

Development of Remediation Targets for Contaminated Land

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Remediation on Nuclear Sites – The Decision Making Process
Birmingham, 7 October 2009



Overview

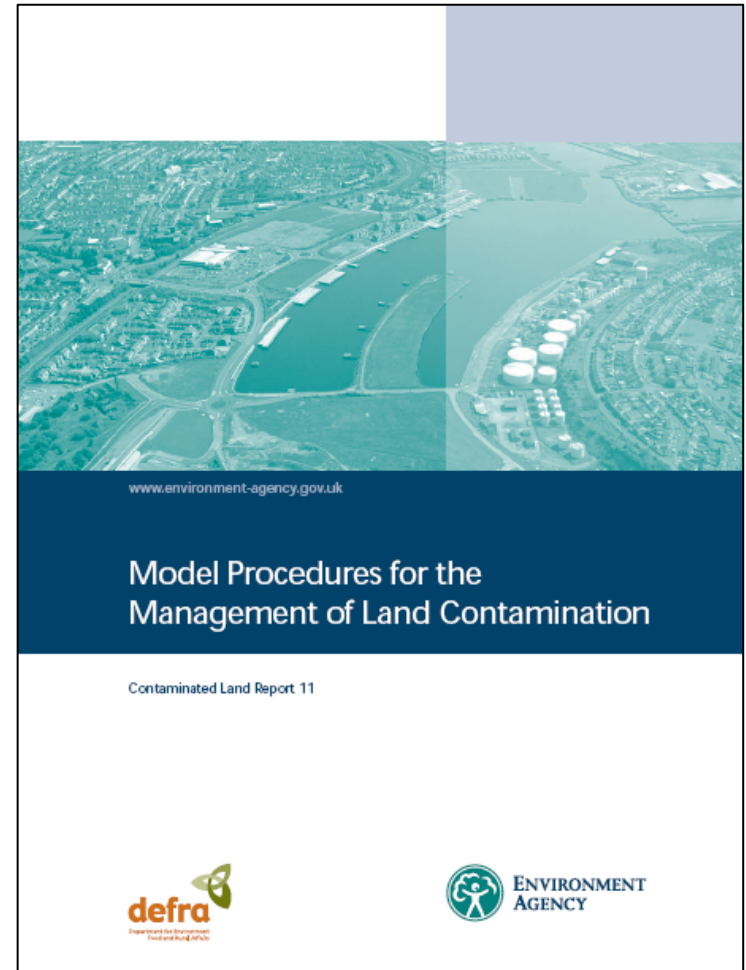
- Framework for managing the decision-making process
- Risk assessment guidance
- Risk assessment models
- Assessing significance of risks

Contaminated Land Decision-Making Framework



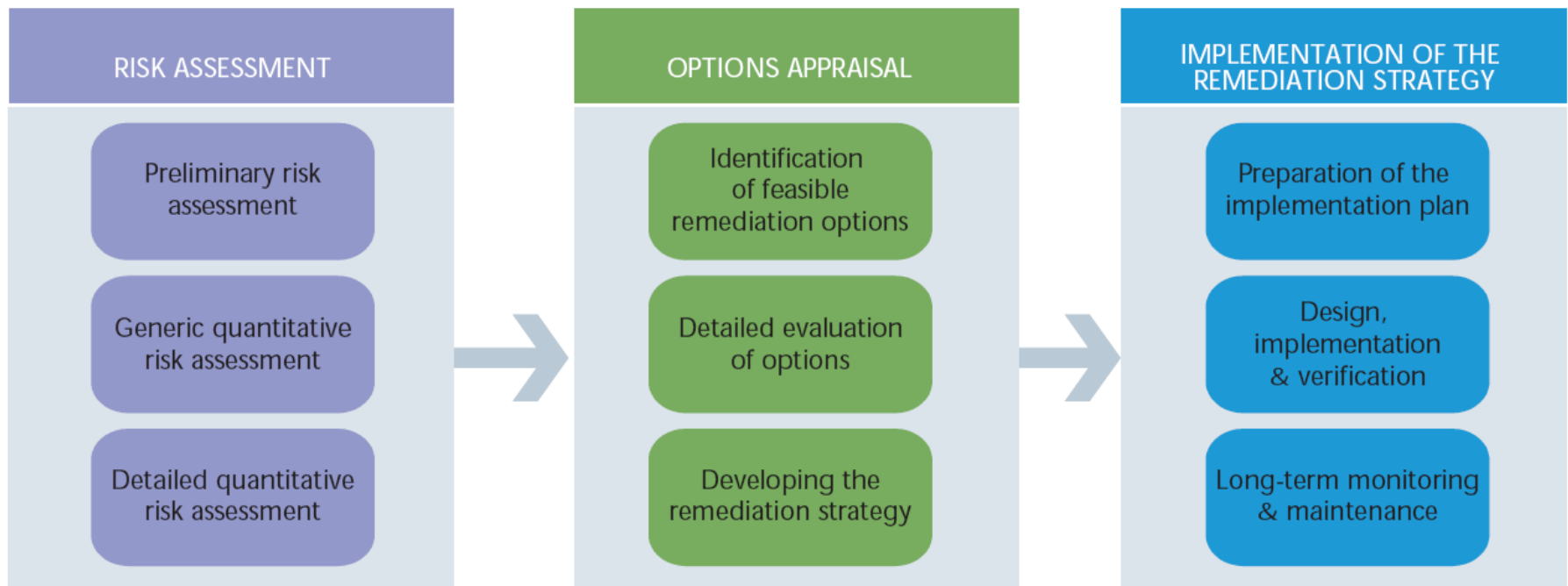
CLR11 Model Procedures

- Structured framework for applying risk management process when dealing with land affected by contamination
- Consistent with UK government policies and legislation
- Recognised by all UK environmental regulators
- Applicable across range of non-regulatory and regulatory contexts, including
 - Planning Regime
 - Part 2A
 - Voluntary investigation and remediation



Components

- Comprises 3 components applied iteratively:
 - Tiered risk assessment to evaluate source-pathway-receptor linkages
 - Options appraisal
 - Implementation

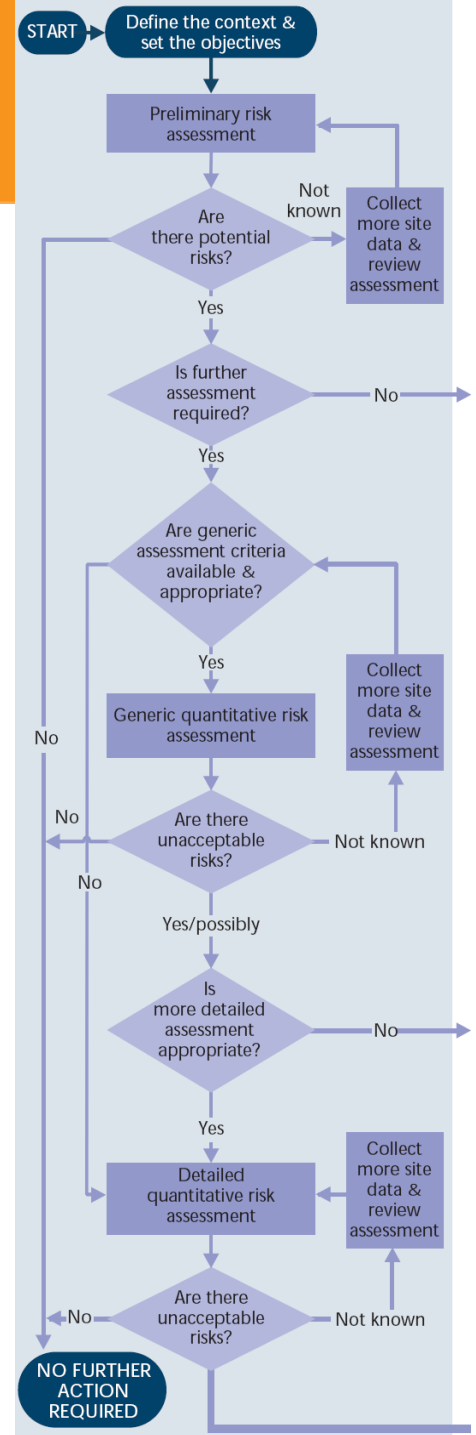


Risk Assessment (1)

- Structured assessment using site-specific data, enabling cost effective decisions based on specified end-use of the land
- Framework allows for evaluation of uncertainties and factors such as costs and benefits
- Tiered approach:

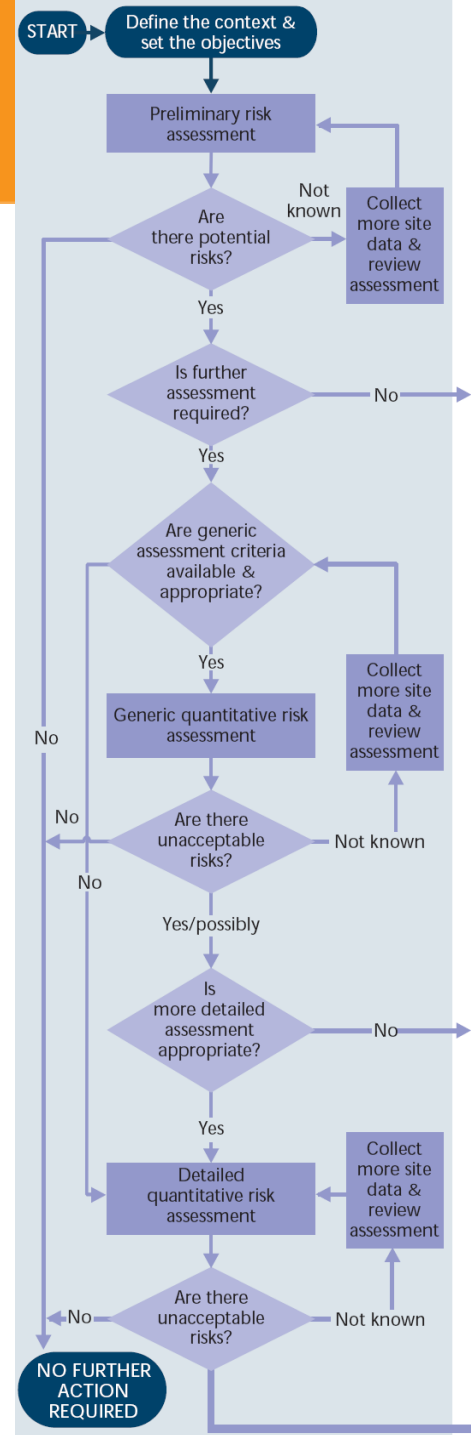
Increasing detail

Tier 1 – Preliminary risk assessment	Determination of context and objectives for risk assessment, development of outline conceptual site model and identification of potential risks
Tier 2 – Generic quantitative risk assessment	Uses generic assessment criteria derived using conservative assumptions regarding characteristics and behaviour of sources, pathways and receptors
Tier 3 – Detailed qualitative risk assessment	Uses site-specific information on the characteristics and behaviour of contaminants, pathways and receptors that correspond to relevant criteria in relation to harm or pollution

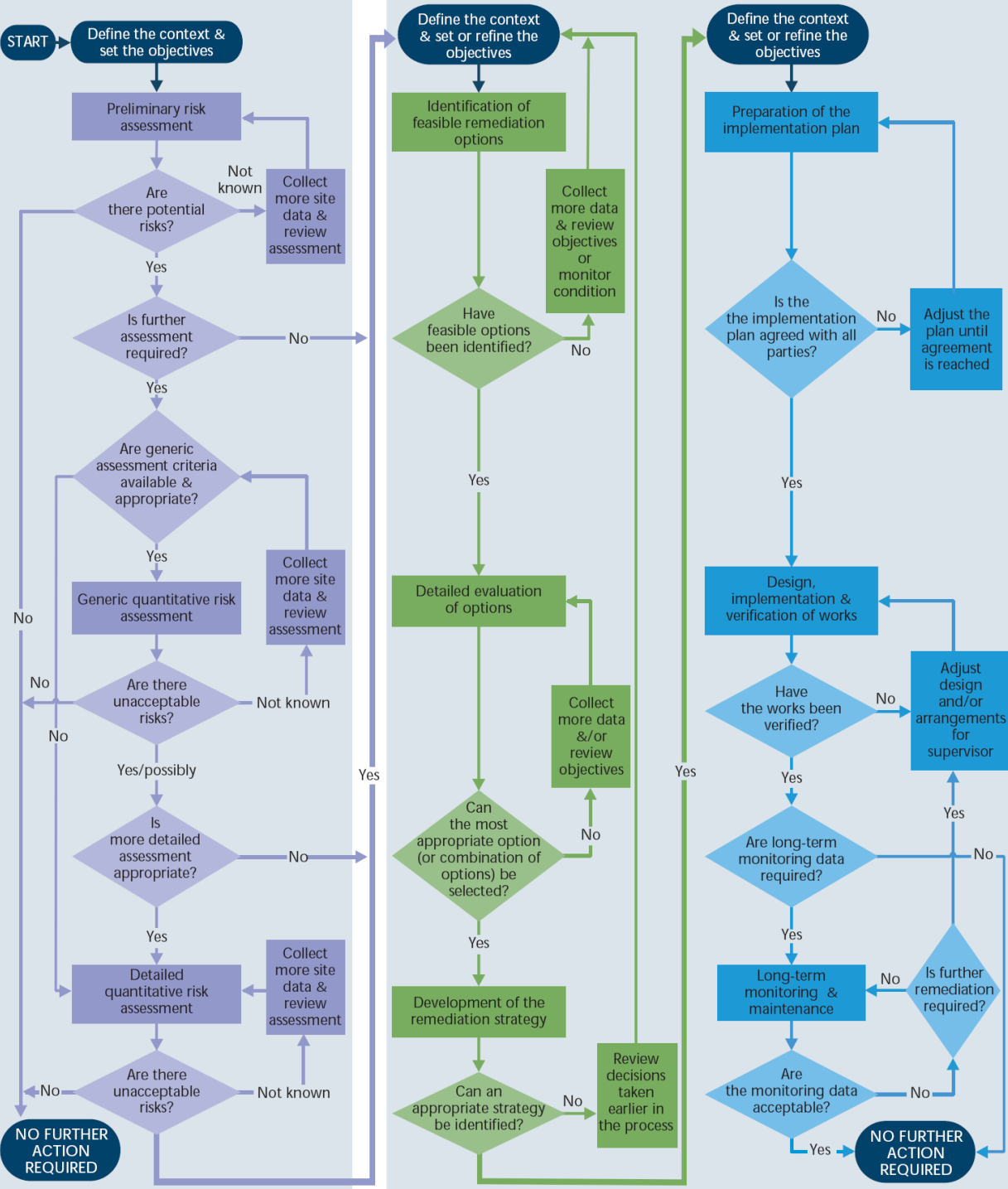


Risk Assessment (2)

- Within each tier:
 - Assessment may be applied separately for some or all pollutant linkages
 - Assessment may be iterative or process revisited in the light of new findings
 - Process may be terminated, e.g. if no unacceptable risk identified, or to proceed straight to remediation
- Following each tier:
 - Conceptual site model updated
 - Options appraisal conducted if action is required to reduce or control risks, followed by implementation of appropriate actions (which could be to undertake more detailed assessment or undertake remediation)



Options Appraisal and Implementation of Remediation Strategy



Risk Assessment Guidance



Risk Assessment Guidance

- CLR11 references a number of documents giving guidance for conducting different types of risk assessment
- Many have been revised or superseded since CLR11 was published in 2004, and some new guidance documents have been published
- The following slides give a brief overview of some of the main guidance documents currently available

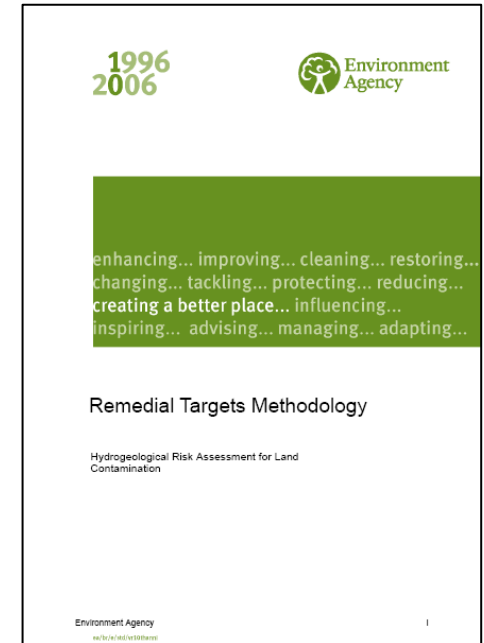
Human Health Toxicological Assessment

- EA Science Report Final SC050021/SR2 published in 2009 – replaces CLR9
- Technical guidance for Part 2A and planning regimes
- Framework for collation and review of toxicological data and its use in derivation of soil contaminant intakes (Health Criteria Values, HCVs) that are protective of human health
 - Non-radiological contaminants only
 - Methodology for deriving Tolerable Daily Intake (TDI) levels for threshold contaminants
 - Methodology for deriving Index Dose (ID) for non-threshold contaminants (e.g. carcinogens)
- HCVs should be derived for each potential exposure route (e.g. oral, inhalation)
- Framework for derivation of Soil Guideline Values (SGVs) for threshold and non-threshold contaminants
 - Can be used to assess contaminants for which no UK HCVs have been published
 - Significant harm unlikely if exposure is less than HCV or SGV; *however*
 - Exceedence of HCV or SGV does not necessarily indicate SPOSH – more detailed assessment required



Hydrogeological Risk Assessment

- Remedial Targets Methodology published by EA, SEPA & NIEHS in 2006 – replaced P20 & SEPA 2001 guidance
- Methodology for deriving site-specific remedial objectives for contaminated soils and/or groundwater to protect water environment
- Applicable for assessments under Part 2A, water pollution legislation, planning regime and voluntary remediation
- Procedure (applied iteratively):
 - Develop conceptual site model
 - Identify compliance point
 - Determine target concentration at compliance point, depending on current and potential use of water resources
 - Assessment to determine whether contaminant source likely to result in exceedance of target concentration at compliance point
- Tiered assessment:
 - Level 1 (soils only) – pore water/leachate concentration compared directly with target concentration
 - Level 2 – takes account of attenuation in soil and unsaturated zone and dilution by groundwater beneath site
 - Level 3 – takes account of attenuation between site and downgradient receptor or compliance point
 - Level 4 (where appropriate) – takes account of dilution in receiving watercourse
- Remedial target calculated by multiplying target concentration by Dilution Factor and Attenuation Factor. Measured soil or pore water concentration compared with remedial target to determine need for remediation
- Following each level, decision whether to remediate or undertake more detailed assessment, which reduces conservatism but increases sophistication of model and data requirements



RCLEA Methodology

- Defra's recommended approach for assessment of radioactively contaminated land under Part 2A
- Largely complements CLEA
- Considers 47 radionuclides (including short-lived daughters) and/or combinations
- Considers generic exposure scenarios:
 - Residential (\pm consumption of home-grown produce)
 - Allotments
 - Commercial/industrial
- Can be used as screening tool using generic exposure parameters
 - Calculation of doses from given concentrations of radionuclides in soil
 - Derivation of RSGVs (radionuclide concentrations corresponding to regulatory dose criteria)
- Key limitations:
 - Contamination assumed to be uniformly distributed in soil to depth of 1m. Cannot consider buried contamination or discrete artefacts
 - Excludes volatile contaminants and skin absorption pathways
 - Excludes exposure from radon
 - Excludes groundwater migration pathway
 - Cannot assess mixed radioactive and non-radioactive contamination



Using RCLEA - the Radioactively Contaminated Land Exposure Assessment Methodology



The Radioactively Contaminated Land Exposure Assessment Methodology - Technical Report

CLR-13
Draft

CLR-14
Draft 1.1

December 2006



Human Radiation Dose Assessment

- HPA methodology for estimating doses to members of the public, published 2003
- Describes general methodology for assessing doses and risks from radioactively contaminated land
 - 36 most common radionuclides (including short-lived daughters) considered
 - Scenarios considered include exposed, buried, uniform and patchy contamination distributions
 - Pathways considered are external irradiation, internal exposure from radionuclides associated with soil (via inhalation and ingestion) and from ingestion of contaminated foods, water and fish
- Methodology applicable to assess risks from current use (intervention situation) and redevelopment (practice situation)
- Used methodology to calculate annual effective dose per unit activity concentration in soil for generic exposure scenarios (Agriculture, Recreation, Construction, School, Industrial, Housing and Hard Cover)
 - Results tabulated for dominant age group and exposure pathway
 - Tables may be used for generic assessment by scaling-up tabulated values to actual inventory present
- General methodology may also be applied to undertake site-specific assessments
- Results can be used to derive remedial targets for concentration of radionuclides which will give a predetermined dose criterion



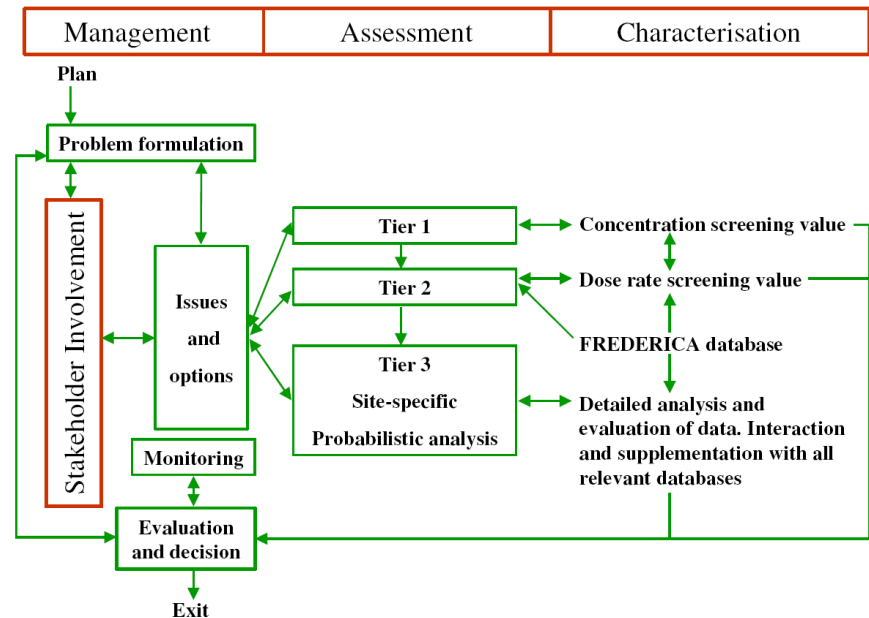
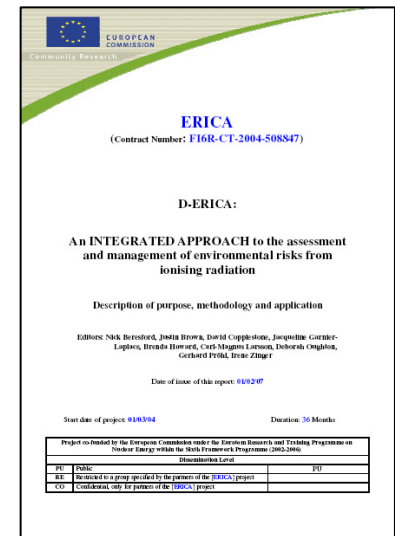
Ecological Risk Assessment

- EA Science Report SC070009/SR1, published 2008
- Structured framework for assessment of risks to ecology from chemical contamination in soil
 - Does not consider radionuclides nor water contamination
- Primary purpose is for assessment under Part 2A, but also applicable under other regimes e.g. conservation, planning & pollution control
- Tiered approach based on identification and assessment of source-pathway-receptor linkages:
 - Tier 1 – screening assessment based on comparison of site soil contaminant concentrations with Soil Screening Values (SSVs)
 - Tier 2 – uses choice of tools (ecological survey & biological testing) to provide evidence for harm to receptors
 - Tier 3 – seeks to attribute harm to the chemical contamination
- Separate document (Science Report SC070009/SR2b) provides guidance on derivation and use of SSVs – concentrations of chemical contaminants in soils below which there are not expected to be any adverse effects on wildlife or microbial function of soil
 - UK SSVs published for 12 substances, based on EC technical guidance
 - US EPA, Canadian, Oak Ridge Laboratory and RIVM guidance suggested as sources of alternative screening criteria for other contaminants



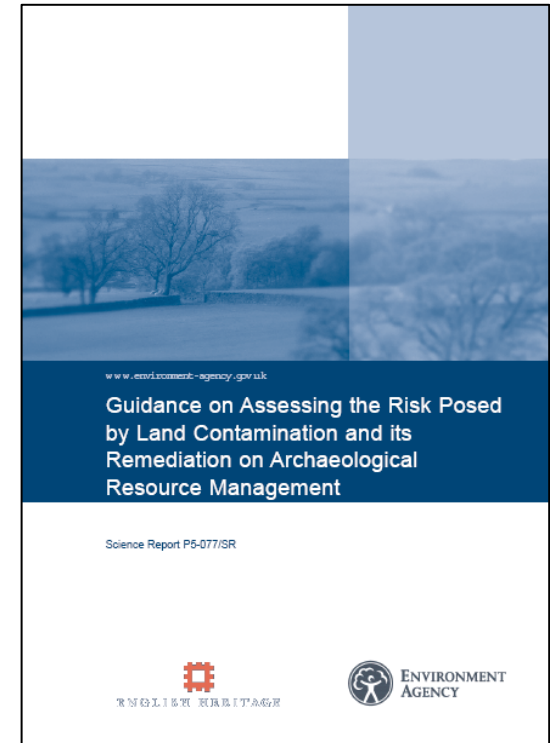
Assessment of Environmental Risks from Radioactivity

- Environmental Risk from Ionising Contaminants: Assessment and Management (ERICA) methodology (2007)
- Integrated framework for decision-making - recognised as “good practice” for radioactive substance habitat assessments by EA
 - Problem formulation – consideration of ecological, political & societal issues
 - Tier 1 assessment – simple screening assessment requiring minimal data
 - Default screening criterion is incremental dose rate of $10 \mu\text{Gy h}^{-1}$ for all ecosystems and organisms
 - Screening dose rate back-calculated to yield Environmental Media Concentration Limits (EMCLs) for all reference organism/radionuclide combinations
 - Exit assessment after Tier 1 if most restrictive EMCL for each radionuclide not exceeded
 - Tier 2 – site and organism specific assessment. Evaluation performed directly against screening dose rate
 - Tier 3 – probabilistic risk assessment using detailed site information and most recent biological effects data



Archaeological Risk Assessment

- EA and English Heritage guidance on assessing risk posed by land contamination and its remediation on archaeological resources
- Addresses requirements for assessment under Part 2A and planning regimes
- Follows risk-based approach underpinned by source-pathway-receptor framework, represented by conceptual site model which is refined as the assessment proceeds
 - In addition to being a receptor, archaeological resource may itself be a contamination source or a pathway
 - Impact of remedial works on archaeological resources also considered
- Part 2A:
 - Only applies to ancient monuments with Statutory designation
 - “Significant harm” defined as substantial damage to features by reason of which monument was scheduled
 - SPOSH defined as “likelihood of significant harm resulting from the pollutant linkage for the foreseeable future”
- Planning regime:
 - Applies to land contamination and archaeological resources in their widest sense
 - Guidance gives considerable discretion to Planning Authority in assessing potential impacts and specifying precautions



Assessment of Risks to the Built Environment

- EA published generic guidance in 2001 on assessment and management of risks to buildings, building materials and services from:
 - Aggressive substances
 - Combustible materials
 - Expansive slags
 - Unstable fills
- Does not cover risks from explosive gases or vapours, for which other guidance exists
- Intended for use where new construction planned; materials must be selected for remedial works; or buildings, materials and services already exist
- Phased risk assessment based on source-pathway-receptor analysis to build and refine conceptual site model:
 - Phase 1a Initial hazard identification based on desk study, site reconnaissance and/or limited sampling
 - Phase 1b More detailed hazard identification, usually through additional desk study and site investigation
 - Phase 2 *Risk estimation*, usually following detailed site investigation, using appropriate assessment criteria (mostly qualitative). Published criteria are listed (NB some now superseded)
Risk evaluation to determine whether remedial measures required
- Guidance is given on risk management strategies

**Assessment and Management of Risks
to Buildings, Building Materials and
Services from Land Contamination**

R&D Technical Report P5-035/TR/01



Risk Assessment Models



Risk Assessment Models

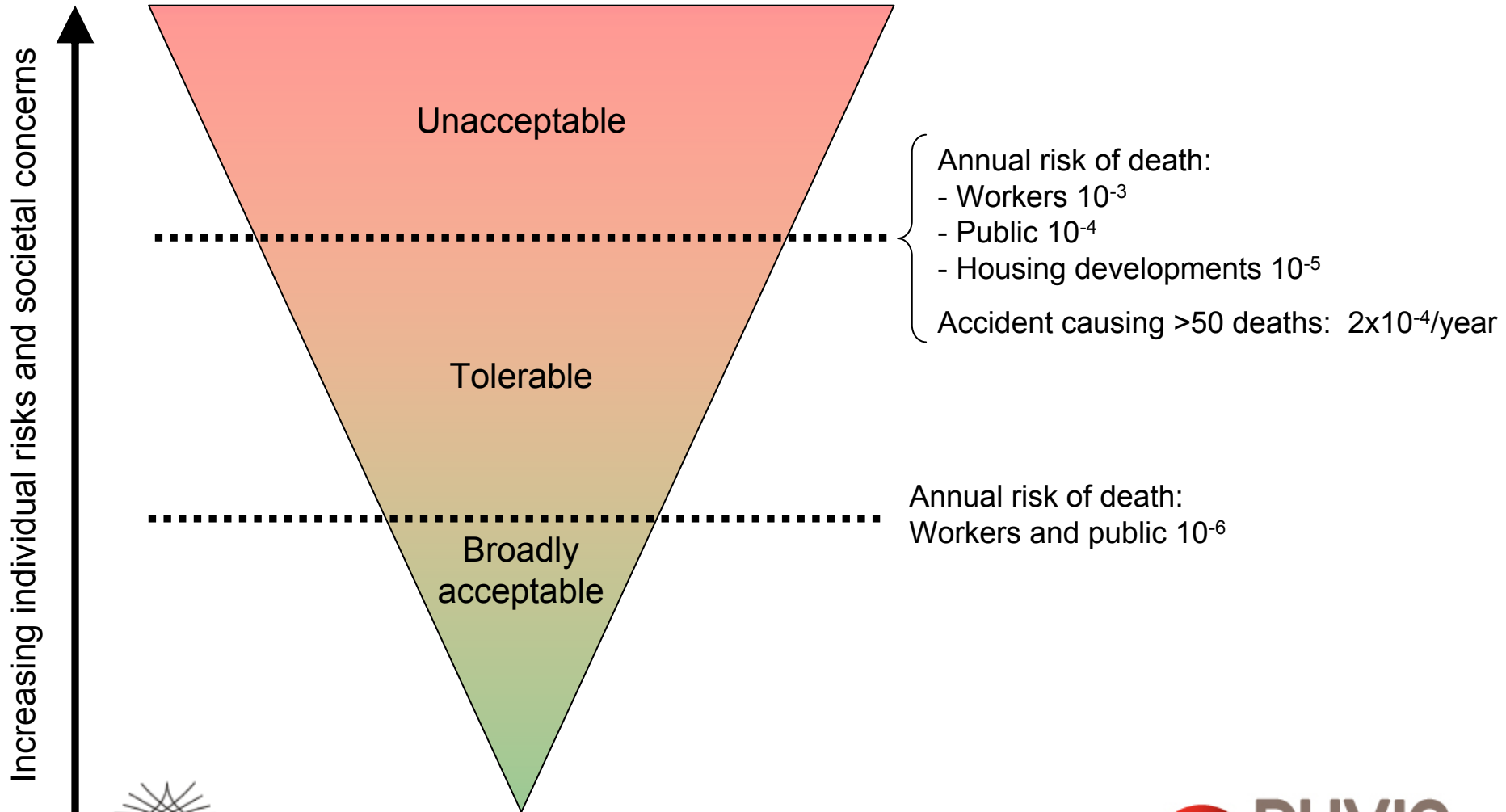
- CLEA model v1.04 (Excel)
 - Deterministic model for generic or site-specific assessment of human health risks from non-radioactive contaminants
 - Can be used to derive SGVs for use in *screening* assessments
- RCLEA model v2 (Excel) (CLR15)
 - Deterministic model for generic or site-specific assessment of human health risks from radioactive contaminants (complements CLEA)
 - Can be used to derive RSGVs for use in *screening* assessments in England & Wales (use with caution in Scotland since model does not account for risks to non-human species or water environment)
- Hydrogeological risk assessment using EA Remedial Targets Methodology
 - EA Remedial Targets Worksheet v3.1 (Excel)
 - Deterministic. Calculates soil remedial targets at Level 1, 2 or 3, and Level 3 groundwater remedial targets
 - ConSim
 - Probabilistic. Level 1, 2 and 3 assessments for soils, Level 2 and 3 assessments for groundwater, and combined soil and groundwater analyses
- ERICA assessment tool v1.0 May 2009
 - Deterministic (Tier 1 and 2) and probabilistic (Tier 3) model for assessment of environmental risks from ionising contaminants
- Numerous other models are available !

Assessing Significance of Risks



Assessing Significance of Risks

HSE Tolerability of Risk Framework



Questions?

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