5. TIER 1 SCREENING CRITERIA

RISKS TO HUMAN HEALTH

In March 2002, The Environment Agency have published the results of research into the long-term risks to human health posed by contaminated land (Ref 5). The Contaminated Land Report (CLR) series of documents have been produced to provide relevant, appropriate, authoritative and scientifically based information and advice on the assessment of risks arising from the presence of contamination in soils. This material can be used to support the application of statutory regimes addressing land contamination, particularly Part IIA of the Environmental Protection Act 1990 and development control under the Town and Country Planning Acts, and effectively supersedes the ICRCL.

The research uses the CLEA (Contaminated Land Exposure Assessment) model to evaluate the risk to human health from contaminates via different pathways for a range of land use scenarios. The Soil Guideline Values (SGVs) are intended to provide a means of assessing chronic risks to human health, and are dependant on exposure in the context of a specified land use, in accordance with the 'suitable for use' approach and do not alter the assessment of risk to other environmental receptors (groundwater, surface water, flora, fauna, etc) or to acute risks to health. To date, guideline values have been set for nine contaminants – arsenic, cadmium, chromium, lead, nickel, mercury, selenium and cyanide with benzo (a) pyrene and phenol soon to follow.

SGVs have currently been derived for the following land uses:

- Residential with or without plant uptake
- Allotments
- Commercial / Industrial

and are also depend on a number of assumptions (for example, relating to the soil conditions (pH of 7 and organic carbon content of 2%), the particular behaviour and type of pollutants the existence of pathways, the land use patterns and the availability of receptors. Where the SGVs have been designed for a land use appropriate to the site being assessed, and the distribution of contaminants has been characterised, the CLR reports recommend the use of statistical tests to estimate the US95 an estimate of the mean soil concentration which the actual mean soil concentration should be below 95% of the time and to use this for comparison with the SGV.

In the absence of SGV guidelines being available for particular parameters, guidelines produced by the Dutch Government (ref. 6) have been used for comparative purposes. Although this Guidance is specific to conditions in Holland, it is often used elsewhere in Europe, including the U.K. as a useful indicator of relative concentrations of contamination. The guideline values have been defined for both soils and groundwaters by the Dutch government research agency (RIVM) using a toxicological risk-based approach (i.e based on determining the maximum tolerable risk from available toxicity and exposure data). The Guidance takes into account the risk to the ecosystem as well as risks to human health. The guidance defines target and intervention values as follows:

- A Target Value – which represents the "background" concentration and can be considered the ultimate level of soil quality which any remediation should seek to achieve;
- An Intervention Value, which if exceeded suggests that there is a potential threat to the environment. In Holland, if measured concentrations exceed the Intervention Value, it is recommended that some form of remediation, or as a minimum, further risk assessment, is undertaken to determine the actual degree of risk.

For U.K. sites where contamination is present at concentrations above Dutch Intervention Values this would normally indicate that contaminants are present at above "background" levels, and probably at potentially significant concentrations. Therefore, in the absence of U.K. or site specific threshold values, the comparison of site data with the Dutch Values (Ref. 6) is an appropriate first

step in the determination of the potential significance of ground and groundwater chemistry. Where either CLEA SGVs or Dutch Values do not exist for a sampled parameter then Enviros Screening Values (ESVs) have been used as a reference. These are based on generally accepted guidelines developed for Tier 1 screening.

In the absence of a CLEA guideline value for Total Petroleum Hydrocarbons (TPH) the Dutch Intervention Value of 5,000mg/kg for mineral oil has been used for comparison purposes. The Dutch guidelines also produce Intervention Values for each of the BTEX compounds (benzene, toluene, ethylbenzene and xylene), which have also been used for comparison.

GROUNDWATER AND SURFACE WATER

A methodology has been developed by the Environment Agency to derive remedial targets for soil and groundwater in order to protect water resources (Ref 7). This outlines the different levels or tiers of assessment that can be undertaken. Although primarily aimed at deriving remedial targets for site remediation, the methodology also predicts the impact on water receptors for a given set of site conditions.

The first stage of the assessment (Tier 1) is carried out by comparing measures or estimates of the concentration of contaminants in the soil pore water with the guidelines acceptable in the target water resources. Further stages consider dilution of infiltrating water in the Aquifer (Tier 2) and then more complex processes such as attenuation or degradation (Tier 3 and 4). The initial Tier 1 assessment is thus used as a screen to determine which if any of the soil contaminants could potentially pose a problem or not.

For the Tier 1 assessment leachate and groundwater concentrations have been compared with the UK Drinking Water Standards (Ref. 7). Where these are not available Dutch Intervention values have been used.

STATISTICAL ANALYSIS

Having established that the CLEA guideline value relates to chronic exposure, and hence the mean concentration of contamination in the soil, the next step is to determine if the mean concentration of contamination in the soil exceeds the CLEA Soil Guideline Value (SGV) as defined in CLR 9.

To measure the mean concentration in soil, soil samples are taken in a distribution ideally similar to that the receptor will intake, although this is rarely known. We will then measure the concentrations in the soils sampled.

As a crude approximation we could then calculate the mean concentration of these samples. This would provide an estimate for the mean concentration of the contaminant in the soil. However, this ignores information about the variability of the contaminant in these samples and thus the variability that is likely in the ground. We are not using the data to its full potential. Additionally there is no built in caution that we may have underestimated the mean.

If the data we get is fairly symmetric and looks normally distributed, we can use the mean value test (which is also called the t-test). This is better than just using the mean as it uses information about how variable the data is. This is the approach suggested in CLEA.

This test derives from CLR7, but can also be used to comparing soil data against other guidelines values, e.g. DIVs. It assumes that the for small sample sets data follow a normal distribution. If the data does not follow a normal distribution, either you need a large number of samples or consider other tests (these are beyond the scope of this note).

In order to estimate the mean concentration in the soil from the mean concentration in the samples we need to calculate the upper bound value (US95) of the average sample values. The US95 is a value that the actual average soil concentration will be below 19 times out of 20 (95% of the time). The upper bound value is then compared to the relevant guideline value. If there are outliers present, these need to be eliminated before using the mean value test.

The formula used to calculate the US95 is as follows:

$$US_{95} = \bar{x} + \frac{t.s}{\sqrt{n}}$$

The US95 tends to decrease as you take more samples (providing the data is similar). As the number of samples (n) increases so the term ts/√n decreases. In addition, t decreases as the number of samples decreases. This means that the more samples analysed, the better the estimate of the actual mean soil concentration, and hence the reduction in uncertainty (expressed in the term ts/√n).