

## Contaminated land

The UK along with other industrialised nations has a legacy of land that is contaminated with materials from previous use or from naturally occurring sources such as radon gas. This *ECG Environmental Brief* outlines the regulation of contaminated land, focusing on the site investigation and assessment methodology.

Contaminated land management requires an integrated approach from a multi-disciplinary team. It should include chemists who understand the behaviour and toxicity of chemicals in the environment and can evaluate the results of chemical testing analyses based on an understanding of the analytical methods used and the information they provide.

### Regulations and Regulators

Greenfield land sites are those which have not previously been built on by humans. This includes the greenbelt land around urban environments. In contrast, brownfield land sites are those which have been built on by humans, including waste disposal sites such as landfills, sewage works and reservoirs where no buildings may be present at the surface. Brownfield and Greenfield land that may be contaminated with pollution is dealt with in the UK by two main approaches:

- Part II(a) of the Environmental Protection Act 1990
- Local Authority Planning System

Under Part II(a), Local Authorities are responsible for the inspection of contaminated land and for ensuring that remediation is undertaken where necessary. Local Authorities also maintain a Public Register detailing the regulatory actions that they have implemented. The Environment Agency has a complementary role, for example acting as the enforcing Authority for designated special sites.

Contaminated land is also a consideration within the Local Authority planning system. When planning permission is sought for the development of a site, the Local Authority may require investigative work to be completed by the applicant with respect to its contamination potential. The Environment Agency will provide advice to Local Authorities on the risk assessment and remediation of contaminated sites with particular emphasis on the pollution of controlled waters. Planning permission may be granted on the condition that the site is remediated to the satisfaction of the Local Authority depending on the results of any investigation.

The main difference between Part II(a) and the planning system is that in the latter, risks have to be assessed based on the new or intended use of the land, rather than on the existing use, which is a criterion in the Part II(a) regime.

### Conceptual Model

A risk-based approach is adopted in the assessment of contaminated land. This approach includes the identification of contaminant-pathway-receptor relationships, resulting in the derivation and updating of a conceptual model through various phases of work.

### Investigation

Typically, Environmental Consultants are employed to investigate contaminated land sites, e.g. on behalf of a

developer seeking planning permission or of the Local Authority assisting with a Part II(a) inspection.

An initial desk study (Phase I) involves the identification of potential sources of contamination, pathways and receptors by assessment of information such as historical plans, geological maps and industrial profiles. A qualitative risk assessment is then performed for the site based on the conceptual model.

If Phase I identifies potentially significant source-pathway-receptor linkages, a site investigation (Phase II) may be carried out to provide quantitative information on the contaminant source, to assess pathways and the risk to the receptors as part of a Generic Quantitative Risk Assessment (GQRA). Phase II involves obtaining soil and/or groundwater samples and submitting them for chemical analysis. Soil and rock samples are obtained by the drilling or excavation of the ground.

If concentrations are particularly elevated, a Detailed Quantitative Risk Assessment (DQRA) can be performed. This detailed assessment involves the use of computer models to derive site specific assessment criteria (SSAC) for comparison with contaminant concentrations in soil.

### Human Health Risk Assessment

Soil Guideline Values (SGVs) are a type of Generic Assessment Criteria (GAC) published by DEFRA/Environment Agency. Soil Guideline Values are “trigger values:” above these levels, soil concentrations may pose a possibility of significant harm to long term human health (**Box 1**).

Soil Guideline Values represent the estimated average daily exposure of a human receptor to a soil contaminant which is equivalent to a minimal risk toxicological value. The two types of toxicology value used are: Threshold (substances where a non-zero, measurable dose produces an adverse effect) and non-Threshold (substances where there is a risk for any dose above zero). Soil Guideline Values are derived for various generic land uses (residential, commercial) using the Contaminated Land Exposure and Assessment (CLEA) model; the latest version of this model is detailed in Environment Agency document SC050021/SR3. SGVs published before 2008 were removed by the Environment Agency in August 2008, with updated values released from March 2009. Soil Guideline Values published between March and July 2009 include BTEX, arsenic, mercury, nickel and selenium.

Risk assessors can derive their own Generic Assessment Criteria using the CLEA model software package, as detailed in Environment Agency (EA) document SC050021/SR4. Land Quality Management (LQM) and the Chartered Institute of Environmental Health (CIEH) published their updated Generic Assessment Criteria in July 2009. Volunteers from environmental consultancies working with the Contaminated Land: Applications in Real Environments (CL:AIRE) and the Environmental Industries Commission (EIC) published Generic Assessment Criteria for a range of contaminants in January

2010. Both the LQM/CIEH and EIC/CLAIRE based Generic Assessment Criteria projects have aimed to complement the EA Soil Guideline Value programme.

The CLEA model software can also be used by risk assessors to derive SSAC values as part of a DQRA to compare with contaminant concentrations in soil. The model is limited in the number of pathways considered and can only be used to assess the risk to long term human health from contaminants in soil.

**Box 1: An example of an SGV.**

Arsenic generally forms organic and inorganic compounds, with the most common valence states being -3, +3 or +5. Arsenic's commercial applications have been in decline for some time due to its toxicity. Potential sources in the environment include non-ferrous metal smelting, pesticides and wood preservatives. Inorganic arsenic compounds are considered carcinogenic both via inhalation and ingestion, and it is classed as a non-threshold contaminant. The CLEA model is used to estimate the average daily exposure from arsenic in soil which is equivalent to its non-threshold toxicity value. This is reported as a soil concentration that represents a minimal risk to long term human health known as a SGV.

**Inorganic Arsenic SGVs are as follows:**

Residential	32 mg/kg dry weight
Allotment	43mg/kg dry weight
Commercial	640 mg/kg dry weight

**Groundwater and Surface Water**

The Environment Agency Remedial Targets Methodology; Hydrogeological Risk Assessment for Land Contamination provides a tiered structure for assessing the risk to groundwater and surface water receptors from soil and/or groundwater contamination. The methodology involves increasingly complex equations to derive remedial targets in soil from Level 1 to Level 4 and in groundwater from Level 2 to 4; data requirements and assessment complexity increase with each level. The remedial target becomes less conservative at increasing levels as more site specific data is used. The remedial target is based on reducing the soil and/or groundwater concentrations at the contamination source to concentration that poses no significant risk to receptors, e.g. rivers, public drinking water abstractions or the sea.

**Remediation**

Remediation is usually required when the results of the GQRA or DQRA indicate that contaminant concentrations pose a significant risk to critical receptors. In general, remediation requires design, implementation of remedial treatment, and validation monitoring following remedial works. Remedial activities may require planning permission and/or other environmental permits. There are many remediation techniques that can be applied either in-situ where treatment is carried out beneath the ground or ex-situ where the ground is excavated and treated at surface.

**Glossary**

CLEA	Contaminated Land Exposure Assessment
DQRA	Detailed Quantitative Risk Assessment
SGV	Soil Guideline Value
GAC	Generic Assessment Criteria
SSAC	Site Specific Assessment Criteria
CL:AIRE	Contaminated Land: Applications in Real Environments
EA	Environment Agency
LQM	Land Quality Management Ltd
CIEH	Chartered Institute of Environmental Health
EIC	Environmental Industries Commission
BTEX	Benzene, Toluene, Ethylbenzene and Xylene

**Useful Links**

Environment Agency. What's in your back yard?  
<http://tinyurl.com/eaback-yard>

Environment Agency. Land Contamination  
<http://tinyurl.com/ealand-cont>

CL:AIRE. Generic Assessment Criteria,  
<http://tinyurl.com/claireGAC>

WHO Guidelines for drinking-water quality  
<http://tinyurl.com/WHO-dw>

US EPA, Regional Screening Levels for Chemical Contaminants at Superfund Sites  
<http://tinyurl.com/EPA-chemcont>

Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance  
<http://tinyurl.com/EPA1990>

Developer's Guide to Potentially Contaminated Land,  
<http://tinyurl.com/o5q825a>

Previous **ECG Bulletin** articles on contaminated land may be found in the July 2008 issue (pages 18-20) and the January 2010 issue (page 36): see <http://tinyurl.com/ECGBulletin>

ATSDR, 2007. *Toxicological Profile for Arsenic*. US Department of Health and Human Services, Agency for Toxic Substances and Disease Registry  
<http://www.atsdr.cdc.gov/toxprofiles/tp2.pdf>

Soil Guideline Values for Inorganic Arsenic in Soil. Science Report SC050021, Environment Agency, 2009  
<http://tinyurl.com/EA-sgv-values>

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