

Part 2A, Environmental Protection Act 1990

Technical Guidance on normal levels of contaminants in Welsh soil

Normal levels of contaminant concentrations in soils are referred to in the contaminated land Statutory Guidance for the Part 2A regime (Wales), published by Welsh Government, 2012. This technical guidance gives an indication as to what BaP concentrations can be expected in soils based on results from samples systematically collected across Great Britain. 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, please refer to the section on ‘Using Normal Background Concentrations’ on page 3, the supplementary information provided by Ander et al. (2013), and the revised Part 2A Statutory Guidance (Wales).

BENZO[α]PYRENE (BaP)

January 2013.

Benzo[α]pyrene (BaP) is a yellow-coloured organic compound made up of five aromatic rings that contain only C and H atoms (Figure 1). It belongs to a family of compounds called polynuclear aromatic hydrocarbons (PAH) and typically comprises about 5 to 7% by weight of the total PAH content. BaP is widely regarded as the most carcinogenic of the non-substituted (parent) PAH compounds and is consequently used as a benchmark for toxic equivalent factors applied to concentrations of other PAH, the only other parent PAH ranked 1.0 besides BaP is dibenz(a,h)anthracene.

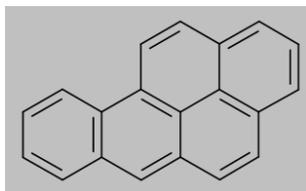


Figure 1: Structure of BaP made up of five aromatic rings containing just C and H

PAHs including BaP are of global ubiquity and reside in the environment primarily as the result of their production during the incomplete combustion of organic matter, including carbonaceous fuels. The fused aromatic ring system is formed from smaller reactive compounds generated from the precursor biomass/fuel source. Once in the soil BaP is unlikely to escape into the air and is fairly resistant to biodegradation having a modelled half-life of 1.15 to 3.2 years and a measured half-life of 8.2 years. Consequently BaP spread by diffuse pollution is found in most soils. Natural sources (e.g. from forest fires) are far outweighed by anthropogenic sources and so populated and industrial areas are most likely to have highest background levels of BaP.

Under normal conditions BaP has a low vapour pressure and is relatively insoluble in water and therefore tends to adsorb to particles in the atmosphere which are eventually deposited onto the soil surface. General diffuse sources of higher molecular weight PAHs such as BaP include exhaust from petrol and diesel motor car engines as well as emission from coal, oil, and wood burning stoves and furnaces. Specific point sources of PAH including BaP are from aluminium, iron and steel works; manufactured gas works; and fossil fuel combustion. Small amounts of BaP have been identified from natural and managed vegetation fires, as well as natural unburnt particles of coal.

NORMAL BACKGROUND CONCENTRATIONS (NBCs)

| Domain | Area (km ²) | Area (%) | NBC (mg/kg) | n |
|-----------|-------------------------|----------|-------------|----|
| Principal | 20,600 | 97 | 0.50 | 71 |
| Urban | 600 | 3 | 3.6 | 32 |

Table 1: NBCs for the BaP domains (cited to 2 significant figures, n is number of samples used in the calculation). BaP is determined on topsoils using results from Great Britain. The NBC is the upper 95% confidence limit of the 95th percentile of the domain data. Domain areas are those for Wales.

Methods

NBCs for BaP are calculated using contaminant data, with demonstrably high levels of quality assurance, for topsoils systematically collected from a variety of land uses and analysed using certified methods. Availability of data for organic contaminants in British soils is very scarce when compared with inorganic contaminants, particularly with regard to results from projects that have not been targeted specifically at industrial land uses. The scarcity of data for BaP has meant that the NBC calculations (Table 1) have used soils from Scotland, Wales and England (Figure 2).

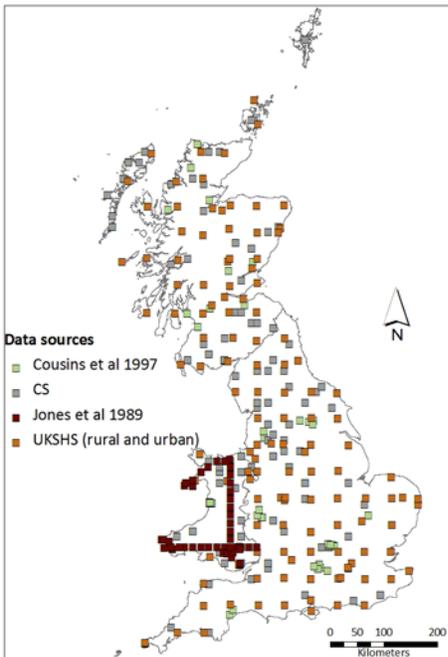


Figure 2: Map showing the distribution of samples used in the BaP NBC determination. For references to peer-reviewed data see Defra (2012b) (CS = Countryside Survey).

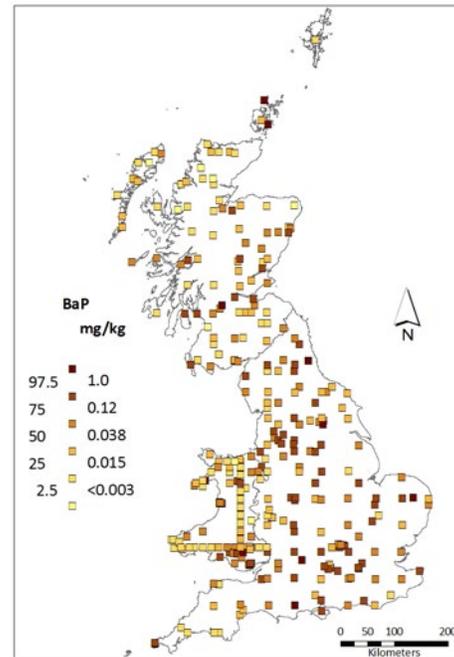


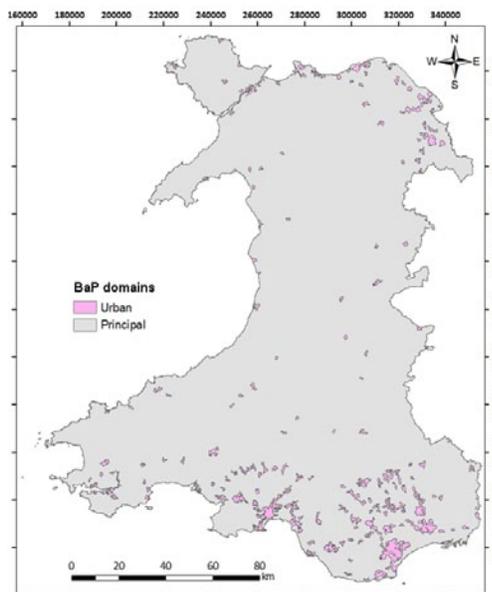
Figure 3: BaP in topsoil as a percentile classified map.

Three primary data sets used are: the UK Soil and Herbage Pollutant Survey (UKSHS) - a project commissioned by a number of agencies, principally the UK Environment Agency; the Countryside Survey (CS) Project - work led by the Centre for Ecology and Hydrology (CEH); and some peer-reviewed published data (see Figure 2).

Welsh soils have developed on a diverse range of parent materials though the geogenic contribution to soils is minor compared to BaP added through human activity. Soils have also been subjected to a long history of diffuse

pollution from industry and general urban activities. This has given rise to variability in the BaP distribution across Britain (Figure 3).

Results for the 407 topsoil collected across Great Britain (Ander *et al.* 2011) range from below detection to 3.7 mg/kg, with a mean and median of 0.14 and 0.04 mg/kg, respectively.



In order to establish meaningful NBCs, soils are grouped in domains, defined by the most significant controls on a contaminant's higher concentrations and distribution. With the low number of results available for NBC calculations, the confidence intervals for the BaP percentiles are large. 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 BaP are represented here by the upper 95% confidence limit of the 95th percentile, *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. Concentrations at or below the NBC for BaP will have been largely derived from diffuse pollution.

Figure 4: BaP domain map.

Results

Exploration of the BaP soil data for England, Wales and Scotland clearly shows that the BaP NBCs are best defined by two domains. These are an Urban Domain and Principal Domain (Figure 4 and Table 1), in Wales the Urban Domain is defined using the Ordnance Survey Strategi™ data (see Ander *et al.*, 2013). The Urban Domain NBC calculation is based on just 32 samples, just above the 30 sample threshold set as being sufficient to calculate a NBC. This NBC calculation will therefore be associated with a greater degree of uncertainty than that for the Principal Domain.

USING NORMAL BACKGROUND CONCENTRATIONS

The NBCs are produced to support the Part 2A contaminated land Statutory Guidance (SG) (Wales) and help inform as to what are normal levels of contaminants. Using this guidance, along with the further information and resources provided, a NBC test can be carried out:

1. A soil sample under investigation for BaP concentration should be spatially located in one of the two domains described. This should be part of a preliminary step in which the scenario and conceptual site model are considered.
2. If the BaP 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 BaP (SG, Sections 5.2 – 5.4), that is, the land lies outside Categories 1 or 2.
4. If the BaP 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 BaP, 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 BaP 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](#). These 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 GUIDANCE SHOULD BE READ IN CONJUNCTION WITH THE FOLLOWING:

Part 2 A documents:

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

Welsh Government. 2012. Contaminated Land Statutory Guidance -2012. Welsh Government, [Document Number WGI5450](#).

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. and Johnson, C.C. 2013. Normal background concentrations of contaminants in the soils of Wales. Exploratory data analysis and statistical methods. *British Geological Survey Commissioned Report*, CR/12/107.

Ander, E.L., Cave, M.R., Johnson, C.C. and Palumbo-Roe, B. 2012b. 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.

Defra, 2012a. Technical Guidance Sheet on normal levels of contaminants in English soils: BaP. Technical Guidance Sheet No. TGS04, July 2012. Department for Environment Food and Rural Affairs (Defra), Soils R&D Project SPI008. Available on-line from Defra project SPI008 [web page](#).

Defra, 2012b. Technical Guidance Sheet on normal levels of contaminants in English soils: Benzo[a]pyrene – supplementary information. Technical Guidance Sheet No. TGS04s, July 2012. Department for Environment Food and Rural Affairs (Defra), Soils R&D Project SPI008. Available on-line from Defra project SPI008 [web page](#).

ACKNOWLEDGEMENTS

The British Geological Survey has produced a series of Technical Guidance Sheets on NBCs for England as part of a project funded by Department for Environment Food and Rural Affairs (Defra) (Soils R&D Project SPI008, October 2011 – March 2012). The work was extended to apply the same methodology for determining NBCs in

Wales. This guidance sheet was compiled by Chris Johnson, Louise Ander and Mark Cave with contributions from Chris Vane. The project thanks the many people and projects that have assisted in the provision of data.

Version 1.0

BIBLIOGRAPHIC REFERENCE

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

Defra, 2013. Technical Guidance on normal levels of contaminants in Welsh soil: BaP: British Geological Survey (Keyworth, Nottingham) and Defra (London). R & D Project SP1008, January 2013. Available on-line from Defra project SP1008 [web page](#).



Llywodraeth Cymru
Welsh Government



**British
Geological Survey**
NATURAL ENVIRONMENT RESEARCH COUNCIL
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