103	14,336	20,523
Midlands	91,254	74,691	71,297
North East	28,641	26,612	29,759
North West	44,515	64,408	54,591
South East	57,897	34,609	57,300
South West	42,749	11,435	10,377
Wales	43,458	17,891	24,200
Yorkshire and Humberside	49,769	28,106	38,192
Total (ha)	425,256	287,134	331,872

5.14   Discrepancies between the CS1 estimates and Landmark estimates in Table 5.8 can be attributed to variations at the study area level and reveal what form the results might have taken had an alternative data source been used. As expected, this shows a greater total for CS1 than for Landmark.

5.15   The differences between the Landmark estimate and the Landmark aggregate show the variation attributable to the methodology and reveal where study areas have not been a representative sample for their area. In three regions (London, Midlands and North East), the agreement is generally good. In the remaining regions, however, the

data suggest that the regions are under-represented. The exception is in the North West, where the reverse applies – the study area polygons are over-representing the regional picture.

5.16   Three potential sources of error (A, B and C) have been identified. Cause C can be discounted because the same method of stripping out the area of overlap was used for both the aggregated total and the estimated total. Although this does not eliminate it from consideration in the overall results, it does not affect the methodology used to extrapolate the study area results to the national total.

5.17   Cause B (the problems arising from the selection of the study areas) cannot be discounted. The expected pattern is that the study areas with the lowest CS1 scores should also be the ones with the greatest underestimate. The regions with the biggest shortfall are South West, East and Wales. Low CS1 scores were found in the South West and East study areas but, in Wales, the CS1 score is around the median value for the regions. Conversely, the regions with the biggest scores should be the most representative; this is true for North East and even more so for North West, where there is an overestimate. Though this suggests that, on the whole, the study areas did not contain enough historic industry to be representative of their regions, the pattern is not consistent. This suggests that Cause B is less important and therefore the overall results are less sensitive to changes leading to underestimates or overestimates in the study areas.

5.18   Cause A is considered the biggest factor, i.e. the assumption that urban areas (where the study areas were sited) account for 90 per cent of the area of contamination. If this figure were adjusted downwards, then the total estimates would rise considerably. If the urban fraction was reduced to around 60%, agreement could be achieved between the Landmark estimated national total and the Landmark actual total. In general, small changes to this assumption have a greater impact on the overall study.

CS1 (RADIOLOGICAL)

5.19   Tables 5.9 and 5.10 give the area results for CS1 (radiological) by local authority classification and by region, respectively. In the case of radiological sites, the extrapolation to national results using the ratio of urban to rural current industrial sites is not practical due to the lower representation of radiological sites in the dataset.

5.20   In total, the area figures for CS1 are:

- 26,000 ha (extrapolated using local authority classification)

- 28,000 ha (extrapolated using region)

Table 5.9 Final study area results for CS1 (radiological) extrapolated by local authority classification

Classification	Total area (ha)	Urban (per cent)	CS1 (per cent)	CS1 (ha)
Centres with industry	321,460	42.9	1.41	1948.27
Coastal and countryside	4,781,509	2.6	0.00	5.15
Industrial hinterlands - A	588,320	19.1	2.47	2786.67
Industrial hinterlands - B	8,239	55.7	7.16	328.60
London and suburbs	156,570	86.9	1.15	1558.20
Manufacturing towns	794,847	15.9	0.45	567.78
New and growing towns	312,055	25.9	6.64	5364.97
Prospering small and/or Southern	7,870,980	5.8	2.61	11915.10
Regional centres	263,509	43.7	1.21	1393.94
Total (ha)	15,097,489			25861.00
Average urban (per cent)		8.6		
CS1 as percentage of urban area				**1.99**

Table 5.10 Final study area results for CS1 (radiological) extrapolated by region

Region	Total area (ha)	Urban (per cent)	CS1 (per cent)	CS1 (ha)
East	1,910,985	7.8	5.82	8686.78
London	155,061	83.1	0.12	156.33
Midlands	2,860,486	8.6	2.60	6393.73
North East	857,320	7.31	7.16	4485.69
North West	1,410,642	11.6	1.35	2197.40
South East	1,906,949	11.4	2.17	4695.04
South West	2,382,076	5.4	0.00	5.43
Wales	2,073,208	3.5	0.71	516.48
Yorkshire and Humberside	1,540,762	8.2	0.45	568.04
Total (ha)	15,097,489			27704.91
Average urban (per cent)		8.6		
CS1 as percentage of urban area				**2.14**

5.21   As discussed previously, the results for CS2 and CS3 have not been included in this section as only two cases of remediation of radiological contamination were found in the study areas. By coincidence, both of these related to the same potential contaminant source, which was relocated from within one study area to a second.

5.22   The remediation activities at other sites may have served to mitigate against radiological contamination, but no evidence was available to support this. However, it would be easy to develop this interpretation from the data should an alternative classification of the data be preferred and such sites included.

UNCERTAINTY

5.23   The uncertainty attached to these results arises from a number of sources:

- **The approaches adopted for the surveys of CS1 in the study areas**. This can be mitigated for by comparison with alternative surveys of the same area. In practice, this was achieved by conducting the sampling first and then comparing the records with the digital HLUD dataset. In most cases, there was good agreement between the two approaches, with the CS1 areas being co-incident with the HLUD areas and, in most cases, exceeding them by a small margin. This suggests that the surveys for CS1 generally identified the right areas.

- **The data available for CS2 and CS3 for the study areas**. The data available to support CS2 and CS3 were patchy and varied considerably between the study areas. This variation seemed to be independent of the propensity for CS1, and was more closely linked to the differing management and data handling regimes at the local level. This factor could have been mitigated for if records had been available from alternative sources, e.g. from those undertaking the mitigation (landowners/site operators) and those contributing to the funding of the mitigation action (HMRC, etc.). However, only limited information was available from such sources and in insufficient detail to substantially inform the final totals. It is therefore considered likely that the overall totals for CS2 and CS3 are underestimates of the true picture.

- **Sampling methodology: selection of the local authorities.** An attempt was made to use local authorities that were the 'average' for their type. This required some modification to take into account regional spread. There was also particular concern about the lack of regional representation in the East Midlands and the single study area in the Coastal and countryside classification which accounted for close to 50 per cent of the land area.

In both the regional and the classification schemes, there were three groups with two representatives. Looking at CS1, Centres with industry produced 26.2 and 27.8 per cent, Prospering small and/or Southern produced 13.6 and 11.3 per cent, and London and suburbs produced 15.9 and 24.4 per cent. For two of the classes, this result confirms the use of these classes. In the regions with duplicate members, the figures were more diverse. CS1 for Wales had scores of 38.2 and 13.57 per cent, the East had 11.3 and 16.9 per cent, and the North West 27.8 and 35.1 per cent. The pattern for the regions is therefore less convincing.

- **Sampling methodology: selection of the study area**. Endeavours were made to select a 'representative' location within each local authority, but this selection was made on the basis of incomplete evidence (i.e. no historical mapping) and often with a lack of detailed local knowledge (the level of co-operation and knowledge of the required information by the local authorities approached was variable). At a local level, this element of the study has the potential to produce large variations in the results – slight variations in the study area location can clearly influence the indicator totals. The analysis of the national totals for Landmark and for CS1, however, reveals that the results may be less sensitive at a national level to this factor than they are to errors in the extrapolation method.

- **Extrapolation to national totals**. The scaling-up exercise involved extrapolating from 3,768 to 15 million hectares – a factor of 4,000. The comparison between the totals for CS1 for the Landmark data reveals the sensitivity of the results to the approach adopted for extrapolation. Two sources of error in the extrapolation technique should be examined.

First, the treatment for rural areas has been shown to have a major influence on the results: the assumed urban percentage of CS1 needs to be reduced from 90 per cent to 60 per cent to minimise the errors in extrapolation in the Landmark HLUD data.

The second area approach to examining the errors from extrapolation is to compare the totals produced from the regional and the classification methods. The differences between the extrapolated results, expressed as a percentage of the regional approach are:

- CS1   12.0 per cent

- CS2   26.9 per cent

- CS3   41.8 per cent.

5.24   Interestingly, this shows that the degree of difference is not constant across the indicators. This suggests an inter-dependence of the extrapolation factor and the availability of the data. Where good data are available and the indicator is well characterised (CS1), the difference caused by the different extrapolation methods is relatively small. The larger difference for CS2 and CS3, however, suggests that the extrapolation approach amplifies the problems encountered in gathering data at the local level. Although this is an obvious finding, it suggests that if data availability is considered likely to be a problem, then the sampling approach is not the best method to adopt.

5.25   Section 6 contains recommendations on how a number of the areas identified above could best be treated in future exercises.

SUMMARY OF RESULTS

5.26   The results obtained from each indicator from the different sources are summarised below in terms of area and number of sites in England and Wales (Tables 5.11–5.14), giving a range of values from which the mid-points have been derived. Totals are quoted from a number of different sources; there will be overlap between these and the estimates for the indicators themselves.

Table 5.11 Summary of results for CS1 Extent of Industrial Land Use

Source	Chemical		Radiological	
	Area (ha)	Number of sites	Area (ha)	Number of sites
Pollution Inventory	15,000	3,200		
NLUD Previously Developed Land	33,420			
Contaminated Land Survey of Wales	48,243	13,725		
Closed landfill sites	62,000	20,000		
By local authority classification	292,000	330,000	25,861	56,037
By local authority region	332,000	322,000	27,705	50,510
Landmark HLUD	425,000	347,266		
Mid-point of range	300,000	325,000	27,000	53,000

Table 5.12 Summary of results for CS2 Identification of Land Contamination

Source	Area (ha)	Number of sites
Part IIA determined sites	500	70
By local authority classification	57,000	30,000
By local authority region	78,000	37,000
Mid-point of range	67,000	33,500

Table 5.13 Summary of results for CS3 Remediation of Land Contamination

Source	Area (ha)	Number of sites
Landfill Tax exemption (2003)	3,500	1,000
NHBC (2002)	3,400	2,300
By local authority classification	32,000	18,000
By local authority region	55,000	24,000
Mid-point of range	44,000	21,000

Table 5.14 Summary of results for CS4 Newly Created Land Contamination

Source	Area (ha)	Number of sites
National Incident Reporting System (NIRS)	30	750
Mid-point of range	30	750

6.   RECOMMENDATIONS FOR FUTURE WORK

6.1   The overall approach adopted by this project has successfully delivered data on the current state of land contamination in England and Wales, its identification and treatment. However, there were a number of challenges in compiling the data. Addressing these would improve both future iterations of this work, and wider endeavours in environmental protection more.

6.2   The four areas of specific recommendations for repeating this exercise are:

1. testing the selection of 1-km sample areas to reveal the risk and magnitude for bias and/or increasing the sample areas to up to including the whole Local Authority area;

2. developing a scheme for classifying local authorities by their likely propensity for land contamination. This would provide a more robust platform for future sampling and extrapolation campaigns;

3. developing a common data dictionary on land contamination, and protocols for data exchange between local, regional and central government agencies;

4. using Best Value Performance Indicators and / or the Brownfield Strategy to improve the national data on the possible extent, identification and remediation of land contamination that is becoming available through both the Part IIA and Development Control processes.

6.3   These four recommendations are discussed in more detail below.

1-KM SAMPLE AREA SELECTION

6.4   The sampling approach adopted in the study attempted to identify an area that was "average" within each representative local authority for historic contamination. It is, however, difficult to say with certainty that this was achieved as the selection process was based on incomplete information, and in some cases there was no repeat sampling within a typology.

6.5   Two approaches could be adopted to resolve this issue:

A. Test the sample area selection so that its location with respect to the mean for that authority is understood;

B. Increase the size of the sample area so that it naturally encompasses a greater degree of variation.

6.6   Approach A can be implemented by examining different positions of a 1-km radius sample area against approximate datasets of the final parameters, e.g. the Historic Landuse Database (HLUD), or data collected under an inspection strategy. By examining all potential candidate locations within a chosen local authority, it would be possible to calculate the degree of variation precisely, and therefore where a sample area would be most likely to be representative. Additionally, the potential for bias by manual selection of the study areas can be tested against the range of possible values and the mean results. This work would necessitate obtaining a full dataset before beginning work on a study area.

6.7   Under approach B, the results would reduce the magnitude of extrapolation required and remove one of the sources of error introduced by the selection of a 1-km radius area. Comparing the results from approach B with those from the use of both the best 1-km radius area and the one actually used would give an indication of the potential bias.

6.8   A number of local authorities have now progressed sufficiently in their Part IIA Strategies to have collected comprehensive data covering their entire area on potentially contaminated land areas. In digital (GIS) form, these data would be appropriate for the tests outlined. Similarly comprehensive data on CS2 and CS3 for the planning regime would be required to complete the picture of land contamination.

6.9   The results from this work would improve the confidence attached to the outcomes of this project by identifying the potential degree of bias. The work would also greatly improve any future sampling campaign or update to the indicators.

LOCAL AUTHORITY CONTAMINATED LAND CLASSIFICATION SCHEME

6.10   The classification aims to produce groups of local authorities with similar characteristics of land contamination. Appropriate sampling from within those groups would give a greater degree of confidence in any national statistics developed in future exercises. The classification would also support more effective targeting of resource and action planning, and provide a mechanism for benchmarking and comparing progress on the recently proposed Best Value Performance Indicator for Contaminated Land (see below).

6.11   Two typologies were used in the current project. The first used the National Statistics Area Classification scheme, which characterises local authorities by 42 social, population and employment parameters collected from the 2001 Census. There is a strong intuitive link between this classification and the historic (and current) level of industrial activity. In contrast, the second (regional classification) does not represent such a good typology, as there is a much weaker link between region and industrial activity.

6.12   The National Statistics Area Classification scheme was developed using a Cluster Analysis procedure. It is well documented and considered a robust methodology. It is proposed that this approach should be used to develop an area classification scheme for land contamination. In simple terms, this methodology involves:

- scaling each value with respect to the total range of values for that parameter;

- combining or removing parameters whose distribution is closely aligned – this avoids over-weighting of the final results;

- analysing potential clusters within the datasets and, where necessary, providing seed points for the cluster centres.

6.13   The choice of parameters on which the groups are established is crucial. Candidate parameters include:

- number/area/density of historic industrial activities (e.g. from the HLUD) classified by activity-type;

- total turnover/total employment level/number of businesses from National Statistics current industrial activity data classified by Standard Industrial Classification (SIC) Code.

6.14   National Statistics data are available freely or at a nominal processing cost. The use of historic activity data would require the purchase of aggregated data at a local authority level from a commercial provider, e.g. Landmark Information Group. Within these datasets information can be determined for the number of operations, relative size of operation and/or land area in a range of different industries. The cluster analysis can be completed with as many or as few of these groups as required; it is suggested that industry types should be combined to reflect a generalised pattern of industry type and relative hazard.

6.15   Ultimately, it is envisaged that the classification scheme would allocate each authority to one of perhaps 10 groups, which reflected historic industrial practices

and their potential for land contamination. These 10 groups could then be sub-divided further into sub-groups or combined into super-groups for a more straightforward overview.

6.16   Using this classification scheme, it would be possible to work with representative authorities to ensure that all relevant data for their entire area were collected over a reporting period for the next iteration of these indicators. Support could be given to the selected authorities to help them set up and implement data collection and management to the quality necessary to reduce the bias and uncertainty discussed above.

DATA DICTIONARY AND EXCHANGE PROTOCOL

6.17   This project revealed that numerous data are being collected at local, regional and national level and which represent individual jigsaw pieces of the overall national picture. If this information was efficiently shared and reported to government, it would lead to a much greater understanding and clarity on the overall status of the response to land contamination issues.

6.18   Furthermore, concerted efforts are being directed toward improved management of public sector information. At both local and national government level, 'e-government' targets have been set to reduce the duplication of data collection and to enable different datasets to be linked at a fundamental level. The datasets identified in this project where such joined-up thinking is applicable include:

- The planning system in England, local authorities and ODPM;

- Landfill Tax exemption, (HM Revenue and Customs);

- Contaminated Land Remediation Tax Credit, (HM Revenue and Customs);

- NLUD PDL, (ODPM/English Partnerships). The NLUD is not available in Wales.

- More recently, data from the BVPI system for England.

6.19   The Environment Agency have a number of important datasets where potential synergies could be achieved:

- regional/local records of planning consultations;

- NIRS recording of incidents;

- IPPC site reports;

- information received from local authorities on to Part IIA activity.

6.20 Other important datasets identified by the report include those held by:

- National House Building Council;

- major landowners;

- Regional Development Agencies and the Welsh Development Agency.

6.21 The key to achieving linkage between all these datasets is the development of a schema or data dictionary for contaminated land/land contamination. This would;

- identify what information is required to support the government review on land contamination;

- provide a structure for how these data should be collected;

- take into account existing mechanisms for information collection;

- facilitate a simple and automated data conversion process.

6.22 Such a schema would be developed using guidance from the government's E-GIF programme (e-Government Interoperability Framework) (http://www.govtalk.gov.uk/schemasstandards/). It would also take account of trends within the data management industry in developing open standards for data collection and classification. Notable in this regard are the US Environmental Protection Agency and the European Environment Agency, which have pioneered the development of mechanisms for data pooling and reporting, albeit with slightly different emphases. The proposed schema would also have regard to the AGS (Association of Geotechnical and Geoenvironmental Specialists) format for data transfer (http://www.ags.org.uk/).

6.23 The benefits delivered by this programme would include:

- removal of duplication of effort in data collection;

- improved inter-departmental linkages;

- more cost-effective mechanisms for maintaining a national oversight of progress in tackling land contamination.

6.24   This work is expect to consist of three phases:

1. analysing the data held and collected by different government agencies, and the requirements of each;

2. developing a common schema that reflected the different data schemes and the requirements of the user community;

3. establishing data exchange protocols and data conversion mechanisms to kick-start an on-going programme of collaboration and reporting.

BEST VALUE PERFORMANCE INDICATORS

6.25   This report demonstrates the importance of the planning system to past and future progress in the identification and remediation of land contamination. It is through redevelopment of previously developed land, much of it industrial, that the majority of the legacy of contamination in the country has and will be dealt with. If local authorities reported their progress in identifying and remediating land contamination through the planning process to government, then this would capture the majority of land under CS2 and CS3.

6.26   Two mechanisms require the reporting of similar information to the CS indicators in this report. The first is the reporting requirements for local authorities in place under Section 78U of the Environment Act 1995 (Section 4). The second mechanism has been recently introduced in England, in the form of new Best Value Performance Indicators (BVPIs) under the Local Government Act 1999.

6.27   The ODPM consulted last year on updating BVPIs for England and has now introduced two relating to the identification of land contamination (BVPI216a and BVPI216b), whether through Part IIA or the planning regime.   The BVPIs are accompanied by ODPM guidance (ODPM 2005). These new BVPIs will be reported English local authorities for the first time for the period 2005/06.

BV216a   **Identifying Contaminated Land:** Number of 'sites of potential concern' [within the local authority area] with respect to land contamination.

BV216b **Information on Contaminated Land:** Number of sites for which sufficient detailed information is available to decide whether remediation of the land is necessary, as a percentage of all 'sites of potential concern'.

6.28 BV216a is a sub-set of both CS1 and CS2, while BV216b is most closely aligned to CS2. They do not correspond exactly because they are not designed primarily to collect data about land contamination, but about local authority performance in assembling information for decision-making. For the same reason, neither BVPI relates to CS3, the amount of land remediated.

6.29 Another possible mechanism is through consultation and agreement with ODPM over the National Brownfield Strategy. English Partnerships is currently drafting the Strategy for ODPM and the potential exists to agree data collection and reporting mechanisms that include the requirements for future reporting of the indicators proposed in this report.

6.30 In Wales, there is currently no requirement for local authorities to collect data under BV216a or BV216b within their performance measurement framework this year. Wales and England have different planning systems, and NLUD does not apply in Wales at present. Whilst Planning Policy Wales includes a strong preference for the development of brownfield sites this is not target-driven as is the case in England and there is no comprehensive or consistent system to enable monitoring.

6.31 BV216a and BV216b will report the number of sites and not the area. However the number of hectares is considered a more useful and accurate measure by the project team for the purposes of providing an overall picture of progress in tackling the legacy of land contamination. The number of sites is open to more interpretation and hence uncertainty than the area of land. NLUD reports in terms of hectares.

RECOMMENDATIONS

6.32 **In order to up-date and regularly report on the CS indicators in this report, a strategy needs to be developed that takes into account the current reporting requirements on the local authorities. This strategy would take as a starting point the data provided under BV216a and BV216b and under Section 78U, and look at the other possibilities including NLUD for England and Planning Policy Wales (PPW) in Wales. Delivery of the strategy could be undertaken through co-operation with a representative sub-set of local authorities from England and Wales (as detailed above), or the strategy could seek to collect data from all local authorities.**

6.33 **It is recommended that the Strategy should seek reporting of both the number of sites and the area in hectares.**

6.34 **It is recommended that all these avenues are pursued and the most appropriate, workable strategy adopted in order to repeat this exercise. The strategy must take into account the differences between England and Wales identified above**.

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Environment Agency 2004 *Model procedures for the management of land contamination.* CLR 11. Bristol: Environment Agency.

Sources of data used in the report

Organisation	Date	Dataset/records	Comments
Centre for Ecology and Hydrology (CEH)	2000	Land Cover Map 2000	Classification of land cover into sub-classes of broad habitat types. Used in the initial characterisation of the study areas.
Defra/Environment Agency	2004	Historic RSA permits and reports	Used to determine radioactively contaminated land area values (CS1).
Environment Agency	2004	Integrated Pollution Control (IPC)	Used to identify the location of CS1 sites.
Environment Agency	2004	Integrated Pollution Prevention Control (IPPC)	Used to identify the location of CS1 sites.
Environment Agency		Radioactive Substances (RAS)	Used identify the location of sites with a history of radioactivity.
Environment Agency	2004	Pollution Inventory	Used to identify sites of historical contamination (CS1) caused by prior activities on the site.
Environment Agency	2004	National Abstraction Licensing Database (NALD	Used in a peripheral number of cases to identify remediation, although not really suitable for validating CS3 values.
Environment Agency	2004	Discharge Consents	Used in a peripheral number of cases to identify remediation, although not really suitable for validating CS3 values.
Environment Agency	2004	National Incident Reporting System (NIRS)	Used to determine CS4 based on reported ongoing land contamination.
Environment Agency	2004	Part IIA Inspection Strategies, Part IIA Public Registers, Reports to Agency on Part IIA	Used to form an estimate of CS2.
Environment Agency		North West Regional Database	Used to derive CS1, CS2 and CS3 for areas of radiological contamination in the north-west of England.
Environment Agency	2004	Sites determined as Contaminated Land	

Organisation	Date	Dataset/records	Comments
Environment Agency		Open & closed landfill sites by Regional Development Agency	Numbers of closed landfill sites used to contribute to estimate of CS1 (since historic, closed landfill sites are higher risk sites for land contamination issues).
HM Customs and Excise	2003	Landfill Tax Exemptions	The number of claims made under the scheme was combined with an arbitrary site area to calculate CS3.
HSE	2000	Radioactively Contaminated Land Database	Used to identify potentially radioactively contaminated sites (CS1).
Inland Revenue	2003	Contaminated Land Tax Credit	Used to determine values of CS2 and CS3.
Landmark Information Group	2004	Historic Land Use Database (HLUD)	Captured from historical Ordnance Survey base mapping. Specific categories were used as an indicator of CS1 and to determine extent of overlap with data collected during site surveys.
Landmark Information Group	2004	EnviroCheck reports	Used extensively in the individual study area reports for local analysis of CS1.
National House Building Council	2003	Remediation for house building in 2002	Used to identify remediated land (CS3).
ODPM	2001	Urban Area Boundaries	GIS boundary files were used to establish survey areas that lay within the extent of defined urban area and to determine the ratio of urban coverage nationally.
ODPM, English Partnerships, Ordnance Survey, I&DeA	2002	National Land Use Database (NLUD): Previously Developed Land	Used to determine areas of previously developed land, which may have been contaminated through its previous use (CS1).
OPDM	2003	Commercial and Industrial Floorspace and Rateable Value Statistics	
Office for National Statistics	1998	VAT Registered Companies	

Organisation	Date	Dataset/records	Comments
Office for National Statistics	2001	Area Classification for Local Authorities	Used to determine the initial survey areas by taking a representative sample across the range of group classifications.
Office for National Statistics	2000	VAT Registered Companies by Industry Group	
Office for National Statistics	2001	2001 Census output area boundaries	Used to plot aggregated statistics on an area basis.
Ordnance Survey/Landmark		Historic Map Data	Used to identify possible past contamination (CS1.
Ordnance Survey	2004	LandLine base mapping data	Used in the GIS to provide background mapping for the individual study areas, for site survey work and the mapping of various datasets and results.
Welsh Office	1998	National Survey of Contaminated Land for Wales	Used to identify CS1 values for Wales.

Sources of data not included in the report

Organisation	Date	Dataset/records	Comments
Coal Authority			No suitable data could be obtained at a national level.
Environment Agency		Mobile plant licence returns and working plans	Further work is required to obtain this information from the Environment Agency records.
Environment Agency	2004	'Waste Licensing information (REGIS	Not considered under the definition of land contamination outlined in the project.
Environment Agency	2004	'Licensed Landfill Sites	Not considered under the definition of land contamination outlined in the project.
Environment Agency	2004	General Quality Assessment (Chemistry)	Found not to yield any information of relevance to the project
Environment Agency	2004	General Quality Assessment (Biology)	Found not to yield any information of relevance to the project
Environment Agency		Pollution Prevention and Control (PPC)	Not found to contribute to the national stock of contaminated land.
Regional Development Agencies (RDAs) and Welsh Development Agency (WDA)			No suitable data could be obtained at a national level.

APPENDIX A

INTRODUCTION

A.1   As discussed in the main report, two methods were employed in an attempt to determine the possible extent of radioactively contaminated land in England and Wales in terms of both the number of radioactively contaminated sites and the total area of contamination. For one method, a number of national datasets were examined. This method was inconclusive in that the datasets available were incomplete in both coverage and detail. In the other method, 12 representative areas of England and Wales, each of 1-km radius, were explored in detail (Appendix B). Information on possible contaminated sites was garnered from local authority and Environment Agency records and historical trade directories, and through area surveys. The researchers were equipped with keyword information on radiological contamination and industry types obtained from published work by the Department for Environment, Food and Rural Affairs (Defra) and a draft report provided by Entec UK Ltd.

A.2   Data from the 12 areas were extrapolated by statistical means to give the figures for England and Wales shown in Table A.1. Because two scaling-up methods were employed, the figures are presented as a range.

Table A.1 Extrapolated totals for England and Wales

	Potential number of sites	Total area (ha)
Method 1	50,510	25,861
Method 2	56,037	27,705

A.3   The sampling method employed is likely to give rise to large uncertainties. Nevertheless, the results are believed to be 'fit for purpose'; the purpose in this case being to provide sufficient information to the Environment Agency on the scale of the issue for planning and resource allocation purposes.

A.4   This Appendix attempts to use the above information to determine how many of the approximately 50,000 sites may become special sites under the proposed new radioactively contaminated land regime.

A.5   The mechanism employed to refine the number of sites was 'expert elicitation'. This involved a small number of key experts (see A.8) meeting to consider all available data in order to elicit the range of outcomes in terms of the likely number of sites in each category to be affected and the likely effect in terms of radiological dose.

A.6   **Note**: a number of matters came to light and were discussed at length during the elicitation session which did not have direct relevance to the stated objective of the elicitation, i.e. to determine an approximate number of contaminated sites. However, these matters are believed to be of value when producing guidance (if guidance is required) to local authorities carrying out desk-studies to ascertain the location of contaminated sites. These matters will be reported separately to this project.

EXPERT ELICITATION

A.7   The sites identified in the indicators project fall into a number of categories and are of different types. An elicitation session was held as a means of trying to determine how many of these categories are likely to be radioactively contaminated land within the meaning of the proposed regime, i.e. may cause a dose of a few, say about 3, millisieverts to one or more individuals.

A.8   The elicitation meeting was held on 23 September 2004 at Defra and was attended by the following:

Mr C K Wilson (Defra Radioactive Substances Policy Division).
Dr S Mobbs (National Radiological Protection Board (NRPB) – now the Radiation Protection Division of the Health Protection Agency).
Mr P Sinclair (Entec UK, specialist in radioactively contaminated land identification and remediation).
Mr B Barnes (Environment Agency, specialist in Part IIA).
Dr A B Ashworth (WS Atkins Environment, specialist in radioactively contaminated land identification and remediation).
Mr M White (WS Atkins Environment, specialist in radioactively contaminated land identification and remediation)

A.9   The elicitation was carried out in two stages:

1. Of the site categories, how many sites of each type are likely to be contaminated, i.e. to contain radioactive materials or wastes?

2. Of those sites likely to be contaminated, how many could give rise to doses in the range nanosieverts (nSv), microsieverts (μSv) or millisieverts (mSv)?

A.10   In order to elicit risk (dose), assumptions were required for each case examined. Strictly, in order for land to be classified as radioactively contaminated land, the source–pathway–receptor triad has to be in place. This can only be determined on a site-specific basis. For the purposes of the elicitation, the source was given and the pathway–receptor assumed to be in place. For each case, therefore, the second task

of the elicitation session was to determine likely pathways between the source(s) and receptor(s). Pathways were selected from:

- ingestion of foodstuffs grown on the site;

- inhalation of airborne dusts;

- drinking water from contaminated groundwater;

- shine (i.e. direct or external radiation).

A.11   The critical group (receptor) was then determined based on the most likely pathway or pathways selected, and attempts were made to assign each case to a dose category within the nSv, μSv and mSv ranges.

A.12   As noted above in A.7, the threshold figure for special site status has not been determined, but is unlikely to be less than 1 mSv. For this reason, the number of sites in the mSv dose category is of particular interest.

ELICITATION CASES

A.13   Those attending the elicitation session were presented with the following cases, which are mainly generic in nature (although a handful are specific). They do not cover the full range of potentially contaminated sites; the cases have been chosen because they appeared within the analysis of the 12 study areas described in Appendix B or feature in one or more of the national datasets reviewed in the main part of the report.

Table A.2 Cases studied during the elicitation session at Defra on 23 September 2004

Case	Type of site	Comments	Radionuclide(s)
1a	Former (closed) landfill site	5 ha site that closed before 1980. The site was not developed or operated according to modern standards, i.e. it was unlined, with loose tipped wastes being partly compacted by the passage of site vehicles. The site was not near any nuclear sites and is unlikely to have received any waste from such sites. It may have been used for the disposal of industrial wastes (including slags, etc., from metal industries) and/or for the disposal of excavated spoils from radioactively contaminated land remediation projects. The site may have been used for controlled burial of low-level waste (LLW) before 1980.	Any
1b	Former (closed) landfill site	As Case 1a, but taking waste exempt under the Radioactive Substances (Phosphatic Substances, Rare Earths, etc) Exemption Order (PSRE Order) such as mineral sands and industry waste containing thorium, polonium, radium, etc. The site was not near any nuclear sites and is unlikely to have received any waste from such sites.	Any
2	Former (closed) landfill site	As Case 1, but in north-west England and likely to have received miscellaneous wastes from nuclear sites operating during the 1950s and 1960s.	Any
3	Sealed mineshaft	Uranium (natural + depleted) and uranium compounds were dumped here in quantities of some tens of tonnes. Depth unknown, but unlikely to be less than 25 metres. The shaft was backfilled with excavation spoil, but no aggregates.	U235, U238
4	Former luminising workshop	A 'cottage industry' scale radium luminising workshop in an urban area, with a customer base in the defence industry. It started up during World War II and closed in 1955. The workshop is known to have disposed of wastes in an on-site pit of area 5 m^2, at a depth of 1 metre.	Ra226

Case	Type of site	Comments	Radionuclide(s)
5	Former watchmaker/repairer	Shop closed in 1950 but was known to repaint watch dials with radium. Operated on a smaller and intermittent scale than Case 4, but disposed of wastes in the same way.	Ra226
6	Original site of former Royal Navy reactor	Location moved in the 1960s. Remediation standards are thought be less rigorous then than those in place in the late 1990s, when the reactor was finally decommissioned.	Activation products Fission products
7	Cemetery	0.5 ha cemetery, one grave (2 x 1 metres) of which contains human remains with a plutonium-fuelled pacemaker at a depth of 2 metres.	Pu238
8	Former gas mantle factory	A small-scale factory in operation from 1920 to 1950, manufacturing lighting mantles impregnated with thorium nitrate. Wastes were disposed of on-site in a pit covering 5 m^2 at a depth of 1–2 metres.	Th232
9	Former natural gas purification and transfer station	A 2 ha plant where pipes were de-scaled using high-pressure water and the scale deposited on 0.2 ha of open ground. The scale was removed when the site was closed, but no investigation or remediation of the site was carried out.	Ra226, Pb210, Po210. Ra228
10	Scrap metal yard	A metal recycling facility of 1 ha with no provision for radioactive monitoring. (Note: such facilities have been known to have problems with respect to lost, remelted, recovered and illegally disposed sources, but the purpose of elicitation was to examine the potential for a dose due to radioactively contaminated land only).	Any
11	Site authorised under Radioactive Substances Act 1993 (RSA93)	Some data are available relating to the number of RSA permits (open or former) in the survey areas and nationally. It is assumed that one in 10 permits are authorisations for disposal of wastes and that some (particularly old) authorisations may have allowed on-site disposal.	Any

Case	Type of site	Comments	Radionuclide(s)
12	Former hospital	The 2 ha site closed in 1970. Wastes, including radioactively contaminated equipment and open source material, were stored on open ground pending disposal. Bagging and segregation of such wastes will have been carried out under a less restrictive regulatory regime to that in place today.	Mainly short-lived beta-emitting sources
13	Former metal processing works	A 1,000 tonne slag heap covering 0.5 ha of open ground was in place for 20 years before being removed and the site closed down. The ground was not remediated. The site could have been a steel, copper or aluminium works.	U238 and Th232 decay chains
14	Sewage works	Deposits 1,000 tonnes/year of sludge on local farmland.	H3, C14, P32, S35, Cr51, Tc99m, I125, I131
15	Former uranium mine	Not worked since 1950, but has left several unremediated spoil heaps on open ground, each approximately 500 tonnes over 0.2 ha.	U235, U238, Ra226
16	Former phosphate industry	A site formerly used for the extraction of phosphates from phosphate-rich minerals.	Naturally occurring actinides

ELICITATION SESSION RESULTS

A.14   The elicitation session outputs are shown in the case study records at the end of this appendix. Table A.3 was generated using those case studies relating to types of site found within the study areas.

Site type	Case study	Proportion in dose range (per cent)			
		Nil	nSv	µSv	mSv
Former closed landfill	1b			99.5	0.5
Radium luminising shop	4				100
Former site of Royal Naval reactor site	6		100		
Cemetery	7	99		1	
Gasworks	9	85	15		
Scrap metal yard	10	100			
Miscellaneous laboratories/ RSA permitted site	11	90	9	0.9	0.1
Hospital	12	97.5	2.5		
Iron works/foundry	13			100	
Sewage treatment plant	14			100	

Table A.3 Proportion of sites in dose range in each category

A.15   Scaling up using either the local or national datasets gave the number of sites in each category (Table A.4).

Table A.4 Number of sites in dose range in each category

Site type	Case study	Number of sites in dose range			
		Nil	nSv	µSv	mSv
Waste disposal site (closed)	1b	0	0	19900[1] 9450[2]	100[1] 48[2]
Radium luminising shop	4	0	0	0	100[3]
Former site of Royal Navy reactor	6	0	1	0	0
Cemeteries	7	2506–4405	0	25–44	0
Gasworks	9	2721–2975	480–522	0	0
Scrap metal yard	10	2959–4661	0	0	0
Miscellaneous laboratories/ RSA permitted site	11	9540	954	95	11
Hospital	12	1874–4190	48–107	0	0
Iron works/foundry	13	0	0	14234–17371	0
Sewage treatment plant	14	0	0	1533–2149	0

Notes

[1] Based on national dataset.

[2] Based on scaled-up figures from area survey.

[3] This figure is highly problematical as it is not based on statistical treatment from the area survey findings. Two areas (and no others) were found to contain some potential radium luminising shops but, in the absence of further detailed investigation, it is impossible to form a view as to the proportion that were actually contaminated. Statistical treatment on this basis is not justifiable. The figure of 100 is therefore an estimate, based on the following data and assumptions:

- 23 premises nationally were registered under the Radium Luminising Regulations 1947 in that year.
- 37 premises were registered under the Radium Luminising Regulations 1947 in 1959.
- Many premises are known to have ceased operation immediately following World War II, i.e. immediately before the new regulations came into force.
- Many premises were never registered – perhaps as many as 50 per cent.
- 38 premises have been located in six East London boroughs that are definitely known to have engaged in this activity.
- The industry is known to have been prevalent in East London to the extent that, with the exception of MoD premises, few such activities have been identified elsewhere in England and Wales.

A.16   The main report identified 46,163–53,808 sites as undertaking activities that may have involved a radiological source. Based on a scaling up from the 12 study areas (or in some cases, by applying the figures to the national datasets), the elicitation outcome gives the following.

- Number of sites eliminated (i.e. zero dose): 19,600–25,771

- Number of sites in nanosievert (nSv) range: 1,483–1,583

- Number of sites in microsievert (uSv) range: 25,337–39,559

- Number of sites in millisievert (mSv) range: 159–211

A.17 The important figure is the final one, dealing with those sites likely to give rise to doses in the millisievert range and thus likely to come within the scope of the radioactively contaminated land regulatory regime.

A.18 It is necessary to add on to this statistically derived figure (including the estimated figure in the case of radium luminising workshops) a few sites resulting from other case studies considered during the elicitation exercise (Table A.5). These considered some other potential sources of doses in other known industries, which were not a feature of the industries found in the study areas or in the national datasets.

Table A.5 Dose range of additional case study sites

Site type	Case study	Dose range of sites + (estimated No. of mSv sites)			
		Nil	nSv	µSv	mSv
Former closed landfill in region of fuel cycle plants	2	–	–	–	4
Sealed mineshaft	3	–	–	–	1
Former gas mantle factory	8	–	–	–	5
Former uranium mine	15	–	–	–	5
Former phosphate industry	16	–	–	–	5

A.19 This gives a total of approximately 20 sites to add to those derived from statistical treatment of the 12 study areas described in Appendix B.

CONCLUSIONS

A.20 For the purposes of planning with respect to the proposed radioactively contaminated land regulatory regime, the likely number of sites in England and Wales that could give rise to doses in the millisievert range is almost certainly in the range 100–1000 (the limits of the statistical analysis and the elicitation session were quoted as order of magnitude ranges). This assumes that the source–pathway–receptor link is in place in each case. The number of sites is most likely to between 150 and 250.

CASE STUDY RECORDS

Expert Elicitation on the Number of Radioactively Contaminated Land Sites in England and Wales	
Case Study Record	
Location: Defra, 123 Victoria Street, London SW1E 6DE	
Date: 23 September 2004	
Case Study No. 1a	**Title:** Former (Closed) Landfill Site

Source

Non-uniformly contaminated landfill site

Contaminants likely to be present include tritium from trimphones, exit signs, etc. and others such as ^{241}Am from smoke detectors.

Pathway(s)

Tritium in groundwater

Older landfill sites would not have an engineered cap, but simply be covered with one or two meters of soil; therefore, a second pathway is resuspension of contaminated soil during excavation/digging activities.

Receptor(s)

Individual consuming groundwater – NRPB dose assessment for similar sites suggests doses of the order of nSv

Walker/birdwatcher on nature reserve on site of closed landfill – NRPB dose assessment for similar sites suggests doses of the order of nSv

Resident living on closed site that bring source to surface through excavations – dose over all pathways is likely to be of the order of μSv

Additional data requirements

None

Possible typical annual dose

	nSv		μSv		mSv	

Possible percentage of sites in England and Wales that would be contaminated

100 per cent

Possible proportion of each site that would be contaminated

Entire site, but non-uniformly contaminated

Comments

Exempt radioactive waste is likely to have been sent to 100 per cent of landfill sites in England and Wales.

Of the 20,000 closed landfill sites in England and Wales, assume 100 (0.5 per cent - see Case 1b) were primarily used for large-scale disposals of material from land remediation projects, metal foundries and mining, while the remainder received items such as trimphones, exit signs, smoke detectors, etc.

Expert Elicitation on the Number of Radioactively Contaminated Land Sites in England and Wales
Case Study Record

Location: Defra, 123 Victoria Street, London SW1E 6DE
Date: 23 September 2004

Case Study No. 1b	**Title:** Former (closed) landfill site

Source

PSRE Order exempt wastes, e.g. mineral sands industry waste with thorium, polonium, radium, etc. activities of 5 Bq g^{-1} (although they could be as high as 14.7 Bq g^{-1})

Pathway(s)

Shine and inhalation of resuspended dust (groundwater migration is likely to be trivial)

Receptor(s)

Resident living on closed site (2,000 hour/year occupancy). No top soil on waste – dose over all pathways of a few mSv

Additional data requirements

None

Possible typical annual dose

nSv		μSv		mSv	

Possible percentage of sites in England and Wales that would be contaminated

0.5 per cent

Possible proportion of each site that would be contaminated

100 per cent

Comments

Exempt radioactive waste is likely to have been sent to 100 per cent of landfill sites in England and Wales.

Of the 20,000 closed landfill sites in England and Wales, assume 100 (0.5 per cent) were used for large-scale disposals in this category, while the remainder received items such as trimphones, exit signs, smoke detectors, etc.

Expert Elicitation on the Number of Radioactively Contaminated Land Sites in England and Wales
Case Study Record

Location: Defra, 123 Victoria Street, London SW1E 6DE
Date: 23 September 2004

Case Study No. 2	**Title:** Former (closed) landfill site

Source

Natural and depleted uranium (no enriched material), uranium salts, etc. disposed of to landfill until the late 1960s. Possible activities 10–100 Bq g^{-1} of ^{238}U and all daughters (excluding radon).

Pathway(s)

Shine and resuspension

Receptor(s)

Resident living on closed site. Without knowing more information about the activity concentrations of the waste, it is difficult to determine likely doses but it is likely that doses (all pathways) would be of a few mSv

Additional data requirements

None

Possible typical annual dose

nSv		μSv		mSv	

Possible percentage of sites in England and Wales that would be contaminated

Low (see Comments)

Possible proportion of each site that would be contaminated

100 per cent

Comments

This is not regarded as being a problem that is general to England and Wales; it is limited to 2–4 recognised sites in a particular region of England.

Expert Elicitation on the Number of Radioactively Contaminated Land Sites in England and Wales					
Case Study Record					

Location: Defra, 123 Victoria Street, London SW1E 6DE					
Date: 23 September 2004					

Case Study No. 3	**Title:** Sealed mineshaft				

Source

Natural and depleted uranium metal and metal compounds, etc. disposed of to a mineshaft the late 1960s. The mineshaft was subsequently backfilled.

Pathway(s)

Groundwater

Receptor(s)

Individuals consuming private water supplied within the area. Doses estimated to be in the region of 0.5mSv per GBq of waste disposed of. No information on the activity of the waste disposed of.

Additional data requirements

None

Possible typical annual dose

nSv		**μSv**		**mSv**	

Possible percentage of sites in England and Wales that would be contaminated

Low (see Comments)

Possible proportion of each site that would be contaminated

100 per cent

Comments

This is not regarded as being a problem that is general to England and Wales; it is limited to one recognised site in England.

Expert Elicitation on the Number of Radioactively Contaminated Land Sites in England and Wales
Case Study Record

Location: Defra, 123 Victoria Street, London SW1E 6DE
Date: 23 September 2004

Case Study No. 4	**Title:** Former luminising workshops

Source

Small luminising waste pits in gardens and factory sites containing paint tins, vials, brushes, rejected painted instruments, etc. ^{226}Ra is principal radionuclide of concern.

Pathway(s)

Direct radiation is likely to be the dominant pathway but unlikely to be so significant if buried to depth of 1–2 metres.

Ingestion of flakes of dried paint may also contribute to significant proportion of dose if exposed at surface.

Receptor(s)

Individuals inhabiting properties with former luminising workshops and waste pits – if material brought to surface, doses are very likely to be in region of mSv

Additional data requirements

None

Possible typical annual dose

nSv		μSv		mSv	

Possible percentage of sites in England and Wales that would be contaminated

100 per cent

Possible proportion of each site that would be contaminated

10 per cent of each site

Comments

This cottage industry was prevalent in certain parts of the country during World War II. Experience of one luminising workshop suggests that only a small amount of material is required to cause substantial contamination and significant doses.

In the 1950s, there were 23 factories registered under The Luminising Regulations 1947, though this is likely to be less than the number in existence during and immediately after the war, when demand would have been higher.

In estimating the proportion of a site that is likely to be affected, it assumed that the works were limited to small workshops (sheds, etc.) within private houses (or their gardens) and waste pits associated with luminising factories.

Expert Elicitation on the Number of Radioactively Contaminated Land Sites in England and Wales
Case Study Record

Location: Defra, 123 Victoria Street, London SW1E 6DE
Date:　　23 September 2003

Case Study No. 5	**Title:** Former watchmakers/repairers

Source
Radium luminised items such as faces, hands, etc. Old radium luminised items could have activities of 55 kBq to 1 MBq.

Pathway(s)
As Case 4, but the impact of direct radiation would be substantially lower.

Receptor(s)
Watchmakers/repairers would probably receive doses in the region of μSv, so those affected by land contamination would probably not receive a dose of greater than this.

Additional data requirements
None

Possible typical annual dose

nSv		μSv		mSv	

Possible percentage of sites in England and Wales that would be contaminated
10 per cent

Possible proportion of each site that would be contaminated
100 per cent

Comments
Watches were luminised between the 1920s and 1960s. The assumptions made for this case were that watch repairers scraped and replaced luminous paint, but that this was not their prime source of income.

Expert Elicitation on the Number of Radioactively Contaminated Land Sites in England and Wales
Case Study Record

Location:	Defra, 123 Victoria Street, London SW1E 6DE
Date:	23 September 2004

Case Study No. 6	**Title:** Former Royal Navy reactor site

Source

Possible low-level waste disposal pit on site.

Pathway(s)

As landfills (Cases 1a and 1b)

Receptor(s)

As landfills (Cases 1a and 1b)

Additional data requirements

None

Possible typical annual dose

nSv		µSv		mSv	

Possible percentage of sites in England and Wales that would be contaminated

Not applicable

Possible proportion of each site that would be contaminated

1 per cent

Comments

This is not a widespread issue in the UK. Only one such reactor has been built at a former Royal Navy college. The original reactor was decommissioned in the 1960s – decommissioning end points are not known. The relocated reactor was decommissioned in the 1990s to appropriate end points. Waste disposal pits are likely to have contained soft LLW and very low-level waste (VLLW), and be completely buried under significant topsoil cover.

Expert Elicitation on the Number of Radioactively Contaminated Land Sites in England and Wales
Case Study Record

Location:	Defra, 123 Victoria Street, London SW1E 6DE
Date:	23 September 2004

Case Study No. 7	**Title:** Cemeteries

Source

114 GBq of ^{238}Pu in pacemaker

Pathway(s)

Direct radiation

Groundwater contamination unlikely as cases are designed not to suffer damage even under the extreme conditions of cremation.

Receptor(s)

Individuals visiting graveyards – shine will be less than mSv levels

Additional data requirements

None

Possible typical annual dose

nSv		μSv		mSv	

Possible percentage of sites in England and Wales that would be contaminated

1 per cent

Possible proportion of each site that would be contaminated

0.1 per cent

Comments

Pacemakers powered by ^{238}Pu were probably only used for a 20-year period between the 1960s and 1980s. They were/are to be removed prior to burial or cremation; the likelihood of a pacemaker ending up in the ground is therefore very low.

Pessimistic dose estimates, which ignore shielding provided by 1– metres of soil and assume an extended exposure, suggest that doses to visitors to graveyards would be much lower than mSv.

Expert Elicitation on the Number of Radioactively Contaminated Land Sites in England and Wales

Case Study Record

Location: Defra, 123 Victoria Street, London SW1E 6DE

Date: 23 September 2004

Case Study No. 8	**Title:** Former gas mantle factories

Source

Soil samples from former factories had levels of ^{238}U at 12 Bq g^{-1} and levels of thorium at 253 Bq g^{-1}

It is likely that solid thorium wastes would have been buried in shallow pits and that thorium nitrate solution would have been spilt frequently.

Pathway(s)

Inhalation and, where foods are grown on the sites, ingestion.

Receptor(s)

Individuals inhabiting properties with contaminated gardens and who grow their own food – doses of up to 2.5 mSv could be received under these circumstances if the ground were uniformly contaminated.

Additional data requirements

None

Possible typical annual dose

nSv		μSv		mSv	

Possible percentage of sites in England and Wales that would be contaminated

Very low

Possible proportion of each site that would be contaminated

Very low

Comments

Thorium mantles were widely used by 1895 and continued to be used until the late 1990s. The activity of thorium in thorium mantles could be as high as 35 kBq g^{-1}.

Contamination is likely to occur through spills of thorium nitrate solution and the on-site storage or disposal of mantles and other solid wastes.

Expert Elicitation on the Number of Radioactively Contaminated Land Sites in England and Wales
Case Study Record

Location: Defra, 123 Victoria Street, London SW1E 6DE
Date: 23 September 2004

Case Study No. 9	**Title:** Gas purification (town gas)

Source
NORM in residues, and uranium oxide catalysts

Pathway(s)
As Case 1a

Receptor(s)
As Case 1a

Additional data requirements
None

Possible typical annual dose
nSv	μSv	mSv

Possible percentage of sites in England and Wales that would be contaminated
15 per cent

Possible proportion of each site that would be contaminated
5 per cent of each site

Comments
Concentrations of radionuclides are assumed to be similar to those in coal ash from modern power stations.
Uranium oxide catalyst present on ceramics so unlikely to be readily resuspended/soluble, etc.

Expert Elicitation on the Number of Radioactively Contaminated Land Sites in England and Wales
Case Study Record

Location: Defra, 123 Victoria Street, London SW1E 6DE
Date: 23 September 2003

Case Study No. 10	**Title:** Scrap metal yards

Source

Unclear – most likely is that sealed sources would be sent to scrap yards. Unless they were subject to mechanical damage, they are unlikely to contaminate sites.

Pathway(s)

Direct shine is unlikely to be particular problem. Prior to construction, a site would be cleared and recovered with top soil, so it is unlikely that any source(s) trodden into the mud would remain on a site after its development.

Receptor(s)

None for contaminated land

Additional data requirements

None

Possible typical annual dose

nSv	–	µSv	–	mSv	–

Possible percentage of sites in England and Wales that would be contaminated

None

Possible proportion of each site that would be contaminated

None

Comments

It is theoretically possible that scrap yards could be contaminated but no convincing pathways or scenarios could be identified.

Expert Elicitation on the Number of Radioactively Contaminated Land Sites in England and Wales
Case Study Record

Location:	Defra, 123 Victoria Street, London SW1E 6DE
Date:	23 September 2004

Case Study No. 11	**Title:** Site authorised under RSA93

Source

Most laboratories, etc. authorised to dispose of wastes would have disposed of mainly short-lived radionuclides – with the exception of tritium and possibly ^{14}C. Examples include the waste pits at Harwell in Oxfordshire (off the licensed site).

Pathway(s)

All – this cannot be determined in the absence of site-specific data. An assumption has been made of 'worst case' for the possible sites identified.

Receptor(s)

See 'pathways'.

Additional data requirements

None

Possible typical annual dose

nSv		μSv		mSv	

Possible percentage of sites in England and Wales that would be contaminated

0.1 per cent

Possible proportion of each site that would be contaminated

5 per cent of each site

Comments

The accumulation of discharges directly into the environment is unlikely to be a problem.

The 0.1 per cent of sites giving rise to doses in the mSv range was derived from:

1. Approximately 10 per cent of RSA permitted sites are for authorisations for discharge; the reminder are registrations for 'keeping and use'.

2. An absolute maximum of 10 per cent of such authorised sites will have permitted disposals in-situ.

A maximum of 10 per cent of in-situ disposals are likely to give rise to doses in the mSv range.

Expert Elicitation on the Number of Radioactively Contaminated Land Sites in England and Wales
Case Study Record

Location: Defra, 123 Victoria Street, London SW1E 6DE
Date: 23 September 2004

Case Study No. 12	**Title:** Former hospitals

Source

Radium, mainly sealed sources – problem likely to be similar to that of scrap metal yards.

Main residual contamination is likely to be ^{14}C in drains.

Pathway(s)

Ingestion of ^{14}C – highly unlikely

Receptor(s)

Individuals living on developed former hospital sites – ^{14}C has very low radio-toxicity, so doses are considered to be in the nSv levels.

Additional data requirements

None

Possible typical annual dose

nSv		µSv		mSv	

Possible percentage of sites in England and Wales that would be contaminated

2.5 per cent

Possible proportion of each site that would be contaminated

<1 per cent of each site

Comments

Of the 1,500–2,000 hospitals in the UK, 100 per cent are likely to have used radioactive substances.

50 per cent of hospitals were assumed to be older hospitals; 20 per cent of these are assumed to be contaminated, i.e. 2.5 per cent of all hospitals are potentially contaminated.

Contamination through poor storage of sealed source wastes on sites prior to disposal was discounted.

Expert Elicitation on the Number of Radioactively Contaminated Land Sites in England and Wales
Case Study Record

Location: Defra, 123 Victoria Street, London SW1E 6DE
Date: 23 September 2004

Case Study No. 13	**Title:** Former metal processing works

Source

Wide range of processes may result in various levels of contamination by different radionuclides:

Aluminium smelting: 0.041–0.527 Bg g^{-1} thorium

Iron sintering: 0.9 Bq g^{-1} ^{232}Th; 11.3 Bq g^{-1} lead; 99.8 Bq g^{-1} polonium; 0.3 Bq g^{-1} radium

Tin smelting: 4–15 Bq g^{-1} thorium; 1.1 Bq g^{-1} ^{238}U; 1.1 Bq g^{-1} radium

Pathway(s)

As Case 1a (landfill)

Receptor(s)

Doses to individuals occupying (on an occupational rather than residential basis) sites covered by tin slags are less than 1 mSv (of the order of 200 μSv at Hawthorne Road in Bootle)

Additional data requirements

None

Possible typical annual dose

nSv		μSv		mSv	

Possible percentage of sites in England and Wales that would be contaminated

100 per cent

Possible proportion of each site that would be contaminated

80 per cent of each site

Comments

Widespread contamination of such sites to µSvlevels is expected, but little potential for contamination giving rise to mSv levels.

Expert Elicitation on the Number of Radioactively Contaminated Land Sites in England and Wales	
Case Study Record	
Location: Defra, 123 Victoria Street, London SW1E 6DE	
Date: 23 September 2004	
Case Study No. 14	**Title:** Sewage sludge spreading

Source

Sewage sludge containing ^{14}C and tritium – perhaps as high as 1 Bq g^{-1} and 100 Bq g^{-1} respectively

Pathway(s)

Inhalation and ingestion of crops grown on land

Receptor(s)

NRPB studies of sites in Cambridge where sewage sludge spreading as been performed for some years showed no accumulation of radioactivity in the land and no discernable doses to members of the public.

Additional data requirements

None

Possible typical annual dose

nSv		μSv		mSv	

Possible percentage of sites in England and Wales that would be contaminated

100 per cent

Possible proportion of each site that would be contaminated

100 per cent of each site

Comments

Main source is short-life isotopes from hospitals.

Expert Elicitation on the Number of Radioactively Contaminated Land Sites in England and Wales	
Case Study Record	

Location: Defra, 123 Victoria Street, London SW1E 6DE	
Date: 23 September 2004	

Case Study No. 15	**Title:** Former uranium mine

Source

Exposed slag heaps and mine tailings

Pathway(s)

Inhalation and direct radiation

Receptor(s)

Individuals residing on or near slag – evidence from eastern Europe suggests that, in some circumstances, doses could be as high as the mSv range.

Additional data requirements

None

Possible typical annual dose

nSv		μSv		mSv	

Possible percentage of sites in England and Wales that would be contaminated

100 per cent

Possible proportion of each site that would be contaminated

100 per cent of each site

Comments

There are thought to be a 'few locations' in south-west England where uranium was mined in the past, e.g. one near Falmouth.

Expert Elicitation on the Number of Radioactively Contaminated Land Sites in England and Wales
Case Study Record

Location: Defra, 123 Victoria Street, London SW1E 6DE
Date: 23 September 2004

Case Study No. 16	**Title:** Sites of former phosphate industries

Source

Scale in pipes have been found to contain levels of NORM as high as 700 Bq g^{-1}, while contamination on sites is likely to be of the order of 1–5 Bq g^{-1}. Rare earth residues may contain levels of thorium of 6–10 Bq g^{-1} and levels of ^{226}Ra of 0.7–5 Bq g^{-1}.

Pathway(s)

As Case 1a (landfill).

Receptor(s)

Individuals residing on or near former sites – doses could be in range of mSv in certain extreme cases.

Additional data requirements

None

Possible typical annual dose

nSv		μSv		mSv	

Possible percentage of sites in England and Wales that would be contaminated

100 per cent

Possible proportion of each site that would be contaminated

100 per cent of each site

Comments

There are a handful of sites where this may be a problem.

Appendix B

LOCAL AUTHORITY A

Region   North East

Area classification   Industrial hinterlands B

Population (2001)   > 500,000

Population category   Major city
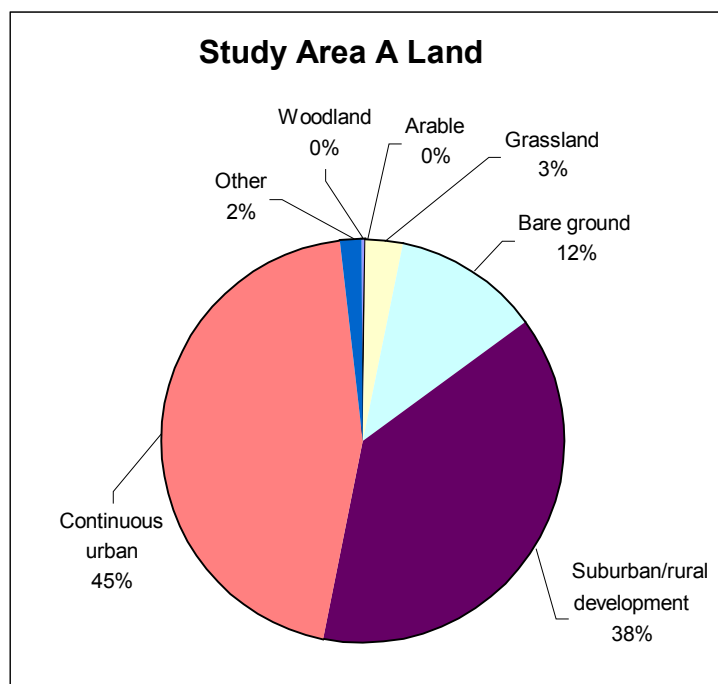
Study Area Selection

B.1   Study Area A is situated on the fringes of a major city in the north east of England. The area was selected as covering both former industrial areas but also areas of residential development and ongoing commercial activity. Shipbuilding in particular has played an important role in the study area coupled with other heavy engineering industries.

Data Acquisition

B.2   The principal sources of information used were as follows:

- historical Ordnance Survey (OS) maps obtained from Landmark Information Group Limited (Landmark) and EnviroCheck datasheets;

- data provided by the Pollution Control Technical Officer in anecdotal, note and GIS database form;

- data provided by the local Environment Agency office (customer services section);

- historical trade directory entries (available until 1936).

B.3 A vehicle-based site reconnaissance visit was not deemed necessary due to the quality of information supplied by both the local authority and the Environment Agency.

B.4 Considerable data were supplied in GIS format from both the local authority and the Environment Agency. This led to problems in reconciling the overlaps between the data sources (see discussion under Desktop Study in Section 2). The figures quoted for site numbers are therefore subject to interpretation, as it is not possible to definitively identify a 'site'. Using various GIS processing techniques, the areas of overlap have been removed from the area figures quoted.

Findings

CS1

B.5 The area was dominated by the former shipping-related industries including shipbuilding, engineering works and cargo handling. The area also contained a number of coal mines. A total of 46 sites were identified under CS1.

B.6 Of the identified historic land uses within the study area, one additional site has been highlighted for CS1 (radiological) , namely a scrap metal merchants. Scrap metal yards are known to have collected and sorted radioactive sources inadvertently. These are usually closed sources with some (but low) potential for ground contamination.

B.7 The bulk of the remaining radiological CS1 sites relate to areas of landfill and waste disposal within the study area. These are considered to have potentially received quantities of low-level radioactive waste.

CS2

B.8   No sites within the jurisdiction of Local Authority A have yet been identified as contaminated in terms of its Contaminated Land Strategy and duty under Part IIA.

B.9   There were no records available that indicated the presence of any previous ground investigation indicating the presence of ground contamination.
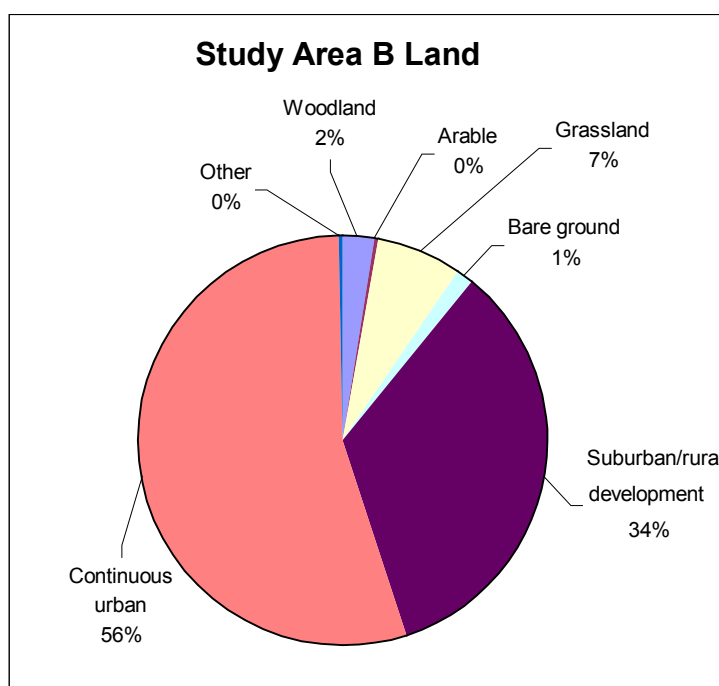
CS3

B.10   Anecdotal evidence supplied by the local authority Contaminated Land Officer indicated that some remediation (largely in the form of capping with clean cover) had taken place within the study area. This suggested that the land is highly likely to have been initially investigated and shown to be contaminated for remediation to be have been deemed necessary. Unfortunately, no quantitative evidence such as ground investigation reporting was available to confirm this.

B.11   Five areas were identified as having been remediated to some degree. However, no quantitative data were available from either the Environment Agency or the local authority that outline the precise boundaries of these areas. All details have therefore been derived and inferred from anecdotal evidence supplied by the local authority Contaminated Land Officer.

B.12   Three of the areas have been redeveloped for residential housing and are known to have been remediated via partial removal of contaminated material ('dig and dump') followed by capping with clean material.

B.13   One of the areas, now developed as a shopping/outlet centre, was also remediated in the form of almost 100 per cent hard cover (hardstanding and structures) in order to remove the risk pathway for the contamination to reach the surface receptor.

B.14   The final remaining area, at the eastern boundary of the site, is currently under predevelopment investigation; its findings are understood to indicate the need for remediation.

B.15   None of the identification or remediation activities had related to radiological contamination.

Table B1 Study Area A results

		CS1	CS2	CS3
TOTAL	Sites	46	10	10
	Area (ha)	138.70	23.01	23.01
	Area (per cent)	44.15	7.33	7.33
Radiological	Sites	12	0	0
	Area (ha)	22.48	0	0
	Area (per cent)	7.16	0	0

LOCAL AUTHORITY B

Region	North West
Area classification	Centres with industry
Population (2001)	> 250,000
Population category	Large town

Study Area B Land

- Woodland 2%
- Arable 0%
- Grassland 7%
- Other 0%
- Bare ground 1%
- Suburban/rural development 34%
- Continuous urban 56%

Study Area Selection

B.16   The 1-km radius study covered a mixture of residential, industrial and commercial land uses with some recreation ground.

Data Acquisition

B.17   The main sources of information used were:

- historical Ordnance Survey (OS) maps obtained from Landmark and EnviroCheck datasheets;

- information included in the local authority Contaminated Land Strategy published in October 2001.

B.18   Information requests to the local authority and regional Environment Agency office failed to yield any further information on the study area.

Findings

CS1

B.19   A total of 91 sites were identified for CS1. The study area is dominated by the textile industry, with a large number of mill sites on both the historic and more recent maps. Other sites were identified from the historic maps included two brickworks, two ironworks, a quarry and a tannery.

B.20   A further 57 sites were listed in contemporary trade directory entries. These current land uses tend to be small independent industries such as garages, depots (for vehicles and building materials) and printers. Although potential sources of unregulated contamination, the area affected would generally be smaller than that involved with a large industrial site.

B.21   The ironworks identified by the historical Ordnance Survey maps was identified for CS1 (radiological) due to the potential concentration of naturally occurring radioactive material (NORM) in slag heaps and disposal pits. One site has a current registration for the use of radioactive substances, while seven revoked or cancelled registrations were found in the area. Two former landfill sites also need to be counted under CS1 (radiological).

CS2

B.22   There are nine sites with known land contamination in the study area. These include three foundries, a welding company, a car body repair shop, a petrol filling station, one mill, a dismantled railway that had subsequently been used as a landfill, and an additional landfill. These sites were initially identified under the planning regime and subsequently confirmed in the Part IIA investigations. The presence of contamination on one site (the mill) was corroborated by records held at the regional Environment Agency office.
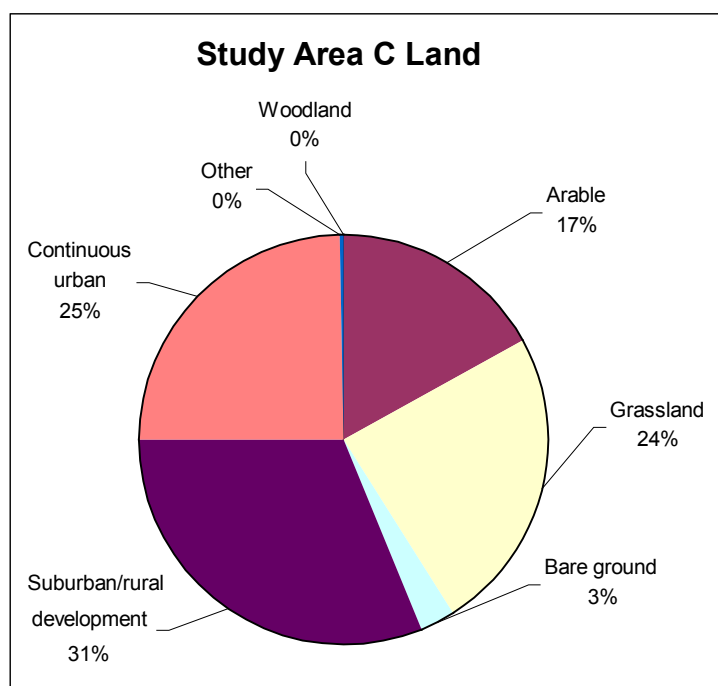
CS3

B.23   Of the nine sites identified under CS2, only the two landfill sites have not been subjected to specific remediation work. In addition, there has been redevelopment to mixed residential and recreational use on two of the CS1 sites, which between them constitute nearly 17 ha. However, no records existed to indicate if remediation work had been completed. These two sites are therefore not included in CS2 or CS3, although they do represent a significant proportion of the overall CS1 total.

Table B.2 Study Area B results

		CS1	CS2	CS3
	Sites	91	9	7
TOTAL	Area (ha)	87.39	12.88	7.57
	Area (per cent)	27.82	4.10	2.41
	Sites	9	0	0
Radiological	Area (ha)	0.70	0	0
	Area (per cent)	0.22	0	0

LOCAL AUTHORITY C

Region	North West
Area classification	Industrial hinterlands A
Population (2001)	> 500 000
Population category	Major city

Study Area C Land

Woodland 0%
Other 0%
Continuous urban 25%
Arable 17%
Grassland 24%
Bare ground 3%
Suburban/rural development 31%

Study Area Selection

B.24   The current land use within the study area is a mixture of residential, industrial and commercial. Residential properties, recreation land and schools form the western part of the area and there is a large industrial park in the eastern part.

B.25   Historically, the main industries within the vicinity of the study area include numerous collieries, the extraction of other minerals (including gravel, marl, clay, sandstones and pebble beds), wire manufacture, watchmaking and potteries. Other forms of manufacturing were also present together with brewing, town gas production and ironworking.

B.26   Currently, the main industrial activities in the area are concentrated on the industrial park in the east and include automotive, chemical, engineering, electronics, food and

drinks, textiles and energy. Of particular historical note is the fact that this industrial park is the site of a former Royal Ordnance Factory, which produced various types of munitions and arms between 1940 and 1946.

Data Acquisition

B.27   Data for the study area were obtained from all the appropriate primary sources – local authority environmental health and planning officers, regional Environment Agency staff and the various data supplied by Landmark.

B.28   The Contaminated Land Inspection Strategy for the local authority has recently been completed and was a major source of information for the area.

B.29   Trade directory searches were completed for 1937, 1955, 1964 and 1968 to confirm historical industrial activities. No information was given in the 1937 directory, but the later directories confirmed entries for 77 industrial sites, of which seven have been deemed to be of radiological significance. The usefulness of these data was limited, however, by the lack of geographical detail in the entries. The majority of entries were classified only by street or general area name, so could only be located to a particular site by cross-referencing to other data sources.

B.30   The drive-by survey confirmed the findings of the desktop study, but highlighted some previously undiscovered development in the northern part of the industrial estate, adjacent to an existing facility.

Findings

CS1

B.31   The area was dominated by the industrial estate, which yielded a total of 69 sites for CS1. These cover a range of sizes from garages to large chemical works, and include electronics, food and drink, and textile industries. The estate is a relatively recent development (post-1960) and was constructed largely on previously undeveloped land.

B.32   The eastern half of the study site has mainly been occupied with a mixture of residential properties and recreation grounds.

B.33   More historic activities in the area included quarrying and metal working, including a tin smelting operation. This latter site was added to CS1 (radiological). Furthermore, a number of pits in the area were used historically for waste disposal. These were

also included in CS1 (radiological), due to the potential for the disposal of slag from the smelting works.

CS2

B.34 No sites have been designated under Part IIA and there are no special sites under investigation by the Environment Agency. At the request of the project team, the local authority Planning Officer retrieved a total of 112 planning permissions for the area that were considered potentially relevant for the period 2001 to 2004. On reviewing these, none were found with conditions relating specifically to the remediation of land contamination.

B.35 Although records pre-dating this period were not readily available from the local authority, information on the boundaries of 13 sites was received from the regional Environment Agency office. The exact state of contamination and requirement for remediation at these sites was not provided in the information, but it is assumed that the existence of an Environment Agency record for the site is indicative of it having been investigated and there having been contamination found. These sites are therefore been included in CS2.
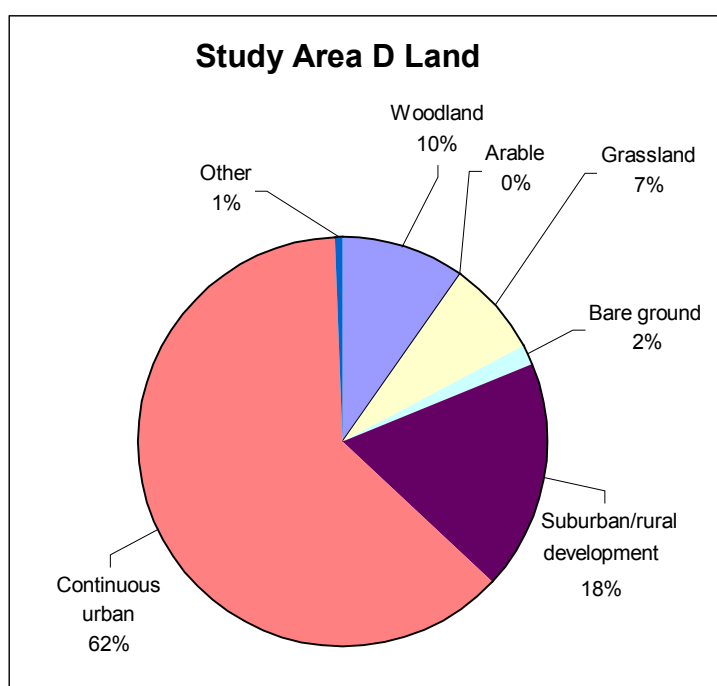
CS3

B.36 A total of six sites with historical potentially contaminative land uses (i.e. Royal Ordnance Factory, two quarries, two pits and a smithy) have been redeveloped for both industrial and residential purposes. However, as there was no information to indicate specific remediation activities, these sites have not been included in CS3. These sites represent a total of 4.71 ha.

Table B.3 Study Area C results

		CS1	CS2	CS3
TOTAL	Sites	81	13	0
	Area (ha)	110.3	32.84	0
	Area (per cent)	35.11	10.45	0
Radiological	Sites	14	0	0
	Area (ha)	7.77	0	0
	Area (per cent)	2.47	0	0

LOCAL AUTHORITY D

Region	Yorkshire and Humberside
Area classification	Manufacturing towns
Population (2001)	>250 000
Population category	Large town

Study Area D Land

Woodland 10%
Arable 0%
Grassland 7%
Other 1%
Bare ground 2%
Suburban/rural development 18%
Continuous urban 62%

Study Area Selection

B.37 The centre of the 1-km radius study area was close to the town centre of a major manufacturing and administrative area. With the decline of many industries, the borough is now dominated by retail, commercial and light industrial land uses. The study area was considered to be broadly representative, containing housing, public open space and commercial land uses.

B.38 The study area has a number of industrial sites and works concentrated along a riverside area in the south-eastern section. The centre of the study area is dominated by the shops and retail facilities of the town centre and is bisected by two railway lines. Also within the study area are a number of small residential areas and a large area of public open space.

Data Acquisition

B.39   The principal sources of information used were:

- historical Ordnance Survey (OS) maps obtained from Landmark and EnviroCheck datasheets;

- data provided by the local authority Contaminated Land Officer in anecdotal, note and GIS layer form, and from examination of large-scale historical mapping;

- data provided by the local Environment Agency office (contamination and groundwater section);

- historical trade directory entries (available until 1936).

B.40   Information was received in various formats including GIS data from the Environment Agency and the local authority.

B.41   In conjunction with the historical maps, the historic trade directories were reviewed to obtain a more precise definition of the industry type at a given address. The search was also used to identify other activities of significance in the area and to obtain an indication of the time period over which these businesses were in operation. The years searched included 1867, 1889, 1908, 1927, 1936, 1958 and 1960.

B.42   The two most recent trade directories (1958 and 1960) appeared to contain fewer entries than those previously referenced, which suggests these may not have been comprehensive directories of all businesses in the study area. The information in these directories was also arranged by business type rather than by street. These directories did allow confirmation that several of the major industrial sites were still active, but were otherwise of little benefit.

B.43   The trade directory search identified several businesses operating within the study area, which were of interest, but could not be located geographically when examining historical map information. This was partly due to the way the information in the trade directories was arranged and partly due to the nature of the study area whereby businesses were often located in informal yards or industrial parks with no street numbering or other identifiers to pinpoint the exact location. These operations were either grouped together as one area in the assessment table, with all activities listed for that area (an example being 'navigation yard'), or not included at all. The significance of the missing businesses may not be that great as they were generally

small operations which would not have occupied much land area. Larger operations were usually clearly identifiable on the historical maps.

B.44   A number of visits to the study area were undertaken. These confirmed the findings of the desktop study exercise.

Findings

CS1

B.45   Three main zones of the study area were identified as sites for CS1: a major chemical works; a trading estate area; and a retail and leisure park. Based on the different historic practices identified in these locations, 134 individual sites were identified.

B.46   Radiological practices have potentially occurred at 26 of these sites (totalling 1.41 ha). These included:

- a laboratory site associated with the chemical works;

- a former gasworks;

- four former scrap merchants;

- five foundry sites,

- two former waste disposal sites.

CS2

B.47   Within the study area, no contaminated land has been identified by the local authority as part of its strategy and duty under Part IIA. However, the local authority was aware of five sites within the study area due to issues with known contamination and for which ground investigation data were held on file. These had been brought to the attention of the local authority via the planning process and appropriate conditions have been placed on them at the appropriate stage of development. These sites were corroborated by records held by the regional Environment Agency office.
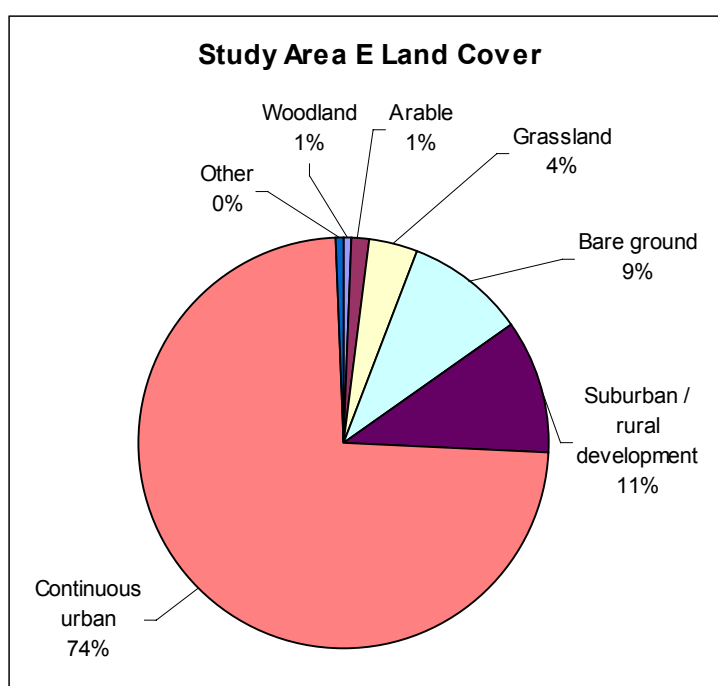
CS3

B.48   Three sites within the study area, totalling 2.62 ha, are known to have been remediated (evidence from the Environment Agency and the local authority). Two were remediated for commercial use and one for residential purposes. One of these was a former foundry site, although no radiological contamination was remediated for.

Table B.4 Local Authority D results

		CS1	CS2	CS3
TOTAL	Sites	134	5	3
	Area (ha)	85.39	6.28	2.62
	Area (per cent)	27.18	2	0.84
Radiological	Sites	26	0	0
	Area (ha)	1.41	0	0
	Area (per cent)	0.45	0.00	0.00

LOCAL AUTHORITY E

Region	Midlands (East and West)
Area classification	Centres with industry
Population (2001)	> 100 000
Population category	Large town

Study Area E Land Cover

Land Cover	Percentage
Woodland	1%
Arable	1%
Grassland	4%
Other	0%
Bare ground	9%
Suburban / rural development	11%
Continuous urban	74%

Study Area Selection

B.49   The study area is situated on the periphery of an area of historic industrial activities in the West Midlands. It is criss-crossed by major road, rail and waterway transport links, and industry remains a major land use in the area with a number of business parks and trading estates. The eastern side of the study area is mostly residential with scattered, smaller industrial units.

B.50   The main industries that feature in the historical records are metal works of various kinds, including iron, brass and steel works. Additional industrial activity is associated with the railway, and there are also leatherworks, corn mills and garages. The gasworks in the area were a significant size, with over 23 gasholders featuring in one epoch of the historical mapping. There is also a colliery site and a number of refuse tips.

Data Acquisition

B.51   The principal sources of information used were as follows:

- historical Ordnance Survey (OS) maps obtained from Landmark and EnviroCheck datasheets;

- Contaminated Land Strategy document, 2001;

- data provided by the contaminated land/pollution control and planning officers of the local authority in tabular and GIS layer form;

- data provided by the regional Environment Agency office in tabular and GIS layer form.

B.52   A visit was made to the Local History Centre to obtain information from the Kelly's trade directories. Directories were studied for 1870, 1932 and 1956, with 1870 being the earliest directory available. The commercial trade section of the directory was used to identify potentially contaminative industries in the study area. This was done by matching street names from the trade directories with those from the historical maps. The directories generally listed only partial addresses (typically excluding a building number), making it impossible to map these precisely to a site location. The information therefore served mainly to confirm the findings from the other sources. A further two trade directories were studied specifically for radiological contamination issues (1932 and 1957).

B.53   A drive-by survey was undertaken for the area where many of the potentially contaminative industries were situated. This allowed the current land uses to be identified and showed that redevelopment had occurred. This redevelopment was discussed with the planning officer to determine knowledge of any associated remediation.

Findings

CS1

B.54   Within the study area, 37 sites were categorised as CS1 due to their past use. The majority of these sites were associated with former metal works and closed landfill sites. Two were closed landfill sites, both of which have been identified as having received contaminative material, including waste from the metal processing activities. These sites are counted under CS1 (radiological). Also counted under CS1 (radiological) are the gasworks, the copper works (which had previously been

registered under section 7 of the Radioactive Substances Act 1993) and the more general metal works in the area.

CS2

B.55 A total of six sites were identified as sites with known land contamination where known site investigation works had been conducted, including the two landfill sites mentioned previously. Despite the potential risk from radiological contamination, none of these six sites had specifically been identified or investigated for radiological concerns. One site (the former copper works) is considered a potential special site.
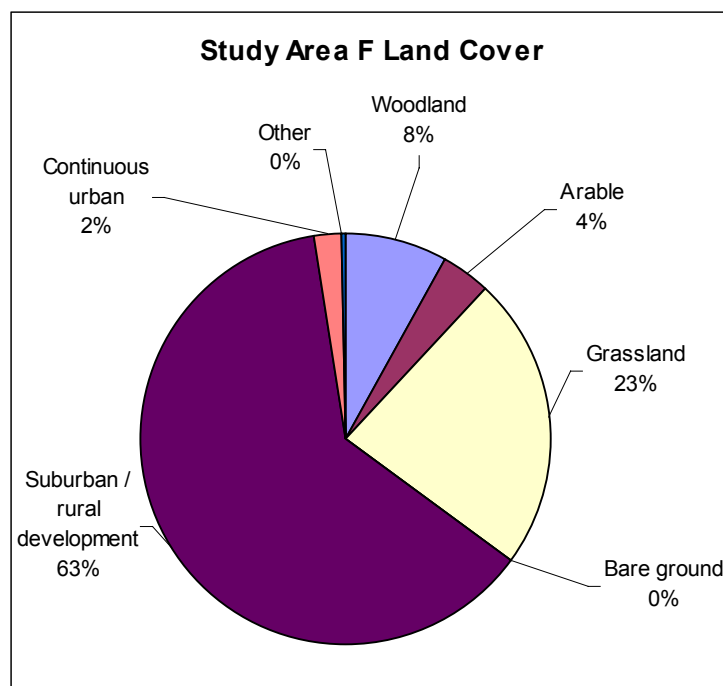
CS3

B.56 All six of the CS2 sites had subsequently been subject to remediation activities and thus also feature under CS3. Some remediation activity dates back to the 1980s and many of the current end-uses are commercial or industrial, rather than residential. There are additional industrial sites featuring on historic maps that have subsequently changed use (e.g. a colliery site now occupied by a hospital), but these have not been included within CS3.

Table B.5 Study Area E results

		CS1	CS2	CS3
TOTAL	Sites	37	6	6
	Area (ha)	82.33	18.68	18.68
	Area (per cent)	26.22	5.95	5.95
Radiological	Sites	19	0	0
	Area (ha)	8.17	0	0
	Area (per cent)	2.60	0	0

LOCAL AUTHORITY F

Region	East
Area classification	New and growing towns
Population (2001)	> 100,000
Population category	Small town

Study Area F Land Cover

- Woodland 8%
- Other 0%
- Continuous urban 2%
- Arable 4%
- Grassland 23%
- Bare ground 0%
- Suburban / rural development 63%

Study Area Selection

B.57   The 1-km radius study area is situated on the fringes of an urban area and is principally residential with some recreational land. The area was selected on the basis of its proximity to the nearby river, and on the assumption that the former industrial activities associated with this waterway would feature in the historic land uses for the area. However, as described below, the particular area selected missed the major sites for this activity and thus is potentially not representative for this type of location.

Data Acquisition

B.58   The main sources of information used were:

- historical Ordnance Survey (OS) maps obtained from Landmark at scales at 1:2500 and 1:1250 and at 1:10000 obtained from the Environment Agency;

- Landmark EnviroCheck datasheets;

- data provided by the local authority Pollution Control Officer;

- data provided by the local authority Planning Officer;

- data provided by entries in records compiled under the Radioactive Substances Act 1993 (RSA93).

B.59   The records at Local Authority F are paper-based and there was no method of retrieving information for areas on a spatial basis. Although limited information was obtained from the local authority, it was not a definitive record of planning or environmental health issues for area. However, comprehensive data were received from the regional Environment Agency office. A limited site visit confirmed the mainly residential nature of the area.

Findings

CS1

B.60   A total of 27 sites were identified as CS1, including a number of depots and factories, a large landfill site and a former airport. These latter two sources together represent the majority of CS1. It emerged from discussions with local officers that had the site centre been a few hundred metres further west, it would have included significant historical dockland activity. This would have increased the number and areas for the indicators.

B.61   Included within CS1 (radiological) were two sites holding closed RSA permits, four sites with open RSA permits, a sewage works and an additional closed landfill site which.
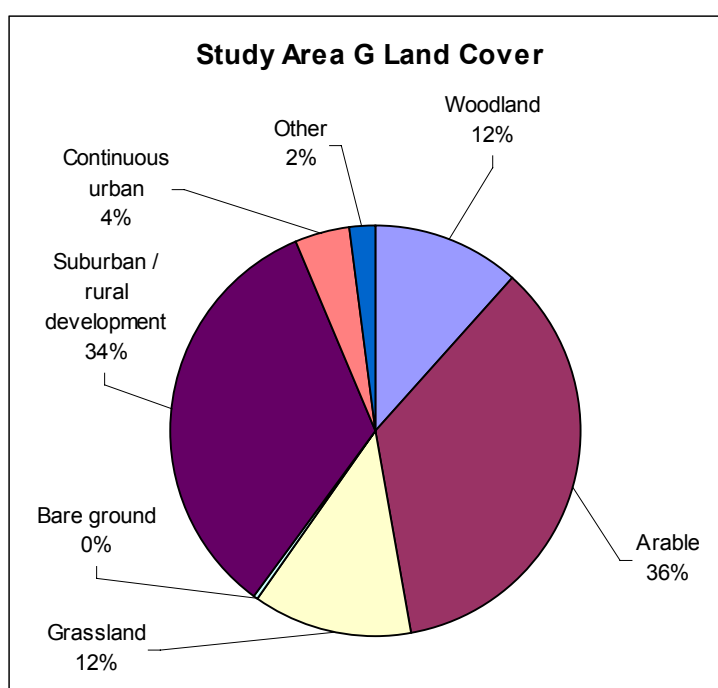
CS2 and CS3

B.62   Only one site within the study area has been positively identified by the local authority as contaminated land – the closed landfill site. No remediation work has been undertaken, however, so this features only under CS2, and not under CS3. The large size of this site compensates for the fact that it is the only such area and the percentage area for CS2 is not unduly low.

Table B.6 Study Area F results

		CS1	CS2	CS3
TOTAL	Sites	27	1	0
	Area (ha)	52.94	19.64	0
	Area (per cent)	16.86	6.25	0
Radiological	Sites	8	0	0
	Area (ha)	20.85	0.00	0.00
	Area (per cent)	6.64	0.00	0.00

LOCAL AUTHORITY G

Region	East
Area classification	Prospering small town and/or prospering Southern
Population (2001)	> 100,000
Population category	Rural

Study Area G Land Cover

Woodland 12%

Other 2%

Continuous urban 4%

Suburban / rural development 34%

Bare ground 0%

Grassland 12%

Arable 36%

Study Area Selection

B.63   The 1-km radius study area was centred on a small town in a mainly rural local authority. The land use is primarily agricultural or non built-up with less than 50 per cent of the land cover classed as developed. The principal current industrial sites are a sewage works, a light industrial area and a tannery.

Data Acquisition

B.64   The main sources of information used were:

- historical Ordnance Survey (OS) maps obtained from Landmark and EnviroCheck datasheets;

- data provided by the local authority Land Quality Scientific Officer in tabular and GIS layer format;

- data provided by the Environment Agency technical officer for the area;

- the local authority's Part IIA Inspection Strategy records.

B.65   Separate information from the planning office was not available for this study area, although progress made on the Inspection Strategy has included the identification and prioritisation of sites based on historic planning data.

Findings

CS1

B.66   A total of 60 sites are classified as CS1, 32 of which have been identified from the contemporary trade directory entries as given in the Landmark EnviroCheck report. In lieu of identifying a specific site polygon, these have each been assigned an area of 0.01 ha.

B.67   The northern area featured a landfill site, several warehouses and factory units, a cemetery, a section of a former railway line, and a sewage treatment plant. To the south is the tannery. Other sites classified under CS1 include factory/works units located on a former gasworks, breakers' yards, settling beds, a garage and a sewage works.

B.68   The classification CS1 (Radiological) was given to two sites with current RSA registrations, both associated with specialist laboratory services. Two revoked or cancelled permits are also known for the area, one for the laboratory and one for the sewage works. Additionally, the gasworks, the cemetery sites (from plutonium-fuelled pacemakers) and the refuse/landfill sites were identified.

CS2

B.69   The local authority has identified a total of eight of these CS1 sites as being of concern under the Part IIA regime. However, the presence of contamination on these sites has not yet been confirmed; therefore, these sites cannot strictly be included in CS2, though this may change in the near future. One site – a former tannery – has been identified under the planning regime as having specific land contamination issues; this has been included in CS2.
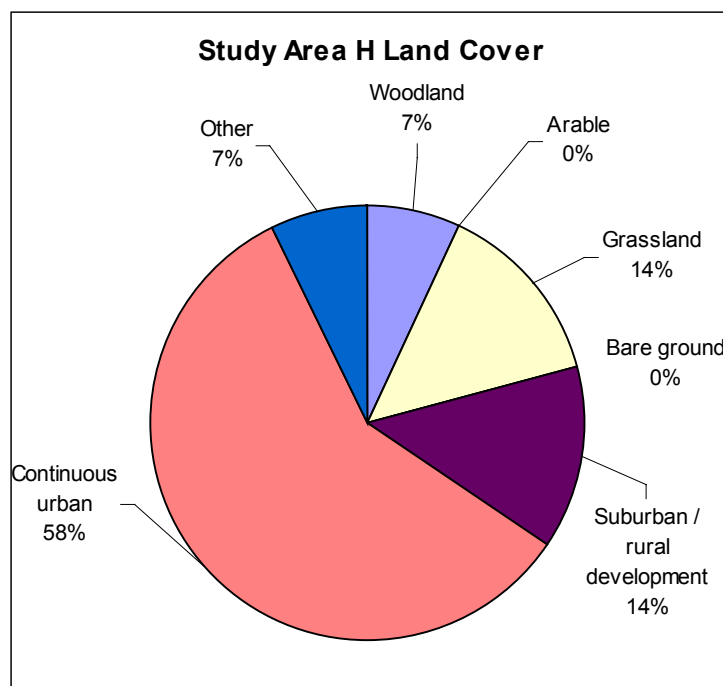
CS3

B.70   Remediation has yet to be undertaken at the CS2 site discussed above, so there are no CS3 sites for this study area.

Table B.7 Study Area G results

		CS1	CS2	CS3
TOTAL	Sites	60	1	0
	Area (ha)	35.40	1.52	0.00
	Area (per cent)	11.27	0.48	0.00
Radiological	Sites	11	0	0
	Area (ha)	15.74	0	0
	Area (per cent)	5.01	0	0

LOCAL AUTHORITY H

Region	South East
Area classification	London and suburbs
Population (2001)	> 200,000
Population category	Major city

Study Area H Land Cover

- Other 7%
- Woodland 7%
- Arable 0%
- Grassland 14%
- Bare ground 0%
- Suburban / rural development 14%
- Continuous urban 58%

Study Area Selection

B.71   The 1-km radius study area is predominantly residential and commercial in land use, but also features recreational land and a section of river frontage. Historic trade and manufacturing industries in the area are primarily associated with this riverside position, but there are also more generic manufacturing works and infrastructure facilities, including power stations and gas storage and distribution.

Data Acquisition

B.72   The main sources of information used in the area were:

- historical Ordnance Survey (OS) maps obtained from Landmark at scales at 1:2500 and 1:1250 and at 1:10000 obtained from the Environment Agency;

- Landmark EnviroCheck datasheets;

- data provided by the local authority Contaminated Land Technical Officer in tabular and GIS layer format;

- data provided by the regional Environment Agency office;

- data provided by the entries in records compiled under the Radioactive Substances Act 1993.

B.73 Planning data held by the borough are not kept digitally and records cannot easily be retrieved by a spatial search. Records obtained from the regional Environment Agency office were therefore the primary information source for remediation activities.

B.74 Trade directories for the area are not all held in one location, so the search was restricted to examining the 1933/1934 Kelly's Directory for sites with the potential for radiological contamination.

Findings

CS1

B.75 The predominant historical industrial activity in the area is associated with the docks that line the river frontage. There are numerous transport depots (with risks associated with fuel storage), together with shipbuilding and maintenance. One site in this area has also been a power station. Elsewhere in the area are gasworks and small garages. Industrial sites in the area have historically been small in nature, densely clustered and subject to frequent changes of activities. The changes in the sizes and extents over time make it difficult to determine a definitive number of 'sites', so an estimate of 112 has been made using assumptions outlined in Section 2 (Methodology).

B.76 The principal site of interest in terms CS1 (radiological) is a former Ministry of Defence (MoD) facility situated in the north of the study site adjacent to the river. This site had been in use for over 400 years, latterly as a training facility with a licence for a keeping and use of a radioactive substance. The site contained a Royal Navy research reactor, which was at a site in Study Area I from 1959 before being decommissioned and moved to the facility.

B.77 Historically, this area was known for watchmaking and luminising. There would have been a number of small workshops undertaking this type of work, could also be

included under CS1 (radiological). No current references have been found to any such activities, but several references have been found to this trade in the historical Kelly's Directory for 1933/1934. In addition to the three watchmakers within the study area, there are also believed to be a similar number of watch repairers.

B.78 A number of entries for brass and bronze foundries were encountered within the study area. However, it was assumed that these would not be involved in the refining of the metals and hence not generate radioactive slag materials. Trade directory entries are limited in terms of what data are given and so it was unclear as to what processes were undertaken at these zinc-handling factories. They may have included smelting and refining, which would generate radioactive slag, or just galvanising and anode manufacture which would not have left a radioactive legacy. It is assumed that these entries are a small in size and, taken together, are not likely to account for more than 1 ha for the study area.

B.79 The former MoD facility includes a hospital that may also be of interest in this category, as it is likely to have used and disposed of open radioactive sources. These sources would have had a short half-life, being used for in-vivo diagnostics and therapy. Contaminated areas have been found on hospital premises and are generally associated with waste stores or waste dispatch compounds. Since the hospital was closed in 1952, it is possible that there is still a radioactive legacy since housekeeping standards and regulation were not as stringent then as today.
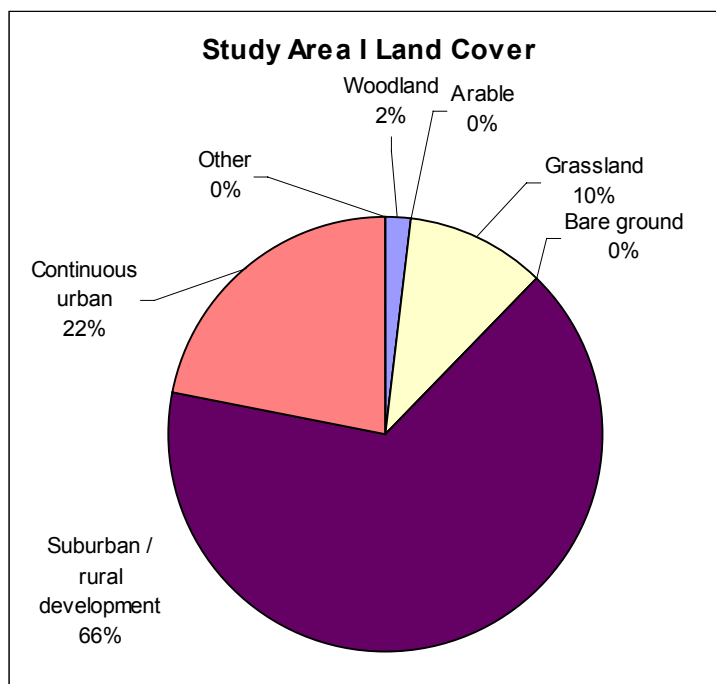
CS2 and CS3

B.80 The local authority has yet to statutorily determine any sites under Part IIA that would be classed as CS2. The Environment Agency has, however, been consulted on a number of sites and has recorded the outcomes of site investigations and the completion of remediation activities. These have been included under CS2 and CS3 as appropriate.

B.81 The site boundaries identified by the Environment Agency differed significantly from other data sources. As with CS1, therefore, the number of sites has been estimated from the merged dataset. However, the area figures quoted remain accurate.

Table B.8 Study area H results

		CS1	CS2	CS3
TOTAL	Sites	112	21	10
	Area (ha)	49.86	18.20	11.22
	Area (per cent)	15.87	5.79	3.57
Radiological	Sites	9	0	0
	Area (ha)	0.38	0	0
	Area (per cent)	0.12	0	0

LOCAL AUTHORITY I

Region	South East
Area classification	London and suburbs
Population (2001)	> 100,000
Population category	Small town

Study Area I Land Cover

- Woodland 2%
- Arable 0%
- Other 0%
- Grassland 10%
- Bare ground 0%
- Continuous urban 22%
- Suburban / rural development 66%

Study Area Selection

B.82   The 1-km radius study area was located on the fringes of an urban area and is predominantly developed land (residential and commercial/industrial) with some recreational ground. The area features two large industrial sites and a cluster of smaller business on an industrial park.

B.83   Moving the study area a few hundred metres in any direction would significantly change its characteristics. A source of potential radioactively contaminated land lies just outside the study area in the neighbouring local authority. Conversely, if the site were moved further to the east, it would include a large component of open land.

Data Acquisition

B.84   The main sources of information used were:

- historical Ordnance Survey (OS) maps obtained from Landmark and EnviroCheck datasheets;

- data provided by the local authority Land Quality Scientific Officer in tabular and GIS layer format;

- data provided by the Environment Agency officer for the area.

B.85   The completed Part IIA Inspection Strategy was an extremely useful source of information. Unfortunately, the format and availability of the local authority's planning records precluded their use in the study. However, information on the remediation of sites through the planning regime was obtained from the regional Environment Agency office.

B.86   A specific trade directory search was not conducted as information had already been collected by the local authority as part of its Contaminated Land Inspection Strategy.

Findings

CS1

B.87   The study area features two large manufacturing plants on its eastern side. These large sites have been used for heavy industry over a number of years. There are also various factories and works in the northern part of the study area. A total of 36 sites were identified from the historic maps, with a further 17 listed in the contemporary trade directory entries, as given in the Landmark EnviroCheck report.

B.88 The site of principal concern in terms of CS1 (radiological) is a vehicle manufacturing plant. One of the buildings on the site originally housed a Royal Navy research reactor, which operated on the site from 1959 to 1962 before being decommissioned and relocated to within Study Area H. As this is a large plant, an estimate of 10% has been taken for the area potentially to be of radiological concern.

B.89 There are five sites within the study area registered under the Radioactive Substances Act 1993 (or its predecessors). The RSA permits were revoked or cancelled by 1989.

B.90 In addition to the sites registered under the RSA, there were six instances of land uses recorded under CS1 (radiological) identified from other information sources. These consisted of sites such as a former landfill site and sites such as a business park near the vehicle manufacturing plant.

CS2

B.91 Under CS2, there are 11 sites identified by the local authority within the study area where detailed site investigation work has been undertaken. Of these, eight were found to have contamination present and are included in CS2. The majority of these sites were identified under the planning regime, although there were a small number of voluntary remediation activities.

B.92 Specific identification and remediation for radiological contamination have been undertaken at the site of the former research reactor. An estimate has been made for the area of this identification and remediation.
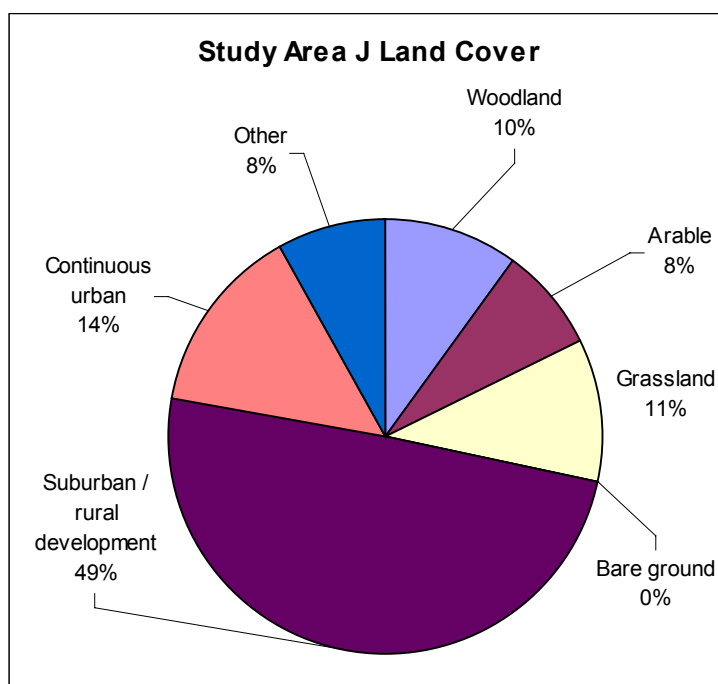
CS3

B.93 Of the eight CS2 sites, remediation activity has been completed on six, and these are included under CS3. The two remaining sites have yet to be remediated, though this is anticipated as part of the redevelopment process.

Table B.9 Study Area I results

		CS1	CS2	CS3
TOTAL	Sites	53	8	6
	Area (ha)	76.68	28.40	26.07
	Area (per cent)	24.42	9.05	8.3
Radiological	Sites	14	1	1
	Area (ha)	8.32	1.5	1.5
	Area (per cent)	2.65	0.5	0.5

LOCAL AUTHORITY J

Region	South West
Area classification	Coastal and countryside
Population (2001)	< 100,000
Population category	Rural

Study Area J Land Cover

Woodland 10%
Arable 8%
Grassland 11%
Bare ground 0%
Suburban / rural development 49%
Continuous urban 14%
Other 8%

Study Area Selection

B.94   The 1-km radius study area incorporates the whole of a coastal town – the largest population centre in Local Authority J. The land use is predominantly residential and commercial (retail), with a number of light industrial properties in the east of the area. Approximately 8 per cent of the study area is the sea, and there are a number of historic industrial sites associated with the harbour.

Data Acquisition

B.95   The main sources of information used were:

- historical trade directories;

- Landmark EnviroCheck Report for the study area;

- 1:2,500 scale historical OS maps provided by Landmark;

- letter from a contact at the Environment Agency regional office;

- telephone conversation with the local authority Planning Officer;

- email response from the local authority Environmental Health Officer;

- data collated during a drive-by survey of the site.

B.96   The Part IIA Inspection Strategy for the authority contains digital records of sites of concern. However, it was not possible to interrogate these for the purposes of the study, so the results prepared independently by the project team were sent to the local authority for confirmation. The response received indicated that none of the sites had been scheduled for investigation or were considered of potential concern.

B.97   Access to planning information was obtained by taking advantage of the personal knowledge of the local Planning Officer, who had 30 years experience of the area.

B.98   The regional contact for the Environment Agency was able to confirm that no special sites have been designated and no determinations made within the area. Six sites were recommended for contamination investigation during 2003 through planning consultations, but only two of these resulted in specific contamination conditions being appended to the planning consent. No Integrated Pollution Prevention Control (IPPC) sites or voluntary remediation was identified.

B.99 The County Records Office was visited in order to review historical trade directories for the area. Eleven historical trade directories were held covering the period from 1859 to 1953; due to the small number of directories, all years were viewed. Industrial entries were identified from the preface, which describes each town prior to private and commercial listings, and from the commercial listings. A total of 37 potentially contaminative sites/entries were identified. However, it has only been possible to locate three of these sites due to the lack of road numbers and full addresses in the trade directories.

B.100 A drive-by and walkover survey of the study area was conducted. This involved detailed observation of current industries and housing present in the study area in order to identify areas of redevelopment and ongoing sources of contamination. These were compared with the list of industries compiled from the historical and contemporary trade directories. During the survey, only a few trade directory listings were observed to still be trading. However, the type of industry present at an individual site was often noted to be similar, e.g. a former vehicle MOT centre had been replaced by a car sales and minor repair centre.

Findings

CS1

B.101 A total of 40 sites (10.74 ha) within the study area have been identified under CS1. Thirteen of these sites were noted as operational during the drive-by survey of the study area.

B.102 The primary land uses were noted to be: garages (11); quarries (5); saw mills (2); filling stations (2); railway land (2); and a variety of works and depots (18). The majority of these sites were or are located in the east and north east of the study area, with the quarries being located in the south of the study area.

B.103 The most common land use appeared to be small garages, which make up 26% of the total number of sites identified (1.13 ha). Of these garages, only four were observed to be operational during the drive-by survey. However, the largest area of potential contamination within the area is from two railway land sites, which cover a total of 2.37 hectares.

B.104 One site has been identified for CS1 (radiological) – a hospital present in the study area since 1929. This site does not currently require a permit for the storage or use of radiological sources.

CS2 and CS3

B.105 No sites within the study area have been identified as contaminated land or have been subject to remediation activities. The only activity of potential concern is the infilling and raising of portions of the study area by 1–2 metres. The materials used in this process were recorded as inert soil, subsoil and other uncontaminated hardcore. There is no evidence, therefore, to warrant inclusion of this area in either CS2 or CS3.

Table B.10 Study Area J results

		CS1	**CS2**	**CS3**
TOTAL	Sites	40	0	0
	Area (ha)	10.74	0	0
	Area (per cent)	3.42	0	0
Radiological	Sites	1	0	0
	Area (ha)	0.01	0	0
	Area (per cent)	0	0	0

LOCAL AUTHORITY K

Region	Wales
Area classification	Prospering small town and/or prospering Southern
Population (2001)	<100,000
Population category	Rural

Study Area K Land Cover
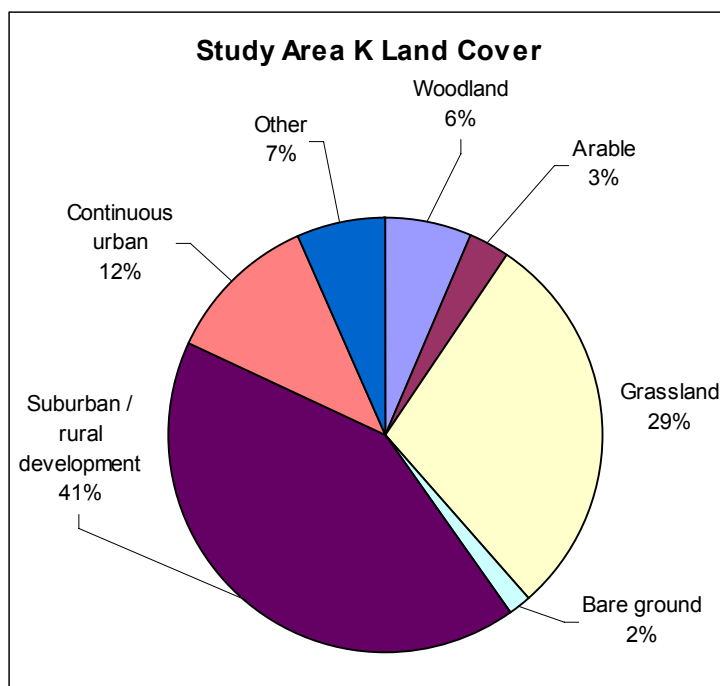
Study Area Selection

B.106 The 1-km study area covered a major proportion of a small town and is mainly residential with commercial (retail) buildings and a significant proportion of open space. However, there are several clusters of light industry and land associated with rail transport and shipping. A range of industrial activities feature in the records for the area including shipbuilding, a gasworks and a number of garages.

B.107 Moving the study area a few hundred metres to the west would significantly change its characteristics. This would have excluded the railway and shipbuilding land, and consequently reduced the results for CS1 significantly.

Data Acquisition

B.108   The main sources of information used were:

- historical trade directories;

- Landmark EnviroCheck Report for the study area;

- 1:2,500 scale historical OS maps provided by Landmark;

- email response from the local authority Environmental Health Department;

- email response from a contact at the Environment Agency regional office;

- review of planning records from 1985 to 2003;

- data collated during a drive-by survey of the site on 4 June 2004.

B.109   Records from both the local authority Planning Office and Environmental Health Department were used in the study. Details of the Inspection Strategy under Part IIA were obtained and 80 planning records were examined.

B.110   Although a number of sites in the area are being monitored by the local Environment Agency office (as opposed to the regional office), no information on these sites was available at the time of writing. No other records for the area were maintained by the Environment Agency.

B.111   The County Records Office was visited in order to review historical trade directories covering the study area. Six historical trade directories were held covering the period from 1822 to 1960; due to the small number of directories, all years were viewed. Industrial entries were identified from the preface, which describes each town prior to the private and commercial listings, and from the commercial listings.

B.112   A total of 41 potentially contaminative sites/entries were identified. However, it was only possible to locate six of these sites due to the lack of road numbers and full addresses in the trade directories.

B.113   A drive-by and walkover survey of the study area was conducted. This involved a detailed observation of current industries and housing present in the study area in order to identify areas of potential redevelopment and ongoing sources of contamination. These were compared with the list of industries compiled from the

historical and contemporary trade directories. During the survey, only a few trade directory listings were observed to still be trading. However, the type of industry present at an individual site was often noted to be similar, e.g. former garages were observed as car sales or light engineering.

Findings

CS1

B.114 A total of 32 sites, covering 43 ha within the study area, have been identified as CS1 sites. Fifteen of these sites were noted as operational during the drive-by survey of the study area. However, only nine of these were actually listed within the contemporary trade directories.

B.115 The primary land uses were noted to be: works (6); quarries (3); sawmills and timber yards (2); filling stations (3); and a variety of depots (5). The majority of these sites were or are located in the north-east, east and south-east of the study area.

B.116 The largest single area identified under CS1is a shipbuilding yard and associated railway sidings and wharfs, which cover an area of approximately 15.64 hectares. This is approximately 37% of the total area of CS1 identified within the study area. This site is still operational and is regulated by under Local Authority Air Pollution Control (LAAPC) as a Part B process.

B.117 A small gasworks along with a small foundry was present in the north-east of the study area until the mid 1960s.

B.118 Seven sites (0.64 ha) were identified under CS1 (radiological). These were three hospitals (one of which is still operational), a gasworks, a foundry and two cemeteries. The hospital sites may contain residual radioactive isotopes from X-ray equipment or in-vivo diagnostics; contamination is predominantly found in older hospital and near waste disposal areas. Waste products (slags) produced by metal foundries and heavy metal works are often found to contain naturally occurring radioactive metals; these are sometimes buried on-site and can result in elevated levels of radioactivity in the subsurface soils.

B.119 Radioactive metals may accumulate within gas pipes and the subsequent de-scaled products at gasworks sites which may be stored on site. This waste can result in elevated radioactive materials in the shallow soils beneath the site.

B.120 The two cemeteries located within the study area have a very low potential of ground contamination from plutonium-fuelled pacemakers which may have been buried on the sites.

CS2 and CS3

B.121 No sites have either been identified or remediated in the study area, so there are no CS2 and CS3 sites. Anecdotal evidence provided by the local planning officer suggested that voluntary investigation work had been undertaken on one of the industrial sites, but no evidence of contamination was found.

Table B.11 Study Area K results

		CS1	CS2	CS3
TOTAL	Sites	32	0	0
	Area (ha)	42.64	0	0
	Area (per cent)	13.6	0	0
Radiological	Sites	7	0	0
	Area (ha)	0.64	0	0
	Area (per cent)	0.20	0	0

LOCAL AUTHORITY L

Region	Wales
Area classification	Regional centre
Population (2001)	>250,000
Population category	Major city

Study Area L Land Cover
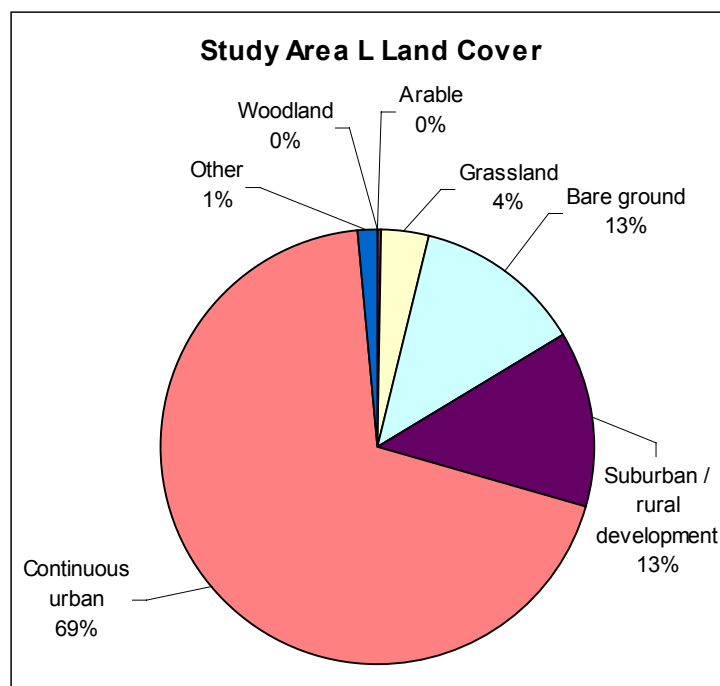
Study Area Selection

B.122 The centre of the 1-km radius study area was in the southern area of this regional centre and features a range of land uses including heavy industrial, light industrial, residential and transport. The study area is considered a representative sample of the wider city.

B.123 The study area features a large area of the former docks. Also in the area is a steel works, considerable rail infrastructure, gasworks and other miscellaneous industrial facilities. The area fell into decline in the 1950s and 1960s, and considerable parts of it were derelict by the 1970s. In the last 10–15 years, however, much redevelopment work has been undertaken and the area is now increasingly residential.

Data Acquisition

B.124   The main sources of information used in the study area were:

- historical Ordnance Survey (OS) maps obtained from Landmark and EnviroCheck datasheets;

- a sample of summary planning information held by the local authority planning office.

B.125   The local authority has invested considerable effort in its Part IIA Inspection Strategy and has compiled comprehensive details of all sites of potential contamination in the area based on historic mapping, planning and other records for the area. Due to a number of constraints, however, this information was unavailable at the time of preparing this report.

B.126   The local authority planning office was visited and maps showing individual planning application reference numbers and their location were viewed. In light of the large numbers of planning records in the last 30 years, a sample of 196 was taken. Of these, 22 consents could be placed within the study area and which also contained a requirement to investigate and remediate potentially contaminated land.

B.127   Information held by the regional office of the Environment Agency was received, but data from the local office had not been received by the time of writing this report. This information should include IPPC permit data and the exact advice given on sites featuring in the site tracking system.

B.128   A search was made in trade directories for the whole of the city for categories of industry with the potential to cause radiological contamination. Two years were studied – 1937 and 1955. From the 1937 directory, 175 addresses were listed have the potential to be radiologically contaminated as a result of previous industry. From the 1955 directory, 111 relevant entries were noted. Of these only, a small proportion (around 15) could be located to the study area.

B.129   A drive-by survey was conducted which confirmed that large parts of the docks areas had been redeveloped, with mostly industrial/commercial units, but with some housing in the south-west. In some cases, original buildings remain in places where redevelopment has taken place.

Findings

CS1

B.130 A total of 119 sites (120 ha) are classified as CS1. As site boundaries have changed with recent redevelopment, the site numbers have been interpreted from multiple datasets and are therefore more subjective than the area calculation, which takes full account of the overlap between adjacent sites.

B.131 In the northern area of the site, the industrial sites include a gasworks, railway lines and their former sidings and goods yards, a hospital and an abattoir. Smaller potential sources of contamination include two former hospital buildings, a number of garages and joinery works.

B.132 The area around the docks has been a focus of industrial activity since the 1790s. The most significant feature within the study area are a former iron and steel works, but other significant sites include heavy machine works, steel mills, mineral railways, gasworks, a paint factory, shipbuilding and the docksides themselves.

B.133 Included within CS1 (radiological) were the hospital sites, five metal foundries, two former gasworks and two scrap metal merchants. In addition, the search of the trade directories for 1937 and 1955 revealed 45 sites for inclusion under CS1 (radiological). The results are summarised in Table B.12.

Table B.12 Potential historic radiological contaminative sources (entries in trade directories)

Category in trade directory	Sites identified
Jewellers and watch and clock makers	16
Wireless manufacturers and merchants	12
Plumbers and gasfitters	10
Watch and clock repairers	3
Engineers – radio	2
Incandescent light dealers	1

B.134 Precise locations for many entries and site boundary plans for any entry were not available for the sites summarised in Table B.12. It is therefore not possible to determine the size of the operations associated with each entry. However, based on the category of entry they are anticipated to be small operations.

CS2 and CS3

B.135 A total of 21 CS2 sites were identified through examination of the planning records where conditions relating to the investigation of ground contamination were attached to the consent. Most of these sites were associated with recent redevelopment activities in the former dock area. Although no records were available on the outcomes of the conditions, the nature of the former industrial uses in the area, the relatively recent timeframe for the redevelopment and the strong involvement of the Regional Development Agency suggest that it is appropriate to include these 21 sites in both CS2 and CS3. Though this may lead to an overestimate, it was felt to be the most appropriate course of action for this particular study area.

Table B.13 Local Authority L results

		CS1	CS2	CS3
TOTAL	Sites	119	21	21
	Area (ha)	120.18	36.12	36.12
	Area (per cent)	38.25	11.50	11.50
Radiological	Sites	11	0	0
	Area (ha)	3.80	0	0
	Area (per cent)	1.21	0	0