

Part 2A, Environmental Protection Act 1990

Technical Guidance Sheet (TGS) on normal levels of contaminants in English soils

Normal levels of contaminant concentrations in soils are referred to in the contaminated land Statutory Guidance for the Part 2A regime Defra 2012. This Technical Guidance Sheet (TGS) gives an indication as to what lead concentrations can be expected in soils based on results from samples systematically collected across England. Normal Background Concentrations (NBCs) can be used along with other criteria (e.g. site investigation data and risk assessments) to help decide whether land is contaminated land as defined by Part 2A, on a site-by-site basis.

The NBCs are not intended to be a tool to be utilised when undertaking works via the planning regime. They are contaminant concentrations that are seen as typical and widespread in topsoils (depth 0 – 15 cm) and include contributions from both natural and diffuse anthropogenic sources.

When using this Guidance Sheet, please refer to the section on 'Using Normal Background Concentrations' at the end, the Supplementary Information, and the revised Part 2A Statutory Guidance.

LEAD (Pb)

Technical Guidance Sheet TGS02, July 2012.

Lead (Pb) is a metallic element naturally occurring in trace amounts in the Earth's surface environment with concentrations in rocks averaging 15 mg/kg. Generally, acid igneous rocks (e.g. granites) are higher in Pb than basic ones (e.g. basalts) and concentrations in sedimentary rocks are variable with up to 70 mg/kg in some limestones. With a low melting point, Pb ore minerals are readily smelted and the metal is easily worked. Lead therefore has a long history of use in human activities. In England there are a number of historical lead mining areas (e.g. the Derbyshire Peak District) where there is a legacy of Pb contamination caused by mining and associated activities. Biologically it is considered as a non-essential element and toxic to man and animals through the food chain and soil dust inhalation or ingestion.

Due to the strong affinity to bond with sulphur, Pb associates with sulphur minerals. Therefore, some rocks and soils containing sulphide minerals can be enriched in Pb. The principal Pb mineral is lead sulphide (galena, PbS). Other common minerals are cerussite (lead carbonate, PbCO₃) and anglesite (lead

sulphate, PbSO₄). The solubility of Pb in soil is very low and decreases with increasing soil pH. During the chemical weathering of rocks, Pb sulphides oxidise and Pb becomes bound to soil components such as clay minerals, iron and manganese oxides, organic matter, or may form carbonate and phosphate minerals.

Soil is a major sink for Pb associated with human activity, and, although many original uses of Pb have stopped because of the recognition of its toxic nature to the environment and humans, Pb contamination persists. Historically, Pb was used for plumbing, in paints and most significantly, in terms of diffuse pollution, tetraethyl lead was used in petrol. Reduction of Pb in petrol commenced in the UK from 1986 and was completely eliminated by 2000. Other notable sources of Pb contamination in the environment are from the application of sewage sludge, vehicle parts (e.g. Pb wheel weights), batteries, some plastics and metallic Pb used as flashing on buildings.

NORMAL BACKGROUND CONCENTRATIONS (NBCs)

Domain	Area (km ²)	Area (%)	NBC (mg/kg)	n
Urban	5,400	4	820	7,529
Mineralisation	2,900	2	2,400	347
Principal	124,600	94	180	34,257

Table 1: NBCs for the lead domains (cited to 2 significant figures, n is number of samples used in the calculation). Lead is determined by laboratory-based X-ray fluorescence spectrometry (XRFs), i.e. total Pb in soils sampled from a depth 0 – 15 cm. The NBC is the upper 95% confidence limit of the 95th percentile of the domain data (see supplementary information).

Methods

NBCs are calculated using contaminant data, with demonstrably high levels of quality assurance, for English topsoils systematically collected from a variety of land uses and analysed using certified methods. For this purpose the primary data sets used are the British Geological Survey's G-BASE results and samples collected for the National Soil Inventory (NSI) by the Soil Survey of England and Wales (now the National Soil Resources Institute (NSRI), Cranfield University, UK) (see Figure 1). The G-BASE samples cover both urban and rural locations and all

data used are total concentrations, measured by X-ray fluorescence spectrometry (XRFs). Soils used to calculate NBCs are from a consistent depth (0 – 15 cm) and are based on aggregating sub-samples collected from within a 20 m square.

England's soils have developed on a diverse range of parent materials (including those hosting Pb mineralisation) which are inherently variable in their chemical composition. These soils have also been subjected to a long history of diffuse pollution from urbanisation. This causes a significant variability in the Pb distribution across the country (Figure 2).

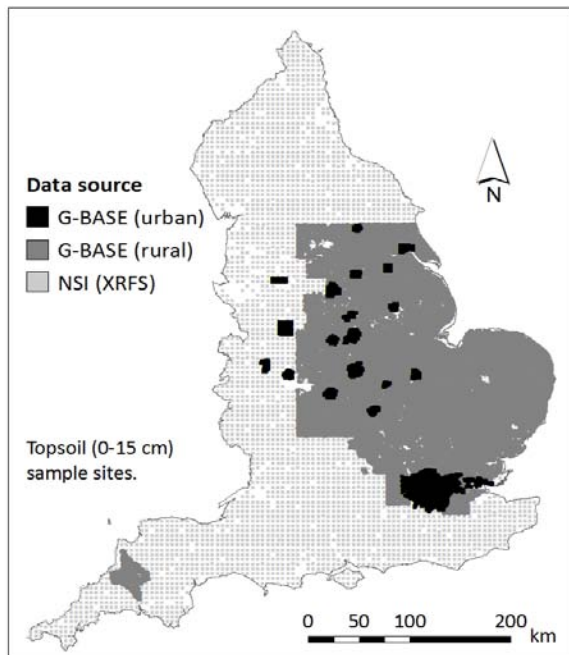


Figure 1: Map showing the distribution of samples used in the Pb NBC determination. NSI (XRFs) covers the whole of England at a sample density of 1:25 km². G-BASE sampling densities for rural and urban areas are 1:2 km² and 4:1 km², respectively.

Results for Pb in topsoils range from 2 - 10,200 mg/kg with a mean of 114 mg/kg and a median of 47 mg/kg. In order to establish meaningful NBCs, soils are grouped in domains, defined by the most significant controls on a contaminant's high concentrations and distribution.

NBCs are determined for each domain using robust statistical analysis that investigates the distribution of results and, by a process of iteration, takes into account the results that may be associated with point source contamination. "Normal" levels of contaminants are referred to in the Statutory Guidance (Sections 3.21-3.26 and 4.21(b)). They are represented here by the 95th percentile upper confidence interval, *i.e.* the NBC value is the upper limit at or below which contaminant levels can be considered to be normal for the defined domain. Levels at or below the NBC may not be naturally occurring.

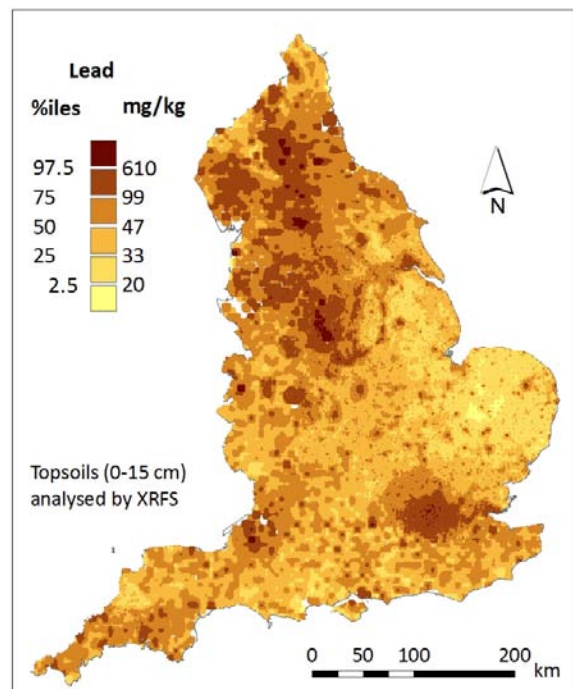


Figure 2: Map showing Pb in topsoil as a percentile classified interpolated image (all data are total concentrations by XRFs).

Results

Exploration of the soil data shows two significant controls on the distribution of higher Pb concentrations in England. These are in areas where: (i) soils have been impacted by Pb mineralisation with a legacy of mining and associated activities (Peak District, North Pennines, Lake District and Mendips);

and (ii) soils in urban and industrialised areas affected by anthropogenic diffuse pollution and exemplified by the London area data set. Therefore, two important domains are identified, the Mineralisation Domain and the Urban Domain. The area not covered by these two domains is referred to as the Principal Domain (Figure 3 and Table 1).

Although three domains have been distinguished, further spatial variability will occur within these domains. The Principal Domain, for example, may contain small scale areas associated with sulphide mineralisation (e.g. Shelve area) not captured in the Mineralisation Domain or elevated levels of Pb associated with soils developed on Coal Measures.

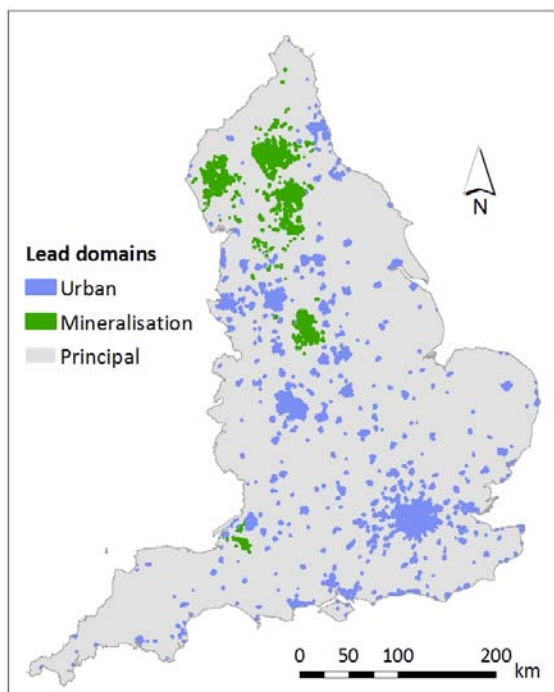


Figure 3: Lead domain map.

USING NORMAL BACKGROUND CONCENTRATIONS

The NBCs are produced to support the Part 2A contaminated land Statutory Guidance (SG) and help inform as to what are normal levels of contaminants. Using this TGS, along with the further information

and resources provided, a NBC test can be carried out:

1. A soil sample under investigation for Pb concentration should be spatially located in one of the three domains described. This should be part of a preliminary step in which the scenario and conceptual site model are considered.
2. If the Pb concentration is at or below the NBC for the specified domain then “*the result should not be considered to cause the land to qualify as contaminated land, **unless** there is a particular reason to consider otherwise*” (SG, Section 3.22). If the latter applies, then proceed to the use of other screening tools or further site investigation as necessary and appropriate.
3. If there is no reason “*to consider otherwise*” then the decision can be made that there is no evidence that the land is contaminated under Part 2A with respect to Pb (SG, Sections 5.2 – 5.4), that is, the land lies outside Categories 1 or 2.
4. If the Pb concentration is above the domain NBC then using the additional resources, including those provided with this technical guidance, a more detailed investigation at a local scale should be carried out or the use of other screening tools considered as appropriate. This is to determine whether the concentrations reflect “*levels of contaminants in the soil that are commonplace and widespread....and for which....there is no reason to consider that there is an unacceptable risk*” (SG, Section 3.21). If this is so, then step 3 applies. In the case of Pb, for example, this may be an area within the Principal Domain where a particular land use has caused widespread low level diffuse pollution.
5. If the concentration of Pb in the soil is not considered to be commonplace and widespread then further testing is required (apply quantitative risk assessment (QRA)).

FURTHER RESOURCES

Additional resources on NBCs are available from the BGS project [website](#) and the more detailed supplementary information provided with this guidance sheet. Additional on-line resources include: project reports; a database of essential information about relevant soil data sets; technical guidance sheets for other contaminants; polygons defining domain boundaries in various GIS formats; and a project bibliography.

THIS TGS SHOULD BE READ IN CONJUNCTION WITH THE FOLLOWING:

Part 2 A documents:

Available from the Defra Contaminated land web site at: <http://www.defra.gov.uk/environment/quality/land/>

Part 2A of the Environmental Protection Act 1990, as amended. The Contaminated Land (England) (Amendment) Regulations 2012 (Statutory Instrument 2012 No 263) (Amends Contaminated Land (England) Regulations 2006 (“the 2006 Regulations”) (S.I. 2006/1380).)

Defra. 2012. Environmental Protection Act 1990: Part 2A. Contaminated Land Statutory Guidance. Department for Environment, Food and Rural Affairs. April 2012

Project Reports:

Available from the Defra Project SPI008 [web page](#) and the British Geological Survey at: <http://www.bgs.ac.uk/gbase/NBCDefraProject.html>

Ander, E.L., Cave, M.R., Johnson, C.C. and Palumbo-Roe, B. 2011. Normal background concentrations of contaminants in the soils of England. Available data and data exploration. *British Geological Survey Commissioned Report*, CR/11/145. 124pp.

Ander, E.L., Cave, M.R., Johnson, C.C. and Palumbo-Roe, B. 2012. Normal background concentrations of contaminants in the soils of England. Results of the data exploration for Cu, Ni, Cd and Hg. *British Geological Survey Commissioned Report*, CR/12/041. 88pp.

Cave, M.R., Johnson, C.C., Ander, E.L. and Palumbo-Roe, B. 2012. Methodology for the determination of normal background contaminant concentrations in English soils. *British Geological Survey Commissioned Report*, CR/12/003. 56pp.

Johnson, C.C., Ander, E.L., Cave, M.R. and Palumbo-Roe, B. 2012. Normal Background Concentrations of contaminants in English soil: Final project report. *British Geological Survey Commissioned Report*, CR/12/035. 40pp.

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BIBLIOGRAPHIC REFERENCE

When referring to this document the following bibliographic reference should be made:

Defra, 2012. Technical Guidance Sheet on normal levels of contaminants in English soils: Lead. Technical Guidance Sheet No. TGS02, July 2012. Department for Environment Food and Rural Affairs (Defra), Soils R&D Project SPI008. Available on-line from Defra project SPI008 [web page](#).

The accompanying supplementary information for the Lead Technical Guidance Sheet:

Defra, 2012. Technical Guidance Sheet on normal levels of contaminants in English soils: Lead – supplementary information. Technical Guidance Sheet No. TGS02s, July 2012. Department for Environment Food and Rural Affairs (Defra), Soils R&D Project SPI008. Available on-line from Defra project SPI008 [web page](#).



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