

Remediation of brownfield land using cement and lime

Introduction

Cement and lime are materials that can be used, singly, together, or in conjunction with additives, to remediate brownfield land. Brownfield land, or previously developed land, is simply land that has been in use and which the government would like developers to use in preference to greenfield land. Depending on the nature of previous use, brownfield land may, or may not, be 'contaminated'. However, the possibility that it may be contaminated presages a formal investigation which leads to a site-specific remediation strategy.

Remediation practice, using cement or lime, falls into two generic categories: **Soil Stabilisation** or **Stabilisation/Solidification (S/S)**. However, the practical techniques used in both are the same, it is the purpose to which they are put that determines the term used. In the case of Soil Stabilisation, the main purpose is to improve the engineering properties of the soil, whereas in Stabilisation/Solidification there is the additional objective to immobilise contaminants as well as the physical improvement of the soil.

This Fact Sheet explores the appropriate use of Soil Stabilisation and Stabilisation/Solidification by describing the regulatory context that governs investigations, and subsequent decision making, and by providing examples that illustrate where cement or lime can be used to remediate brownfield land appropriately.

Remediation of brownfield land

Prior to being able to assess if Soil Stabilisation or Stabilisation/Solidification is a suitable remediation treatment for brownfield land it is essential for the developer to establish the nature of the land. This requires formal investigation leading to compilation of a Contaminated Land Report that has to be submitted to the local planning authority within the procedures for applying for planning permission.

Local Contaminated Land Officer – Environment Agency

From the outset it is recognised that as brownfield land has been in use, there is a possibility that there is contamination of the soil and this possibility requires formal consideration. It is important to note that under the Town and Country planning system the responsibility for providing information on whether the site is contaminated rests primarily with the developer. In general the local planning authority issues guidance as to what information and paperwork is required, where this can be a useful summary of regulatory requirements; an example is attached as an Annex. Where advice from the Environment Agency or their direct involvement is required then this is usually done through the local planning authority.

Uncontaminated or Contaminated Soil

Whilst the Environment Agency has produced guidance on the classification of contaminated soils as hazardous waste¹, there is no similar guidance on the classification of soil as uncontaminated or contaminated. For ten particular contaminants, Soil Guideline Values (SGV's) have been derived² but the guide level of contamination varies in accordance with land use. For example the SGV for arsenic is 20 mg per kg of dry soil for residential land use

¹ Environment Agency. Hazardous Waste and Contaminated Soil V.1 July 2004. 4 pp.

but 500 mg per kg for industrial use. It would be very unusual for a site just to be contaminated with a combination of the ten chemicals for which there are SGVs, and even if it did happen the SGV are only guide values and there ought to be a degree of flexibility on their application.

Uncontaminated Soil

Where it can be shown, or where it can be agreed between the developer, planning authority and Environment Agency that there is no contamination, a soil may only require its engineering properties to be improved to make it suitable for development. **Stabilisation** or **Soil Stabilisation** refers to improvement of the engineering properties of a soil for either highways or pavement type applications usually in accordance with the Highways Agency's Specification for Highways Works.

Contaminated Soil

Where it is understood that a soil is contaminated, **Stabilisation/Solidification, S/S**, may be an appropriate remediation technology. **S/S** of material is carried out to immobilise contaminants and improve engineering properties of soil for the remediation of brownfield sites; it may also be referred to as **S/S Remediation**. **S/S** can also be used to treat various hazardous waste streams prior to their disposal to landfill. Such waste streams may include contaminated soil, classified as hazardous and removed from brownfield sites.

Preliminary site assessment

To understand if it is **Soil Stabilisation** or **S/S Remediation** that is required then it is necessary to establish the nature of the brownfield land. This is a procedure called the preliminary site assessment.

A brief guide to what is required is set out in The Building Regulations Approved Document C 'Site preparation and resistance to contaminants and moisture'³. Essentially, the minimum requirement is a preliminary site assessment which consists of a desk study and a site walk-over in order to obtain an initial understanding of the potential risks.

It is at this stage that a fairly reliable indication of the level of contamination and the potential risk can be obtained and it may even be possible that the method of dealing with the land presents itself. To illustrate this, it is possible to imagine a number of scenarios (see below) where the action is either self-evident or where detailed consideration would be necessary:

Scenario A

There is no reason to suspect the site contains any contaminants and there is no evidence any contaminants are present. The soil requires no treatment to improve its engineering properties.

Remediation: There is no need to employ any remediation technique as none is required.

² Department of the Environment, Food and Rural Affairs & Environment Agency SGV1 Arsenic, SGV3 Cadmium, SGV4 Chromium, SGV5 Inorganic mercury, SGV7 Nickel, SGV8 Phenol, SGV9 Selenium, SGV10 Lead, SGV15 Toluene and SGV16 Ethylbenzene

³ The Building Regulations 2000. Approved Document C. Site preparation and resistance to contaminants and moisture. 2004 Edition

Scenario B

There is evidence of a limited volume of contaminants in discrete and accessible areas. The vast majority of the soil requires no treatment to improve its engineering properties.

Remediation: Excavate the contaminants and dispose to landfill. If this is a hazardous waste it should go to a hazardous waste landfill and it may well require treatment prior to landfill.

[Note: It is likely to be prohibitively expensive to develop and gain approval for an on-site or in-situ remediation treatment for a limited volume of contaminated material]

Scenario C

There is no reason to suspect the site contains any contaminants and there is no evidence any contaminants are present. The soil requires some treatment to improve its engineering properties prior to incorporation into the completed works.

Remediation: Cement or lime based soil stabilisation is a suitable well proven method of improving the engineering properties of a soil. Usefully this type of operation is given as an example of where the Environment Agency would not regard it as a waste activity and so should not need the completion of a Deployment Form Mobile Treatment License (MTL) as set out in recent guidance⁴. There may be a requirement to register an exemption with the EA, where appropriate exemptions are:

- Exemption 13. The manufacture and treatment of waste soils.
- Exemption 19A. Use of waste for ‘relevant works’
- Exemption 24. Crushing, grinding or size reduction of bricks, tiles or concrete
- Exemption 41. The temporary storage of waste at site of production

Scenario D

There is evidence of widespread low levels of ‘organic contaminants suitable for bio-remediation’ and a local Environment Agency preference for the bio-remediation solution. The soil requires some treatment to improve its engineering properties by reducing moisture content but there is no urgency as the land is only required for a long term local authority project.

Remediation: Cement or lime based Soil Stabilisation may well be suitable and could be preferred to bio-remediation if time is a consideration. However, if there is time for bio-remediation to work and the contaminants are treatable by this method then it is unlikely that a cement or lime based soil stabilisation technique would be approved.

[Note: It is worth noting that as successful bio-remediation means essentially no contamination in the treated material there is a natural tendency for the Environment Agency to ensure this option is considered.]

Scenario E

There is evidence of widespread low levels of inorganic contaminants in a poor soil of high moisture content. Once treated by Solidification/Stabilisation the material is suitable for supporting an area of hardstanding to be used as a car park for a large retail development.

Remediation: The treatment of low levels of contaminants by Solidification/Stabilisation and improvement of the soil is common and will require a Deployment Form Mobile Treatment Licence. Once incorporated into the works, and it is verified that the material is stable and

⁴ Environment Agency. The definition of waste – Developing greenfield and brownfield sites. April 2006

does not constitute a significant, or potential, risk of doing harm then the Environment Agency should consider the material as fully recovered, as set out in the EA Remediation Position Statement No. 14⁵. This position statement makes it clear that *'the treated material has been tested both physically and chemically to demonstrate that it will not cause pollution of the environment, harm to human health...'* Provided these requirements are met a Waste Management Licence should not be required for the 'permanent storage' of the treated materials.

[Note: Contractors confirm that it is not unusual for it to take six to eight weeks to obtain approval for a Deployment Form and this is in addition to obtaining the original Mobile Treatment Licence (MTL) itself.]

Scenario F

There is evidence of widespread contamination at sufficiently high levels that the soil once moved or treated in-situ is designated a hazardous waste. Similar materials have been treated by Solidification/Stabilisation such that the leachate from a monolithic test would meet drinking water limits on contaminants. Once treated by Solidification/Stabilisation the material is suitable for supporting an area of hardstanding to be used as a car park for a large retail development.

Remediation: As the material to be treated is classified as a hazardous waste, then it should be noted that achieving recovery, even within a limited scope of applications, will mean assiduous application of Environment Agency guidance with respect to contaminated land, where the starting point is Contaminated Land Report 11⁶. Notwithstanding how rigorously the Environment Agency guidance is followed there is no guarantee that the treated material will be regarded as 'recovered' at *'completion and verification of the works'* and therefore the EA may insist that the site requires a Waste Management Licence to store the treated material. Holding such a licence is likely to restrict the potential use and value of the land. For this reason early open consultation with the Environment Agency on what is required to achieve recovery is essential.

Contacts at BCA

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⁵ Environment Agency. Guidance Remediation Position Statements. Version 1. 22 March 2005

⁶ Defra/Environment Agency. Handbook of model procedures for the management of contaminated land. September 2004.

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The Berkshire Guide to Developing Potentially, Contaminated Land.

This leaflet is issued to assist developers, agents and consultants involved in the development of land that may be contaminated as a result of historical land use.

It has been produced by the Berkshire Contaminated Land Group (comprised of representatives from Local Authorities in that geographical region) with the aim of encouraging a consistent approach to the presentation and information content of contaminated land reports provided to local planning authorities within the area.

Under the Town and Country planning system the responsibility for providing information on whether a site is contaminated rests primarily with the developer. You should also be aware that the responsibility for safe development and secure occupancy of the site lies with the developer.

There are three phases of contaminated land investigation and management that may be undertaken dependent upon the condition of the site, these are:

- Phase I, Desk study,
- Phase II, Intrusive investigation
- Phase III, Remediation and/or risk management

The information listed provides a guide to what is required by the local planning authority. Reports submitted at each stage should be fully referenced and signed by a suitably qualified person.

The information listed is not intended to be comprehensive or exhaustive in content. In each phase the greater the information provided, and the earlier this is made available to the local planning authority, the sooner the scope and cost of any further investigation or remediation that may be required can be established. Some Local Authorities may request this information prior to an application being decided.

If at any point in the process the identified risks are shown to be acceptable, then the condition attached to the planning permission may be discharged enabling site works.

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Identify the phase and make sure the following have been considered/included?

A. PHASE I REPORT	Included?
(i) Purpose and aims of study	<input type="checkbox"/>
(ii) Site location (inc. OS NGR) and current/historical site feature plans	<input type="checkbox"/>
(iii) Appraisal of site history and previous uses of the land surrounding the site	<input type="checkbox"/>
(iv) Identify key potential historical contaminants both on-site and off-site	<input type="checkbox"/>
(v) Assessment of environmental setting, to include:	
• geology, hydrogeology, hydrology (inc. culverted streams)	<input type="checkbox"/>
• information on quarrying activities	<input type="checkbox"/>
• information from Environment Agency on abstractions, pollution incidents, water quality classification, current landfill sites, etc.	<input type="checkbox"/>
• Information from Local Authority on prescribed processes, hazardous substances, former landfill sites, private water supplies, contaminated land, etc.	<input type="checkbox"/>
(vi) Assessment of current site use and surrounding land uses	<input type="checkbox"/>
(vii) Review of any previous site contamination studies (desk-based or intrusive) or remediation works	<input type="checkbox"/>
(viii) Preliminary (qualitative) assessment of risks based on proposed site use	
• Appraisal of actual and/or potential contaminant sources, pathways and receptors	<input type="checkbox"/>
• Conceptual site model (visual and written)	<input type="checkbox"/>
(ix) Recommendations for intrusive contamination investigation, if necessary	<input type="checkbox"/>
B. PHASE II REPORT	Included
(i) Review of any previous site contamination studies (desk-based or intrusive) or remediation works	<input type="checkbox"/>
(ii) Site Investigation Methodology	
• methods of investigation	<input type="checkbox"/>
• justification for investigation locations, plan showing locations	<input type="checkbox"/>
• sampling and analytical strategies- justify contaminants to be assessed	<input type="checkbox"/>
(iii) Results and findings of investigation	
• ground conditions to include assessment of: made ground; natural ground; gas; vapour; groundwater (inc. depth & flow direction); and on-site/adjacent surface water	<input type="checkbox"/>
• Always use an accredited lab and have the full results attached to report including sampling precision and bias	<input type="checkbox"/>
• discussion of soil/gas/vapour/water contamination (including visual, olfactory, in-situ testing (PID etc), laboratory analytical and monitoring data)	<input type="checkbox"/>
(iv) Conceptual site model (visual, written - changes?)	<input type="checkbox"/>
(v) Risk assessment (RA) based on source-pathway-receptor model. It should take account of the severity of consequences and likelihood of occurrence and include a justification of the model used. Generally semi-quantitative assessment using generic and/ or site specific derived targets will be necessary. A quantitative RA using generic and/ or site specific derived targets may be required.	<input type="checkbox"/>

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(vi) Recommendations for remediation - justification should relate to proposed site end use, risk assessment findings, as well as technical and financial appraisal

(vii) Recommendations for further investigation (if necessary)

C.Phase III REMEDIATION STATEMENT (submitted before remediation)

Included

(i) Objectives of the remediation works

(ii) Detailed outline of the works to be carried out

- Description of ground conditions (soil, gas, water)
- Type, form and scale of contamination to be remediated.
- Remediation methodology, including remedial, protective or other works
- Site plans/drawings
- Phasing of works and approximate timescales

(iii) Consents, agreements & licences (i.e. discharge consent, waste management licence)

(iv) Site management procedures to protect site neighbours, environment and amenity during works, including where appropriate

- Baseline monitoring of dust, vapour, odour and groundwater quality
- Health & safety procedures
- Dust, vapour, noise & odour controls
- Control of surface water run-off (e.g. from stockpiles)

(v) Details of how any necessary variations from the approved remediation statement arising during the course of works will be dealt with, including notification to the relevant planning authority or officer dealing with contaminated land issues (contact details can be found on the back page of this guidance note).

(vi) Details of how the works will be validated to ensure the remediation objectives have been met, should include details on:

- Base line monitoring strategy and variations found during works
- Validation sampling strategy
- Use of on-site observations e.g. visual/olfactory/photographic evidence
- Chemical analysis/monitoring data (water level, gas and vapour release)
- Proposed risk based/ generic remedial targets (i.e. contaminant concentrations)

D. SITE COMPLETION/VALIDATION REPORT (submitted following remediation)

Included

(i) Include information as per C(i) to C(vi)

(ii) Details of who carried out the work

(iii) Details and justification of any changes from original Remediation Statement

(iv) Substantiating data - should include where appropriate

- Laboratory and in-situ test results
- Monitoring results for groundwater, gas and vapours
- Summary data plots and tables relating to remedial targets
- Plans showing treatment areas and details of any differences from the original Remediation Statement
- Photographic and other media records
- Waste management details and records

(v) Confirmation that remediation objectives have been met

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Please note:

- (1) Phase I & II Reports may be combined
- (2) General recommendations for remediation made in the Phase II Report will not be accepted as a substitute for a Remediation Statement.

In addition to the information requested by the Local Authority - the Environment Agency may specifically request information on pollution of Controlled Waters, drainage, surface water etc.

Reference Material:

BS10175

CLEA

www.DEFRA.gov.uk

Further Contacts and Advice:

- Human Health issues are dealt with by the Local Authority /Environmental Health.
- Controlled Water issues are dealt with by the Environment Agency.

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