NRA GUIDANCE ON THE ACCEPTABLE LEACHABLE VALUES FOR CONTAMINATED MATERIAL TO BE DEPOSITED IN UPPER TAME CATCHMENT

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CONTAMINATED LAND AND LANDFILL IN THE UPPER TAME CATCHMENT

1 Introduction

The NRA has a statutory duty to protect and maintain the quality of all controlled waters which includes surface waters and groundwaters. This duty is specified in the Water Resources Act 1991. In order to minimise the risk to the water environment from the deposition of contaminated material both in landfills and during redevelopment work on contaminated sites it is necessary to ensure that the soluble constituents of such material are kept down to an acceptable level, that is the substances which can be leached out of the material.

Due to the increasing number of contaminated land sites being redeveloped and the increasing economic pressures to redeposit contaminated material as close to its original location as possible, the NRA has devised a method which can be used to assess acceptability of contaminated material. The scheme involves assessing the leachable or soluble content of the contaminated material to be deposited and comparing these results with the acceptable quality for discharge into the watercourses in the Upper Tame Catchment. This is the only catchment so far considered due to the large number of developments occurring within a relatively small area and the need for a consistent approach by the NRA.

The main guidance used in redevelopment is the ICRCL trigger and action levels. These are inadequate for water pollution prevention. In this catchment the groundwater flows into the surface water and is rarely abstracted for direct use. Therefore NRA trigger levels can be derived for areas away from the water courses but leaching into groundwater.

2 Leachability Tests

The soluble content of the material can be assessed using the leachability test methodology given in the NRA R & D Note 301 entitled "Leaching Test for Assessment of Contaminated Land : Interim NRA Guidance." The NRA recommended test contained in that report which is to be used for much of this work is attached (Appendix 1). Additional test methods may be required for certain contaminants or specific situations as is stated in the R & D note. The entire R & D Note should be read for information purposes. It is available from National Rivers Authority, Distribution Centre, Washington, Newcastle-Upon-Tyne, NE85 4ET.

By assessing the leachability of contaminants a clear picture can be formed of the pollution potential of the material to water. No amount of analyses of the solid material or soils can help in determining the leachable content. Depending on the nature of the contamination a wide range of chemical constituents can be present and their inter-reaction means that there is no direct relationship that is universally applicable between total or soil results and leachability test results.

3 Relating leachability tests to water quality

3.1 Background

In much of the Upper Tame Catchment (see map Appendix 2) the underlying geology is Carboniferous Coal Measures strata which consists of a mixed sequence of layers of clays, shales, coals and occasional sandstones. Groundwater resources are restricted to the higher permeability layers and former mine workings. There are only a limited number of licensed groundwater abstractions, mainly for industrial use. The Coal Measures are overlain in places by alluvium and drift deposits which also contain limited groundwater resources.

The groundwater quality throughout the area reflects the mineralogy of the aquifer layers and also the long history of industrial development. Much of the groundwater discharges as baseflow to the surface water maintaining the flow in periods of dry weather. This is the major 'use' of groundwater throughout the catchment. Surface water quality reflects the history of the area in a similar manner to groundwater.

The Tame catchment also includes areas underlain by Triassic Sherwood sandstones. These areas are of Major Aquifer and higher standards may well apply.

3.2 Application of the Standards

As much of the groundwater in the area discharges to the surface water it is necessary to consider discharges or leaching of contaminants to groundwater in relation to their effects on the adjacent watercourse. The derivation of the standard is related to what would be acceptable as a direct discharge to the surface waters in this area and is discussed in more detail in Appendix 3. This is most appropriate in sites with a relatively high water table and close to a watercourse. In practice an amount of dilution, attenuation and retardation of many chemical species can occur within the ground. The rate at which physical or chemical or biological processes occur beneath and within any site is likely to be variable in time and space and difficult if not impossible to ascertain with any certainty without a detailed and prolonged investigation. This would need to consider the conditions within a site, and between the site and the nearest watercourse including the unsaturated and saturated zones and natural and made ground. In practice, both economic and time restraints on contractors and developers mean that it is impossible to obtain sufficient technical detail to adequately quantify such processes. It is therefore assumed that attenuation will be nil unless adequately quantified.

Thus the standards derived will apply to all the areas of the Upper Tame Catchment shown on the map regardless of proximity to watercourses. Standards will need to be tightened where there is a water abstraction nearby

but are based on what would be acceptable for a direct discharge to the watercourses in the area.

All contaminated land redevelopments and unlined landfills and uncapped landfills within the area should comply with the set standard. If they are not met the waste must be disposed of in a suitably engineered and licensed waste disposal site and not into an unlined landfill or redeposited on a contaminated site. These standards relate only to the risks to the water environment and additional controls may be necessary to ensure public health risks and other legislative controls are complied with.

The soluble trigger levels should be applied across the whole of contaminated site redevelopments whether or not material is excavated or not.

The list of contaminants within this guidance must not be considered exhaustive. If specific alternative contaminants are present on a particular site these must also be considered and advice can be obtained from the Groundwater and Contaminated Land Section or Pollution Control Sections at the addresses in Appendix 4.

Each new source of material for a landfill or new site being developed must be tested at a representative number of locations (areal and depth) to ensure the test results reflect its leachable constituents. The number of tests will vary according to the nature of the material to be tested. It is likely to be inappropriate to use a regular grid system for sampling given the variation within contaminated sites due to their origin. For instance, sampling on a regular grid on a former gas works may, for example, miss the coal tar filled gasholder and areas of 'blue billy' and only sample less polluting material. The sampling regime must reflect the site's history. A detailed desk study should always be carried out before carrying out the site investigation (DD175).

The approach is considered pragmatic and not unduly onerous on the developers, land owners and site operators in the area. There are currently only a few companies that regularly supply leachability test data to the NRA and it is hoped that this document will increase this practice. Too often NRA officers are required to assess the pollution risk of a proposal merely on the basis of soil analyses that have been related to ICRCL or Kelly tables for example. These tables do not consider risk to the water environment and are entirely inappropriate to base a consideration of water pollution risk on. A full impact assessment of the proposals on the receiving water body, either groundwater or surface water, may well be needed in addition to leachability test data. It is not appropriate to contact the NRA once contractors are on site as often happens currently.

Similar standards may be considered elsewhere in the Severn-Trent Region in the future. There is no firm programme for this and it is advisable to contact Groundwater Protection Officers at our Regional Headquarters for advice. The

address is included in Appendix 4. In many places particularly those on Major Aquifers it will be more appropriate to consider the drinking water standards for comparison with any test results. These trigger levels for the area of the Upper Tame were specifically developed as a result of the large number of contaminated sites being redeveloped need to suitable disposal facilities and the need for consistent and justifiable approach on all sites.

Further research is being carried out for the NRA on the relationship between leachability test results and receiving water quality. This document may therefore be revised in the light of this work. It is to be considered acceptable for the foreseable future though and retrospective changes would not be insisted upon by the NRA in the light of any revision part way through a construction or remediation project.

Appendix 1: NRA Recommended Leachability Test

SUMMARY NOTE
LEACHING TEST METHOD FOR THE ASSESSMENT OF CONTAMINATED LAND: INTERIM NRA GUIDANCE

Background

Land which has been used for activities such as coal gas production, chemical industries, landfill, etc, is potentially contaminated and under certain hydrogeological conditions, may pollute controlled waters (as defined in the Water Resources Act 1991).

In the normal course of events the National Rivers Authority (NRA) would request the proposed developer to conduct a site investigation, including the sampling of subsoil, surface water and groundwater, to establish the extent of contamination. In assessing the risk to the aquatic environment from the contaminated material itself, it is common practice to request leaching tests to be undertaken. These investigative measures will assist developers in assessing the need for remedial action.

The enclosed leach test method is 'NRA recommended' on a national, but interim basis; it will not be endorsed fully until validation exercises have been completed. It satisfies NRA requirements that such a test should be i) indicative of pollution potential under natural rainfall conditions, ii) simple, inexpensive and capable of rapid turnaround, and iii) compatible with leach tests which may be associated with proposed waste disposal legislation.

It is stressed that this test method is a basic test, designed to provide as much information as possible on largely inorganic contaminant leachability within certain time and cost constraints. Additional, more complex test procedures may be required in order to ascertain leachability characteristics in more detail, particularly for organics.

The use of leaching test results to assess the need for removal of contaminated ground, or remediation, is not a straight forward matter. The results cannot be compared with any set of groundwater quality standards without consideration of site specific conditions, such as the type of cover to be provided, the subsequent rate of infiltration, the nature and thickness of the unsaturated zone, the underlying aquifer properties, the dilution available and the existing groundwater quality. Such assessment needs to be undertaken by a suitably experienced hydrogeologist and should be discussed with NRA Regional staff.

The process by which the NRA recommended test was selected (following a review of all appropriate methods available) is described in R & D Note 301, entitled 'Leaching Tests for the Assessment of Contaminated Land: Interim NRA Guidance', 1994. References are given in the document. Copies may be purchased (price £5.00) from National Rivers Authority, Newcastle-Upon-Tyne-X, NE85 4ET.

SMH
March 1994

NRA

LEACHING TEST PROTOCOLS

The protocols for sample handling and preparation for the leaching test itself are presented below and as flow diagrams.

Sample handling and preparation protocol

1. Sampling: the quality of the data is dependent on the collection of representative samples both on site and at each sub-sampling stage. In terms of sample site selection, current guidance issued by the British Standards Institution should be followed (DD175,1988). During sampling, large inert material eg flints should be discarded and the quantity of sample reduced on site, preferably by coning and quartering[1].

   The sample should be returned to the laboratory in a sealed container. Consideration should be given to the quantity of sample needed for the range of contaminants of interest. It is likely that at least 2 kg of sample will need to be collected.

2. Particle size reduction: to minimise sample handling (to avoid risk to personnel and cross-contamination) do not dry or sieve the samples. Inert material such as stones, should be removed and their percentage recorded.

   Size reduction should be carried out on oversized material only ie material >5 mm. Carefully disaggregate oversized material with a disposable spatula or gently grind manually, to a particle size of approx 5 mm. On no account should the material be finely ground. Samples containing particles smaller than 10 mm, but larger than 5 mm can be tested as such, when the fraction larger than 5 mm does not exceed more than 10% of the total weight.

   After size reduction the size-reduced and the original material less than 5 mm is mixed to reconstitute the sample for testing.

3. The material should be coned and quartered and three portions selected from the same quarter for the following purposes:

   a) Leaching test, see below.

[1]Coning and quartering: a straight edged stick at least as long as the mound of material is used to spread the material and gently divide the pile into quarters. Opposite quarters are discarded, taking care to avoid damage to the solid particles due to excessive pressure on the yardstick. The pile is mixed and flattened and the process repeated until the required sample volume is obtained (ASTM 1973 and 1985).

b) Soils analysis: it is recommended that the number of samples for "totals" analysis equate to at least 30% of the final number submitted for leaching tests. Where appropriate, place sample in individual sample pots and submit for "totals" analysis.

c) Moisture content: dry 100 g samples at 105 $\pm$3°C until no further weight loss is observed and record moisture content. (The material for use in the leaching test is not dried).

4. If the soils are saturated, submit free-draining liquid for analysis.

Leaching test protocol

1. Fill a container with sufficient deionised or distilled water to carry out entire leaching test. Leave to stand overnight ie do not use straight from cylinder or still. Carbonate equilibrium should be attained overnight and the pH will be approximately 5.6; no pH adjustment is required.

2. Place 100 g of sample at natural moisture content (i.e. not dry weight equivalent) into flask of appropriate volume (1.5 or 2 litres). Record exact weight of sample.

3. Check leachant pH and add 1000 ml to flask.

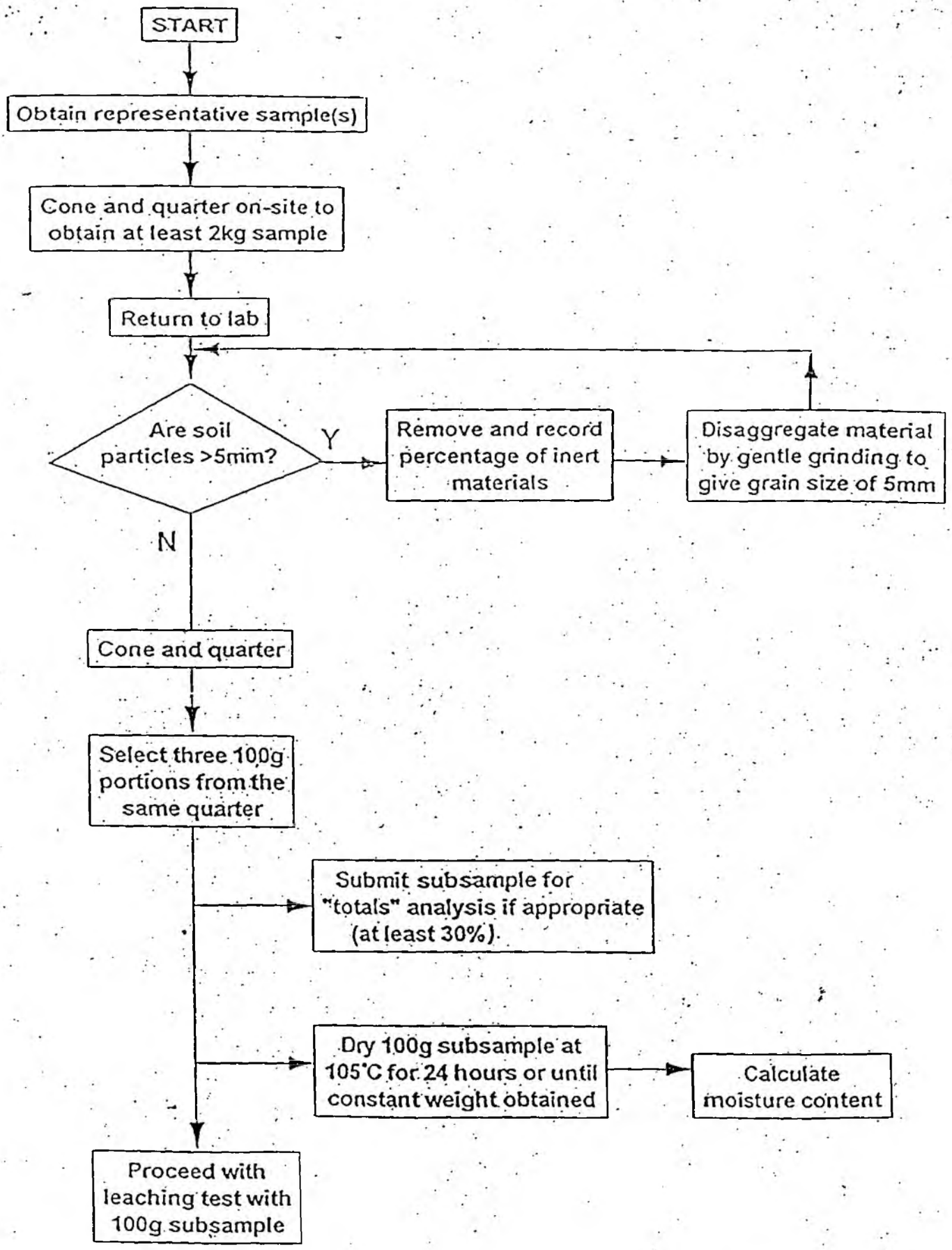
4. Prepare one "blank" sample of leachant per batch of samples. Add 1000 ml leachant to a flask without a soil sample and then process (ie follow steps 5-8) as for all other samples.

5. Agitate flask and contents for twenty-four hours. It is important that the agitation is neither too aggressive to cause particle abrasion nor too gentle that settling of the solid material in the flask occurs. Any method of agitation may be used (eg end-over-end shaker, orbital shaker at 100 rpm) as long as it fulfils these criteria.

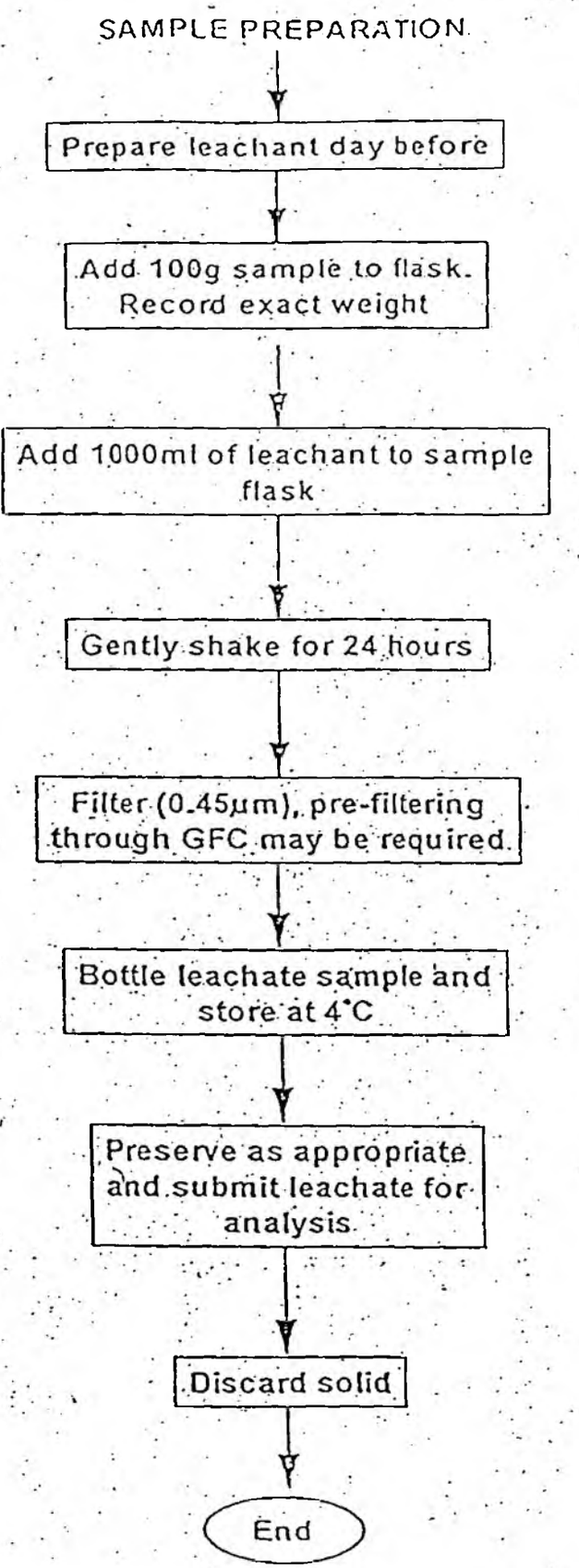
6. Remove flask from the shaker, and leave contents to settle for 15 minutes. Filter liquid through a membrane filter of 0.45 μm pore-size, with a glass-fibre GFC pre-filter (1.2 μm pore size) if required; do not rinse the filter. A vacuum or pressure-filtration system may be used.

7. Pour the filtered leachate into bottles, add preservatives as appropriate and store at 4°C in dark until ready to be submitted for analysis.

8. Discard solid material and filters.



Sample preparation prior to leaching test



Leaching test procedure

Equipment and Reagents

The following experimental details are given in the CEN TC 292 Working Group 2 document and relate to the "European Leaching Test for Granular Waste Materials", Third Draft, 26 May 1993. These recommendations should be followed as far as possible:

- Bottles of glass or polyethylene according to ISO6567 (part 3) normally with nominal volumes of 500 to 2000 ml. For inorganic constituents polyethylene bottles are preferred, except for samples analysed for mercury. Polypropylene bottles may be used instead of polyethylene.

- An end-over-end tumber or rollertable rotating at about 10 rpm are the preferred devices for the extraction. (Note: WRc recommend orbital shaker at about 100 rpm.). Other shaking or mixing devices can be used provided that during the test, material to be leached remains in good contact with the leachant (no settling in the bottle).

- Filtering apparatus, if necessary vacuum filtration device (between 2500 - 4000 Pa) or a high pressure filtration apparatus.

- Device for measuring electrical conductivity, see method DIN 38 404 - C8.

- pH meter, eg as in DIN 19 261.

- Pt electrode for measurement of redox potential (optional).

- Balance with accuracy of at least 0.1 g.

- Pre-rinsed membrane filters for filtration (eg rinsing with 0.1 N HNO_3). The filter material should be inert (eg PTFE), or compatible with the test material.

- Measuring cylinders for volume determination with 1% accuracy.

- Any reagents used shall be of analytical grade.

- Distilled water or water of equivalent purity with a conductivity <0.5 mS/m. (Note: WRc note that deionised and distilled water will equilibrate to a similar pH (see section 4.2) if left overnight; since the leachant is unbuffered, either distilled or deionised water may be used.)

- (Note: it is Good Laboratory Practice to run blanks of reagents and solutions used in this type of testing.)

Analysis

The laboratory selected to analyse the soils and leachates should offer standard methods of analyses which conform to recognised techniques (eg SCA, BS, ASTM, USEPA). The analytical laboratory should be certified by a third party accreditation scheme such as NAMAS (National Measurement Accreditation Service). Accreditation provides independent assurance of a laboratory's capability of working to national specifications.

The appropriate analytical method should be selected with the laboratory prior to sampling, as the choice of method will affect the sample preparation procedures, eg preservation, and the volume of sample required.

It is not appropriate to stipulate specific analytical methods here. General Criteria of Competence for Calibration and Testing Laboratories are specified by NAMAS (1989) including:

> "the laboratory shall use appropriate methods and procedures for all tests and related activities within its responsibility. (including sample handling, sample storage and transport...). They shall be consistent with the accuracy required and with any standard specifications relevant to the calibration and tests concerned."

The data from the leaching tests shall be expressed in two forms:

- mg contaminant per litre of leachate
- mg contaminant leached per kg of soil at natural moisture content.

The first case is useful for the interpretation of regulatory test procedures where the leachate concentrations are compared with water quality standards, as appropriate. However, a more relevant measure for environmental assessment tests is concentration of leachable contaminant per kilogram sample. Conversion to this measure is necessary for the direct comparison of leaching test results derived from different tests, as an allowance is made for the weight of sample and the volume of leachant used.

Conversion to mg kg^{-1} leached contaminant:

$$\text{mg kg}^{-1}\text{ leached contaminant} = \text{leachate concentration (mg l}^{-1}\text{)} \times \frac{1000\text{ g}}{\text{Sample weight (g)}} \times \frac{\text{leachant volume (ml)}}{1000\text{ ml}}$$

The results relate only to the contaminated portion of the sample.

The percentage of "inert" material that was in the original sample (removed prior to conducting the leach test) should be recorded with the test results, but unless this constitutes a significantly high proportion (greater than 25%) it would not normally be taken into account in any interpretation. Any correction for moisture content would normally only apply to sludges and slurries.

Appendix 2: Map of Area Concerned


WALSALL
DUDLEY

APPENDIX 3

The Standards and their derivation

The standards below are to apply to the results of leachability tests carried out on a representative number of samples from each source of material to be deposited or redeposited. If they are not met material must be disposed of in a suitably licensed and engineered landfill and not in an unlined landfill or construction site.

In drawing up these values consideration has been given to the known groundwater and surface water qualities in the area in addition to EC Directives and statutory water quality in relation to fisheries and drinking water and discharges to groundwater. The Working Environmental Quality Standards used by the NRA to consent discharges and play a major role in the final standards.

The source or sources of each standard are given in the attached table. In some cases the relevant source of reference does not specify particular figures but merely highlights the pollution potential of the substance. In other cases, various standards are set in relation to different types of fisheries for instance and the appropriate one for the Tame is considered. Substances contained in List 1 of either Surface Water or Groundwater Directives have far tighter standards than those in List II for example due to their toxicity.

This list is not exhaustive and other parameters may need to be added to characterise particular source material depending on the type of contamination likely to be present. The list is intended to give an indication of the main inorganic pollutants and an idea of the total organic content of the material.

The values reflect the requirement of both fisheries and needs for abstraction from the watercourses and assume that dilution of such a discharge would occur in the watercourse itself.

Leachability Trigger Levels for Upper Tame Catchment

DETERMINAND	NRA PROPOSED	DATA SOURCE
Ammoniacal Nitrogen (mg/l)	5	Nda
Chloride (mg/l)	400	N#ad
Sulphate (mg/l)	250	NS
Free Cyanide (mg/l)	0.1	ANSd
Phenols (mg/l)	2	aNEd
P.A.H. (ug/l)	40	aCDd
Oils/Hydrocarbons (ug/l)	600	AC
BOD (mg/l)	25	NR
COD (mg/l)	125	N
Chromium (ug/l)	250	aNdn
Copper (ug/l)	100	aNdn
Nickel (ug/l)	200	aNdn
Zinc (ug/l)	500	aNdn
Lead (ug/l)	250	aNdn
Cadmium (ug/l)	5	ANDQ
Mercury (ug/l)	1	ANDQ
Arsenic (ug/l)	50	aNdn

\# Taken from The Water Supply (Water Quality) Regulations (1989)
A List 1 under EC Groundwater Directive (80/68/EC)
a List 2 under EC Groundwater Directive (80/68/EC)
D List 1 under EC Dangerous Substances Directive (76/464/EC)
d List 2 under EC Dangerous Substances Directive (76/464/EC)
C Derived from Dutch 'C' value for groundwater
n National Environmental Quality Standards for List 2 substances. DoE Circ. 7/89
R Royal Commission Standard (95%ile)
N NRA working standard for discharges to surface water in this area
S Surface Water Abstraction Directive standards, from Stat. Inst. No 1148, 1990 (DW3)
E European Inland Fisheries Advisory Commission (Coarse fishery standard)
Q Statutory instrument 1990 No 2286; Statutory Environmental Quality Standards for List 1 substance

NB It is recognised that many other substances with set limits may be present, particularly Red List and List I and II substances. These must be considered on a site by site basis. If all the above levels are met, there may be other substances that are of concern.

APPENDIX 4

NRA Contacts within Severn-Trent Region

1. Groundwater quality, groundwater protection contaminated land and waste disposal matters.

Groundwater and Contaminated Land
NRA Severn-Trent Region
Sapphire East
550 Streetsbrook Road
Solihull
B91 1QT

Tel : 021 711 2324
Fax : 021 711 5824

2. Pollution control, surface water quality, discharge consents etc. contact Pollution Control Section at :-

(a) Upper Trent Area (including Upper Tame catchment)

Sentinel House
Wellington Crescent
Fradley Park
Lichfield, WS13 8RR

Tel : 0543 444141
Fax : 0543 444161