Network Rail

CONTAMINATED LAND TECHNICAL MANUAL

NR/TM/ESD001

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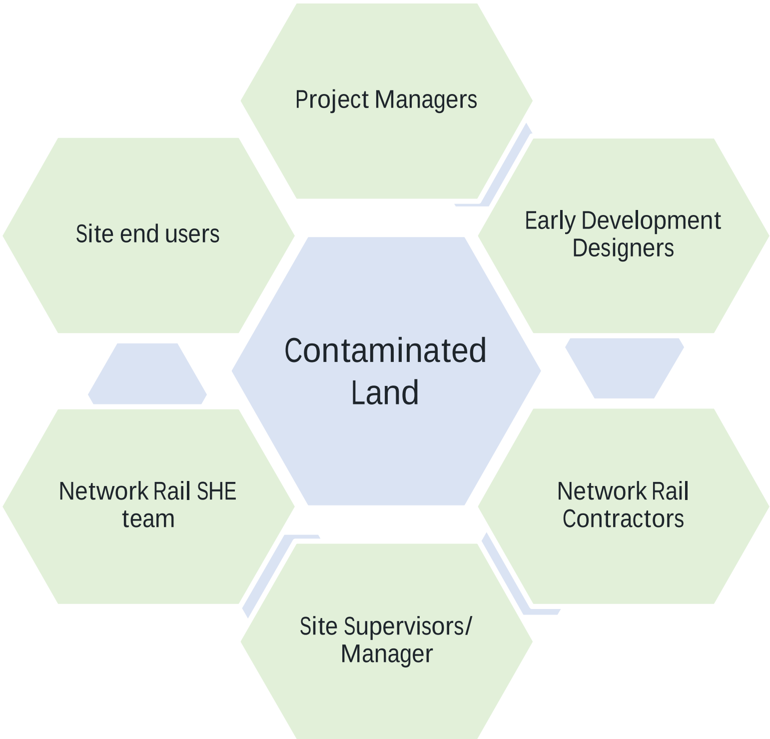

Is this what I am looking for?

- I want to know what contaminated land is.
- Do I need to consider contaminated land in my project?
- Why do I need to consider contaminated land in my project?
- I want to know the potential impact of contaminated land on my project.

2) TECHNICAL GUIDANCE

Is this what I am looking for?

- I want to know if I need to assess contaminated land at my site.
- I want to understand the process and stages for assessment of contaminated land.
- Who should undertake the assessment works?
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1 AWARENESS GUIDANCE

1.1 WHAT IS CONTAMINATED LAND?

As one of the larger landowners in Britain, Network Rail sites and schemes may be potentially contaminated due to historic and/or current use.

Land can be contaminated by things like:

- heavy metals, such as arsenic, cadmium and lead
- oils and tars
- chemical substances and preparations, like solvents
- gases, such as methane, carbon dioxide and radon
- asbestos
- radioactive substances

> ***Watch Point!-***
>
> *Even expected 'Greenfield' sites may contain made ground and fill materials that could be contaminated*

Generally contaminated land occurs as a result of previous industrial uses of sites, but in some cases can be due to naturally occurring hazardous substances.

1.2 DO I NEED TO CONSIDER CONTAMINATED LAND IN MY PROJECT? / WHY DO I NEED TO CONSIDER CONTAMINATED LAND IN MY PROJECT?

Contaminated land is legally defined as where substances are causing or could cause;

(i) significant harm to people, property or protected species;

(ii) significant pollution of surface waters (for example lakes and rivers) or groundwater;

(iii) harm to people due to radioactivity.

The UK approach to the assessment and management of contaminated land is through the planning regime for development projects, legislation for enforcement and in some cases by corporate policy.

Details of the planning policy, legislation and statutory guidance within the UK are included within Appendix A.

The processes by which contaminated land is identified and investigated are outlined in the Environment Agency Land Contamination Risk Management (LCRM) document (which is recognised as current best practice), CIRIA C552 - Contaminated Land Risk Assessment – A Guide to Good Practice, 2001 and BS 10175:2011+A2:2017- Investigation of potentially contaminated sites – Code of practice. The Environment Agency's LCRM guidance uses a staged risk based approach. For further details of the LCRM approach please refer to Section 2.3 of this document.

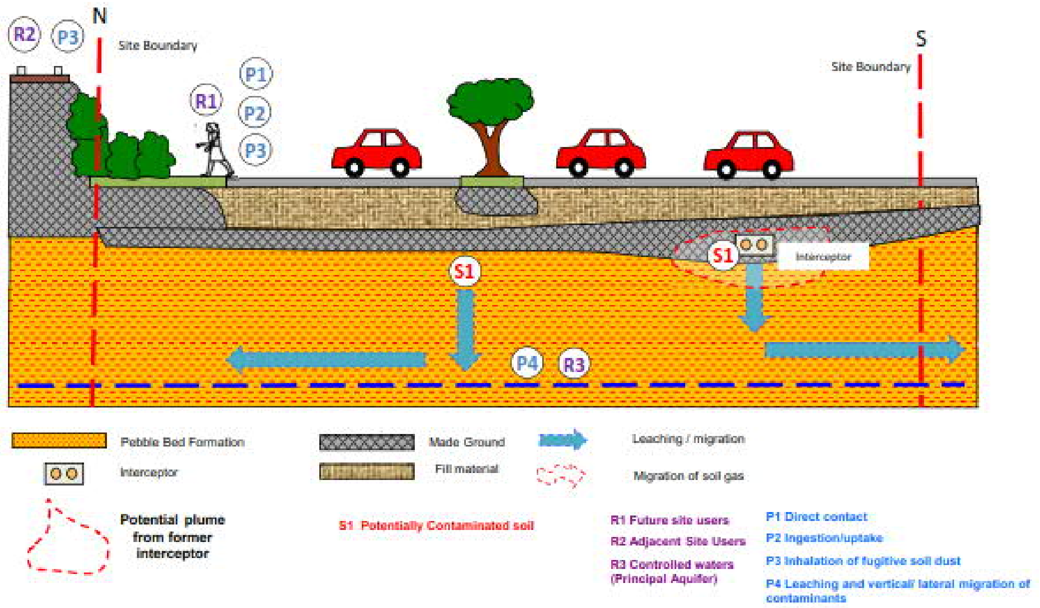
To assess the risks from contaminated land, a source of contamination, and receptor need to be identified, together with a pathway or process for the contamination to reach the receptor. This is known as a contaminant linkage.

Potential contaminant linkages for a site should be represented on a conceptual site model (CSM) which can be tabular or graphical, such as the examples shown below;

Tabular CSM Example

1. Hazard Identification	2. Hazard Assessment		3. Risk Estimation		4. Risk Evaluation	5. Managing the Risk
Contaminant Source	**Pathway**	**Receptor**	**Consequence of risk being realised**	**Probability of risk being realised**	**Classification**	**Discussion / Action required**
S1 contaminated made ground	P1 – Direct contact	R1 - Future site users including maintenance workers	Medium	Likely	Moderate	Remediation measures will be required in landscaping areas. To confirm anticipated ground conditions on site in the location of the repairs and maintenance garage, confirmatory ground investigation works are recommended to be undertaken upon completion of the demolition phase.
	P2 – Ingestion	R1- Future site users including maintenance workers	Medium	Likely	Moderate	
	P3 – Inhalation of dust	R1 – Future site users including maintenance workers	Medium	Likely	Moderate	
	P3 – Inhalation of dust	R2 – Adjacent site users	Medium	Likely	Moderate	
	P4- Inhalation of vapours / soil gas	R1 – Future site users	Medium	Low	Moderate / Low	
		R4 – Adjacent site users	Medium	Low	Moderate / Low	
	P5- Leaching and migration	R3 - Controlled waters	Medium	Low	Moderate/Low	

Graphical CSM Example



1.3 POTENTIAL IMPACT OF CONTAMINATED LAND ON PROJECTS

PACE / GRIP / LCRM STAGES OF ASSESSMENT

The activities and deliverables required in the LCRM stages of assessment have been represented in the flow diagram below and linked to the PACE and GRIP lifecycle stages as shown in Table 1-1 below, providing a single-glance point of reference when undertaking Contaminated Land assessment as part of a Rail project. Please refer to Section 2.3 of this document for further details of the LCRM stages of assessment.

LCRM Stages of Assessment

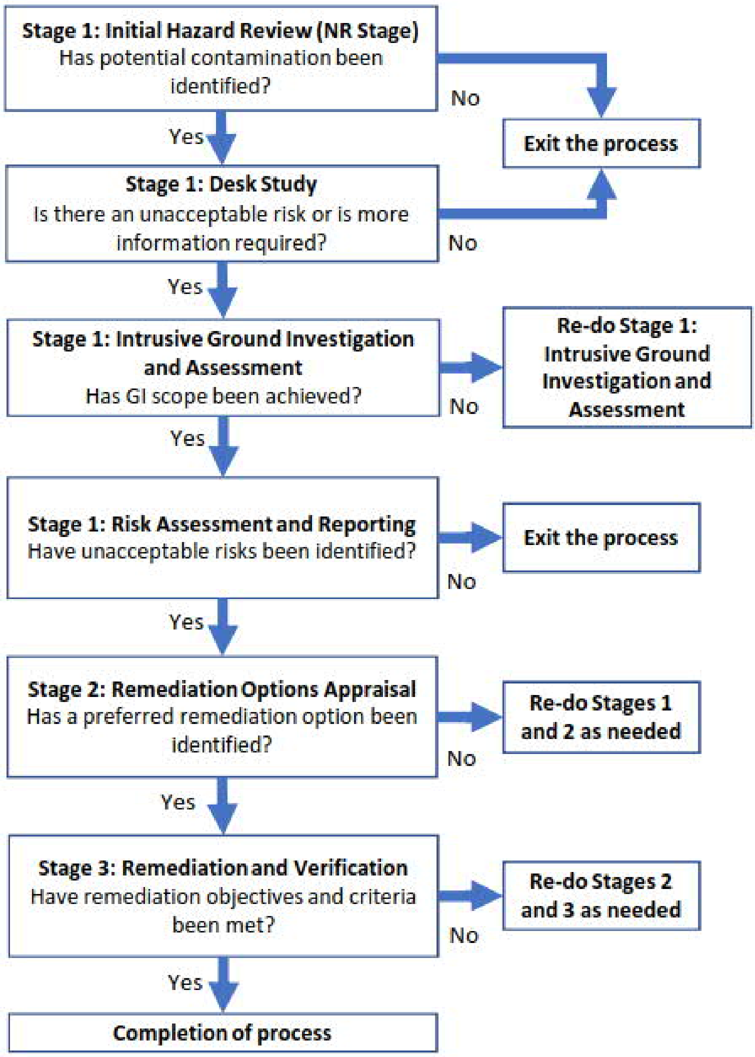


Table 1-1 PACE / GRIP / LCRM STAGES OF ASSESSMENT

PACE phase		Milestones		Equivalent GRIP stage	Key activities	Deliverables	Technical Standards / Guidance documents	Network Rail guidance documents
1	Strategic Development & Project Selection	ES1	Client requirement defined and baselined	GRIP 1				
		ES2	Constraints identified and project feasibility confirmed	GRIP 2/3	LCRM Stage 1: Preliminary Risk Assessment, Desk-based assessment.	Initial Hazard Review Desk Study (if required) Interpretative ground investigation report including GQRA, DQRA (if required)	LCRM CIRIA C552 -, 2001 BS 10175:2011 BS 5930:	NR/L2/ENV/015 Ground Investigation (Scoping of works for contaminated land) NR/GN/CIV/208 Ground Investigation
		ES3	Single option identified and endorsed	GRIP 4	LCRM Stage 1: Preliminary Risk Assessment, Intrusive Ground Investigation & Assessment and risk assessment			
2	Project Development & Design	ES4	Design standards approved and AiP	GRIP 5	LCRM Stage 2: Remediation Options appraisal LCRM Stage 3: Remediation Strategy and detailed design	Remediation options appraisal Remediation Strategy Detailed design Contract documents	LCRM	NR/L2/ENV/120 Waste Management
		ES5	Construction-ready design approved					
3	Project Delivery	ES6	Construction complete	GRIP 6	LCRM Stage 3: Remediation works	Ongoing progress reports	LCRM	
4	Project Close	ES7	Project handback	GRIP 7	LCRM Stage 3: Verification	Verification Report	LCRM	
		ES8	Close-out	GRIP 8				

It should be noted that sites will vary significantly in relation to the type and quantities of contamination present, as such timescales for the different stages of LCRM and the associated deliverables will also vary. The assessment of risk and mitigation for contamination at sites can be a lengthy process and should be assessed at an early stage of project design to enable programmes and cost reviews to take account of contaminated land and ensure alignment with the project delivery.

The following table provides an outline indication of the expected timeframes for the LCRM assessment stages.

Table 1-2 – Assessment Stages Outline Timescales

Activity	Estimated Timescale	Comment
Initial Hazard Review	Up to 1 week	NR review stage
Desk Study	2-3 weeks	Assumes standard desk study data is available and access to the site
Site Investigation	2-4 weeks with additional time for monitoring	Site investigations are usually up to 4 weeks on site, but can take months for large complex sites
Site Investigation reporting and Risk Assessment	4-6 weeks	Timescales will be driven by the size and complexity of the site and the amount of data to assess
Remediation Options Appraisal	3-4 weeks	Timescales will be driven by the size and complexity of the site and the remediation drivers.
Remediation Strategy	4-5 weeks	Timescales will be driven by the size and complexity of the site and the remediation drivers.
Remediation Works	Likely to be months	Depends on the site size and remediation work being undertaken
Verification Reporting	1-2 months	Data assessed during remediation, verification report expected 1-2 months after remediation completion- does not allow for prolonged monitoring which may be needed

Please note that the timescales above are for guidance purposes only and provide an indication only for the LCRM stages of assessment, other aspects which may impact significantly on programme such as regulatory liaison and contractor procurement have not been included.

2 TECHNICAL GUIDANCE

2.1 PURPOSE AND SCOPE

PURPOSE

The purpose of this Technical Guidance is to provide guidance, information and best practice on the risk assessment and implementation of contaminated land assessment for Network Rail schemes in England, Scotland and Wales.

SCOPE

This technical manual on land contamination has been developed to provide further detail to Network Rail's existing contaminated land guidance, and will provide information on the following:

a. An introduction to Contaminated Land and land affected by contamination. The UK's legacy and the legal drivers (please refer to Section 1 Awareness Guidance).
b. Process for Identifying and Investigating Contaminated Land: Including the competence required for practitioners, PACE/GRIP stages (please refer to Section 1 Awareness Guidance), roles and responsibilities.
c. Initial hazard review and Preliminary Risk Assessment, sources of data and the Conceptual Site Model.
d. Intrusive Ground investigation, sampling strategies, testing suites and methods of investigation.
e. Risk assessment (GQRA and DQRA).
f. Remediation options appraisal,
g. Remediation Strategy, remediation and validation.
h. Waste management and waste, definitions of waste and options for re-use, and import material.

2.2 ABBREVIATIONS & DEFINITIONS

Term	Definition
AGS	Association of Geotechnical and Geo-environmental Specialists
BGS	British Geological Survey
CDM	Construction (Design & Management) Regulations 2015 (CDM, 2015)
CL:AIRE	Contaminated Land: Applications in Real Environments
CSM	Conceptual Site Model
CPD	Continued Professional Development
DoW CoP	Definition of Waste Code of Practice
DEFRA	Department of Environment, Food, and Rural Affairs
DQRA	Detailed Quantitative Risk Assessment
DWS	Drinking Water Standards
EA	Environment Agency
EQS	Environmental Quality Standards
GAC	Generic Assessment Criteria
GPVS	Gas Protection Verification Scheme
GQRA	Generic Quantitative Risk Assessment
GRIP	Governance for Railway Investment Projects
IHR	Initial Hazard Review
LCRM	Land Contamination Risk Management
LOD	Limit of Detection
MCERTS	Monitoring Certification Scheme
MMP	Materials Management Plan
PRA	Preliminary Risk Assessment

2.3 PROCESS FOR IDENTIFYING AND INVESTIGATING CONTAMINATED LAND

The processes by which contaminated land is identified and investigated are outlined in the Environment Agency Land Contamination Risk Management (LCRM) document (which is recognised as current best practice), CIRIA C552 - Contaminated Land Risk Assessment – A Guide to Good Practice, 2001 and BS 10175:2011+A2:2017- Investigation of potentially contaminated sites – Code of practice.

LCRM

The Environment Agency's LCRM guidance uses a staged risk based approach. There are 3 stages and each stage is broken down into tiers or steps:

Stage 1: Preliminary Risk Assessment (PRA)

- Preliminary risk assessment including information from intrusive site investigations
- Generic quantitative assessment
- Detailed quantitative risk assessment.

Stage 2: Options Appraisal

- Identify feasible remediation options
- Do a detailed evaluation of options
- Select the final remediation option.

Stage 3: Remediation and Verification

- Develop a remediation strategy
- Remediate
- Produce a verification report
- Undertake long-term monitoring and maintenance, if required.

CIRIA C552: A Guide to Good Practice, 2001

The identification of potential "contaminant linkages" is a key aspect of the evaluation of potentially contaminated land under Stage 1 of the LCRM guidance. An approach based on the UK CIRIA report C552 is usually adopted by contaminated land practitioners. For each of the potential contaminant linkages, an assessment is made of:

- The potential severity of the risk; and,
- The likelihood of the risk occurring.

An overall assessment of the level of risk is gained from the comparison of the severity and probability, resulting in a risk classification rating such as Low, Moderate or High.

Details of the classification tables and definitions of the risk classification ratings are included in Appendix A.

BS 10175:2011+A2:2017: Investigation of potentially contaminated sites – Code of practice

The recommendations and guidance of this British Standard are applicable to the investigation of all potentially contaminated sites, and also to land with naturally elevated concentrations of potentially harmful substances.

COMPETENT PERSON

Staff who undertake works in relation to contaminated land are expected to have appropriate knowledge, skills, experience and qualifications.

The level of knowledge, skills, experience and qualifications required to undertake each stage of works will depend on the nature and complexity of the site being assessed. In general, it would be expected that increased levels of competence would be required for the later stages of assessment such as risk assessments and remediation design and implementation. All deliverables should be reviewed and approved by a competent person as defined by the appropriate legislation and guidance.

The National Planning Policy Framework (NPPF) defines a competent person as someone with recognised and relevant qualifications, sufficient experience in the area of work and contamination being assessed, and membership of a professional organisation.

Competence is demonstrated with qualifications and experience in a specific technical or scientific discipline or application, or by multidisciplinary qualifications. These include for example:

- A Suitably Qualified Person (SQP) registered under the NQMS;
- The Society of Brownfield Risk Assessment (SoBRA) accreditation scheme;
- A Specialist in Land Contamination (SiLC);
- Membership of a professional organisation relevant to land contamination;
- A specialist in the gas protection verification accreditation scheme (GPVS); and,
- A proven track record- someone who regularly deals with the technical aspects of land contamination.

ROLES AND RESPONSIBILITIES

Contaminated land assessment can significantly impact on the delivery of projects and needs to be managed through the clear identification of roles and responsibilities. Early engagement by the design team with the contaminated land specialists at GRIP2/3 to ensure it is embedded in the project processes and site surveys. The level of assessment and project roles required will vary depending on the size and complexity of projects. Roles and responsibilities for contaminated land assessment should be defined on a project specific basis.

Co-ordination should be ensured with other environmental disciplines regarding contaminated land risk throughout a project e.g Ecology, and air quality alongside interface with designers.

For guidance purposes Table 2-3 provides an example of a tabulated summary of key roles and the responsibilities which lie with each role in relation to the stages of contaminated land assessment and associated deliverables for typical Rail design projects, using a RACI (Responsible, Accountable, Consulted, Informed) model.

Activity / Deliverable	Network Rail	Regulator	Designer (Early Development)	Ground Investigation Contractor	Designer (Detailed Design)	Principal Contractor (Delivery)
Initial Hazard Review	A/R		C			
PRA	A	C/I	R			
GI scoping and design	A	C/I	R	C		
GI implementation	A		C	R		
GI Reporting and Risk Assessment	A	C/I	R	C		
Remedial Options Appraisal	A	C/I	R	C		
Remedial Strategy	A	C/I	R	C		
Detailed remediation design	A	C/I			R	C
Remediation works	A	C/I			C	R
Remediation Validation	A	C/I			R	C
Monitoring/ Maintenance	A	C/I			C	R

Table 2-3 – Example Rail design scheme with typical roles and responsibilities

R- Responsible: The person who actually carries out the process or task, responsible to get the job done

A- Accountable: The person who is ultimately accountable for the process or task being completed appropriately

C- Consulted: People who are not directly involved with carrying out the task or process but who are consulted, may be a stakeholder or expert

I- Informed: Those who receive output from the process or task or who have a need to stay informed

2.4 STAGE 1: PRELIMINARY RISK ASSESSMENT (PRA)- DESK-BASED ASSESSMENT

A flow diagram of the Stage 1 PRA process is included in Appendix B.

INITIAL HAZARD REVIEW

Section 6.2 of the Network Rail Level 2 Business Process – Environment and Social Minimum Requirements for Projects – Design and Construction document, specifies that the designer/contractor shall conduct an Initial Hazard Review to determine whether the site could contain contamination associated with the current and/or previous activities on site and in the local vicinity. This review will be used to understand what action, if any, needs to be taken in relation to contamination or potential contamination at a site.

An Initial Hazard Review should assess the desk based data available (Geo-RINM, previous reports, on-line data sources) and provide an outline risk assessment and conceptual model for a Site. Initial Hazard reviews will be site specific but are expected to cover the following main topics and conclude with an overall risk rating for the site and a recommendation for further assessment if required;

- Project Background
- Site Setting/Description
- Site sensitivity
- Site History, including review of industry profiles for land uses identified
- Data Review- Geology, flood potential, previous reports etc.

An example approach for an Initial hazard review, including criteria for assessing the requirement to undertake a full Desk Study is included in Appendix F along with a flow chart outlining the process.

The Initial Hazard Review will usually determine whether a Desk Study is required, for example, if a potentially unacceptable risk to receptors has been identified. If sufficient information is available, it is possible to proceed straight to a Desk Study without an Initial Hazard Review.

DESK STUDY

Where determined by the Initial Hazard Review that further, more detailed assessment of land contamination risks is required this is undertaken by production of a Desk Study.

The Desk Study report is an important pre-requisite to further intrusive ground investigations, as historical site activity and site sensitivity can play an important role in determining risks and potential constraints.

Please find below a checklist (expected minimum content for a desk study) taken from the LCRM guidance which provides an example of the expected content for a Desk Study;

Desk Study Checklist:

From a Desk Study find out the:

- site ownership and current status
- location, national grid reference, rail line references, chainage
- size of the site – include any plans and maps
- history and general description of the site
- potential for unexploded ordnance

> ***Watch Point!-***
>
> *Desk based assessment is a critical point of the process, if this is wrong it feeds into the rest of the assessment……*

- contact details of relevant organisations

Get details of any:

- pollution incidents, spills, accidents or regulatory actions
- current or past permits, licences or authorisations
- proposed future changes to land use, such as planning applications
- previous investigations or remediation
- chemical or biological information from for example, previous site monitoring reports
- natural background contamination information, such as for radon gas, if available
- audit reports that may have been done

Also find out the:

- location of historical landfill sites
- details of any reviews of coal or other mining related contamination hazards – current or historic
- presence or proximity of sensitive ecological receptors such as Special Protection Areas – to find out, you can use Natural England's MagicMap
- location of any protected areas of countryside
- presence of any archaeological or heritage sites such as scheduled ancient monuments
- details on other specific Part 2A receptors such as property in the form of crops, livestock, buildings

Find out geological, hydrogeological and hydrological information. Include:

- made ground, drift deposits, bedrock
- geological features such as faults
- presence of groundwater aquifers – unconfined, confined or a mixture of both
- the aquifer type – principal, secondary or unproductive strata
- sensitive groundwater locations such as source protection zones or safeguard zones
- the vulnerability of the groundwater to pollution
- the likelihood of perched groundwater
- any abstraction points or wells on or close to the site – you must include private water supplies
- the presence of and proximity to other controlled waters such as surface water and coastal
- any available water quality information
- information on characteristics such as the likely groundwater flow direction

Information Sources

The sources of information from which Desk Studies are compiled are varied and designed to capture as much environmentally relevant information about the site and its surroundings. This information is used to inform a preliminary conceptual site model, scope ground investigations and produce preliminary risk assessments.

Desk Studies typically include information from site walkover visits, public records and information procured from specialist companies. Information gathered during site walkovers will vary depending on who attends site and their technical specialism, but typically includes visually assessing the site for evidence of potential contaminative substances, invasive species or flooding. It will also assess access and egress constraints to the site that will be useful in planning future intrusive ground investigations. Please find below an example checklist for the requirements of a site walkover as taken from LCRM guidance;

Record and describe information such as the:

- current use and status of the site
- general condition of site and surrounding land use
- presence of surface staining and odours
- topography and surface condition – open ground, hardstanding and other geotechnical or surface features
- local surface water features
- ecology
- presence and type of vegetation
- signs of any vegetation dieback
- presence and extent of any non-native invasive plants such as Himalayan balsam, New Zealand pigmyweed, Japanese Knotweed or Giant hogweed
- buildings and below or above ground structures such as fuel tanks
- above and likely below ground services
- access to and security of the site
- presence of any potential off-site receptors
- potential presence of any asbestos cement material within buildings or throughout the site
- communications or discussions with site personnel

You can take photographs and consider the use of unmanned aerial vehicles (drones) for site reconnaissance. Please note you must consider health and safety issues before doing the site walkover.

Other information is gathered from public sources, including details of the local geology, logs from historical boreholes (Provided by the British Geological Survey (BGS)), groundwater and surface water quality data, flooding potential and current/historical landfill sites (provided by the EA for England, NRW for Wales and SEPA in Scotland), information regarding radon (provided by Public Health England for all three nations) and mineral safeguarding areas (defined by local councils). Network Rail also has access to the GeoRINM information source which includes historical maps and BGS data. The Network Rail Hazard Directory should also be consulted.

In addition to publicly available environmental data, further information can be procured from third party providers such as Landmark (Envirocheck), Groundsure or the Coal Authority regarding the use of hazardous substances on and around a site, historical pollution incidents, nearby groundwater abstractions, and historical mining within the area.

Preliminary Conceptual Site Model (CSM)

One of the primary tools to identify whether there are potentially unacceptable risks originating from contamination at a site is through the development of a CSM, which is a representation of the conditions and the physical, chemical and biological processes that control the transport, migration and potential impacts of contamination (in soil, air, ground water, surface water and/or sediments) to human, environmental and infrastructure receptors.

The information on which this assessment is based, may be gathered through review of historical information, site walkover surveys and/or intrusive investigation, sampling and monitoring. A preliminary CSM should be produced as part of the Desk Study assessment. The level of detail within the model will depend upon the complexity of the site, but it should include the identified sources and the potential contaminants of concern, together with features that will dictate contaminant migration, potential receptors, and the applicable remediation criteria.

The CSM should clearly show the sources, pathways and receptors that potentially exist on site and can be presented as diagrams or text/tables. The suitability of the presentation style will be dictated by the complexity of the site and the amount of data that is available, examples of different types of CSM can be found in BS EN ISO 21365 Soil quality- Conceptual site models for potentially contaminated sites. An example of a graphical CSM, and a tabulated version are included in Section 1.2 of this document.

The CSM should be continually updated and reviewed and refined as more information and data becomes available, for example following ground investigation works. In addition to help to illustrate potentially unacceptable risks under current site conditions and those that may arise should development proceed without intervention it may be appropriate to produce a CSM for the current site setting and a CSM for the proposed development.

High-level Ground Investigation Scope

Once the desk-based information has been compiled and the CSM has been established, scoping of a ground investigation to address data gaps and confirm potential contaminant sources and pathways can be undertaken. The scope should include a plan detailing the locations and types of exploratory holes proposed, along with requirements for ground water and/or ground gas monitoring installations.

2.5 STAGE 1: PRELIMINARY RISK ASSESSMENT- INTRUSIVE GROUND INVESTIGATION & ASSESSMENT

INTRUSIVE GROUND INVESTIGATION (GI) AND SUPPORTING ACTIVITIES

With progression through the stages of the LCRM guidance, more detailed information is required about the site to provide data for a review of the conceptual model and to update the risk assessment

This information typically requires ground investigation works to assess ground conditions and to acquire samples for chemical analysis, which can be gathered using a number of different intrusive ground investigation methods, such as drilling exploratory boreholes or excavating trial pits.

Guidance on ground investigation scoping works for contaminated land risk assessment are provided in draft Network Rail Design Delivery Guidance Ground Investigation (Scoping of Works for Contaminated Land).

BS10175 provides detailed guidance on the approach to producing a GI strategy and design to ensure that an appropriate investigation is undertaken.

SAMPLING AND TESTING FREQUENCIES

When designing a sampling strategy, a detailed knowledge of the CSM is required. The number, location, and spacing of sampling and monitoring points across the site and within individual exploratory holes will be controlled by:

1) The purpose of the investigation;
2) Knowledge of the site history;
3) Development proposals;
4) The variability of the ground conditions;
5) The sensitivity of the potential receptors;
6) The accessibility of potential investigation locations and areas around the site;
7) The degree of confidence required in identifying unknown areas of contamination;
8) The type of contaminant (solid, liquid or gas) and its mobility; and,
9) Health and safety, timescale or budgetary constraints.

> ***Watch Point!-***
>
> *Make sure sampling strategies are site specific, as very different investigations can be needed depending on site conditions*

Three sampling strategies can be adopted; (i) targeted; (ii) non-targeted; and, (iii) random sampling.

Targeted Sampling

Targeted sampling aims to confirm the presence or absence of a particular pollutant linkage established in the CSM to establish 'worst case' degrees of contamination and/or delimit the extent of potentially contaminated materials. Whilst this approach clearly allows specific horizons, such as discoloured layers, odorous material or pockets of a distinct material to be sampled, it is vitally important that the material being sampled is carefully recorded as being targeted.

Non-targeted Sampling

This uses a statistical approach to cover the site with sampling locations. This is normally undertaken with a grid or consistent shape of variable dimension and spacing mainly dependant on the level of confidence, risk mitigation or reduction in uncertainty that is required. In practice the number of sampling points is often a trade-off between the cost of mitigating a potential risk posed by a given volume of unknown contamination between sampling points that is either acceptable within the project budget and/or less than the cost of additional investigation at a later stage.

Random Sampling

Random sampling is rarely used as a standalone method, and is more commonly adopted as a combined approach with a targeted strategy to address specific contaminant linkages highlighted in the CSM, in combination with a grid and/or random positions to provide a more general coverage of the site. Guidance on actual sampling methods to be used in implementing the sampling strategy is provided in the AGS Guide to Environmental Sampling (2010). However, when samples are recovered, consideration should always be given as to the purpose for which they are being tested and how the results are to be used and/or statistically treated.

Environmental Sample Collection

The type of contaminants likely present within the environment need to be considered when selecting an investigation and sampling methodology. Sampling of environmental soils, liquids and gasses needs to be undertaken in a manner that is consistent across the industry, and based on good practice to avoid cross contamination and degradation of the sample during transport and recording (in accordance with BS 10175, BS ISO 18400-105(2017)). Please find further details of sampling techniques within Appendix C.

Analytical/Testing Suites

Chemical analysis suites are determined on a site specific basis depending on parameters such as current and former land use on-site and for adjacent sites and potential receptors.

The analysis of soils and groundwater is driven by a regulatory requirements, and the laboratory standards are frequently required to be accredited to UKAS 17025:2005 and MCERTS.

Typical contaminants associated with railway land are as follows (taken from DOE Industry Profile for railway land):

Fuel oils, Lubricating oil, Parrafin, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), Solvents, Ethylene glycol, Creosote, Herbicides, Ferrous residues, Metal fines, Asbestos, Ash and Sulphate.

To cover the typical contaminants above and for general assessment purposes, analysis suites should include;

Metals, inorganic compounds, organic compounds such as PAHs, PCBs, semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), organochlorine and organonitrogen pesticides, asbestos.

When considering the laboratory test to select, it is important to consider the criteria against which the results will be screened and ensure the laboratory limit of detection (LOD) is lower than the required screening value. Where the LOD is greater than a published target standard, it is prudent to not conclude that a potential risk exists to the relevant receptor. This is in line with the approach that the EA and SEPA take in determining the classification status of the water bodies.

During the intrusive works, the on-site engineer may be able to spot visual or olfactory evidence of contamination such as hydrocarbons. This information should be included within the soil log, and used to inform analytical laboratory tests. However, not all contamination can be identified on site, and the scheduled testing should be informed by the CSM.

If samples of Made Ground are being analysed for chemical contamination, it is important to also schedule asbestos testing to prevent exposure of laboratory staff to potentially lose fibres. All Made Ground samples are treated as asbestos positive until proven otherwise, to reduce the risk to human health.

An asbestos screen of a sample can be carried out, which is a visual assessment to determine if asbestos containing material is present in the sample. This will only cover pieces of asbestos and fibre bundles, and would not include small fragments or free-fibres. UKAS state that 'screening' is now removed from accredited schedules, as it is not a method in itself, only part of the identification process.

Quantification of asbestos is achieved by a multi-stage process which involves the identification and mass quantification of asbestos fibres in both fragments of asbestos containing materials, and free fibres dispersed throughout the soil matrix. Quantification can provide a breakdown of the amount of fibres present in each type of asbestos, and will normally be used in mass quantification results to generate the number of respirable fibres per gram of soil.

Laboratories offering asbestos identification testing must be ISO 17025 accredited.

Further information on the control of asbestos in soils is provided in CL:AIRE CAR-SOIL guidance.

INTRUSIVE GROUND INVESTIGATION:

There are numerous methods by which samples can be gathered, such as various types of borehole drilling techniques and open excavations (such as trial pits), however, the most appropriate means will depend on the characteristics of the site and the contaminants being investigated.

Drilling Techniques

The method selected for advancing a borehole will depend upon a number of factors:

- Depth and diameter required;
- Depth to the water table;
- Ability to penetrate the formations anticipated (determined by soil/rock strength and structure);
- Impact on groundwater quality (particularly the use of a flushing media);
- Requirements to obtain samples for the purposes of borehole logging;
- Extent of disturbance of the ground materials around the boreholes (such as smearing of side walls);
- Access restrictions;
- Cost considerations including the size of contract (number of boreholes) and relative costs;
- Availability, particularly for novel or unusual techniques;
- Other objectives, such as requirements for geotechnical or hydraulic testing.

A variety of drilling techniques are available, the details of which along with advantages and limitations are provided in Appendix D.

Trial Pitting

Trial pits and trial trenches are often undertaken using mechanical excavators to rapidly expose shallow ground conditions. They allow examination of both horizontal and vertical faces exposed as the pit is advanced, and enable the collection of a wide variety of sample sizes and types. A large number of pits can be advanced in a single day, enable the rapid characterisation of shallow ground conditions.

MONITORING

Monitoring of borehole installations for ground gas and groundwater is usually required following ground investigation works to obtain representative data over an appropriate period of time. The frequency and type of monitoring required will be determined during the ground investigation design process and should take account of appropriate guidance.

2.6 STAGE 1: PRELIMINARY RISK ASSESSMENT - RISK ASSESSMENT AND REPORTING

The risk assessment stage must always be completed prior to undertaking an options appraisal and remediation and verification. The process is iterative, and requires the availability of detailed, site-specific information, usually obtained through intrusive investigation.

For desk based assessments, risks are evaluated qualitatively. However, if the site is progressed to a generic or detailed quantitative risk assessment, and suitable ground investigation data is available, evaluation criteria are used to judge whether the potential contamination requires further assessment or is classified as unacceptable. These include generic assessment criteria (GAC) and detailed site-specific assessment criteria.

Generic Quantitative Risk Assessment (GQRA)

The GQRA comprises an initial assessment to understand the Conceptual Site Model (CSM), to identify whether a 'Source-Pathway-Receptor' linkage exists (e.g. the mechanisms by which contamination can harm a receptor, such as controlled waters) and to identify specific contaminants that require further, more detailed assessment.

As part of this assessment, the results of the laboratory analysis of soil and groundwater samples are screened against a set of GAC which have been generated from a range of published environmental standards for differing generic end-use scenarios for the site (such as commercial use, open public space, etc.). An example list of GAC are provided in Appendix E for information.

Common examples of evaluation criteria include:

- Category 4 screening levels (C4SLs);
- Human health toxicological assessment of contaminants in soil (SR2) tolerable daily intakes and index doses;
- Drinking Water Standards (DWS);
- Environmental Quality Standards (EQS); and,
- Ecosystem endpoints which consider the ecological value of a site – e.g., used under Part 2A for assessing significant harm to ecosystems.

The risk to human health from exposure to contaminants is often based on direct ingestion and inhalation intake pathways.

GQRA Conclusions

When you have assessed each potential contaminant linkage and updated the CSM, the GQRA can be used to decide if:

- the assessment has shown the risks are low enough that no further action is needed and you can exit the process
- further assessment, site investigation and monitoring are required to address uncertainties and complete the risk assessment
- there are unacceptable risks and you need to proceed to detailed quantitative risk assessment or direct to the options appraisal stage

The decision selected may need approval or agreement from the regulator.

Detailed Quantitative Risk Assessment

To further refine the CSM and obtain a more site-specific assessment of the risk for each of the contaminants exceeding the (more conservative) GAC, a DQRA must be undertaken.

The assessment includes consideration of:

- Site characteristics and surroundings;
- Contaminants and degradation products;
- Hydrogeological and hydrological properties;
- Ground gases and vapours; and,
- Current or proposed site-specific building parameters.

> ***Watch Point!-***
>
> *DQRAs can be very complex and need competent and experienced staff to carry them out*

This information is then used in forward modelling, to (i) predict concentrations at a compliance point to compare with allowable concentrations or generic assessment criteria for example, using the Remedial Targets Methodology (RTM) or ConSim; or, (ii) predict a dose to compare with an allowable dose for example, use the average daily exposure: health criteria value (ADE:HCV) ratio model in CLEA.

It is also possible to derive Site Specific Acceptance Criteria (SSAC) using the RTM, which override GAC, and may reduce the number of exceedances for specific contaminants and allow a greater understanding of the scope of remediation that will be required. In this context, GACs and SSAC are the levels in soil above which an unacceptable risk of harm to human health may be present. The evaluation criteria will take into account different land uses and the type and sensitivity of the human health receptor.

The findings of the DQRA process are usually set out in a DQRA Assessment report.

DQRA Conclusions

When you have assessed each potential contaminant linkage and updated the CSM, the DQRA can be used to:

- Decide whether the risks are low enough that no further action is needed and you can exit the process;
- Undertake further assessment, site investigation and monitoring to address uncertainties and complete the risk assessment; and,
- Identify unacceptable risks that indicate an options appraisal stage is required.

The decision selected may need approval or agreement from the regulator.

2.7 STAGE 2: REMEDIATION OPTIONS APPRAISAL

Following the identification of contamination that requires remediation, a Stage 2 Remediation Options Appraisal is required. The appraisal uses the findings from the previous Stage 1 investigations to inform a detailed assessment of the feasible remediation options to reduce the risk from contamination to acceptable levels. The options will then be narrowed down based on how appropriate and cost-effective each technique is, and a remediation strategy will be produced.

The three steps to follow are;

1) Identify feasible remediation options.

2) Do a detailed evaluation of options.

3) Select the final remediation option.

1) Identify feasible remediation options

The aim of Step 1 is to identify a shortlist of feasible remediation options that can be evaluated which are able to achieve the remediation objectives and criteria you set for the site.

To be able to select feasible remediation options a clear set of options appraisal objectives need to be in place. These include: management and technical objectives, remediation objectives and criteria and must consider the regulatory controls that may be required.

There are a wide variety of remediation options commonly available, including;

Civil Engineering- Cover systems, barriers, excavation and disposal.

Biological- Natural attenuation, biopiles, windrows

Chemical- Oxidation, dehalogenation, soil flushing, solvent extraction

Physical- Soil vapour extraction, air sparging, permeable reactive barriers

Stabilisation and solidification- Chemical stabilisation, vitrification

Thermal- Incineration, thermal desorption

2) Detailed evaluation of options

The detailed evaluation of the remediation options which are most suitable for dealing with the identified contaminant linkages needs to assess the following:

- the limitations, advantages and disadvantages of each option
- develop and use options appraisal evaluation criteria to assess the merits of each option
- establish which options are most suitable – singularly or in combination
- include any proposals for combining options
- get detailed information on the technical aspects of each option, including the cost

Options appraisal criteria are factors against which the ability of different remediation options to meet site-specific objectives are measured, and are set on a site specific basis. A list of example evaluation criteria is included below for guidance purposes;

- Regulatory and stakeholder requirements
- Sustainability
- Cost

- Timescales
- Practicability
- Effectiveness
- Durability
- Environmental impact
- Track record
- Availability
- Health and safety requirements

> ***Watch Point!-***
>
> *You can apply weighting to critical parameters during the options appraisal process*

At the end of Step 2 the feasibility of remediation options will have been assessed and the potential of combining options considered.

3) Select the final remediation option

The final remediation option decision is made based on the step detailed assessment results and may be a single option, multiple options or a combined approach, it will need to meet the;

- overall site objectives set in the preliminary risk assessment
- options appraisal management and technical objectives
- options appraisal remediation objectives

Options Appraisal Conclusions

At the end of the options appraisal stage you will have:

- selected the final remediation option
- assessed how a combined or integrated approach will work in practice
- decided what action to take if feasible options could not be identified
- decided and got agreement to do long term monitoring and maintenance or Monitored Natural Attenuation as a remediation option

And be able to confirm that the selected remediation option will:

- manage the risk effectively
- be verifiable at remediation stage
- Record and justify decisions in the options appraisal report.

2.8 STAGE 3: REMEDIATION AND VERIFICATION

The options appraisal will have identified the most feasible remediation option, there are now four steps to follow to design and implement the remediation;

1) Develop a remediation strategy.

2) Remediate.

3) Produce a verification report.

4) Do long term monitoring and maintenance, if required.

> ***Watch Point!-***
>
> *Don't forget to speak to the regulators as early as you can in the remediation process, it will save time in the long run…….*

1) Remediation Strategy

A remediation strategy can vary widely in the method and scope from site to site. It forms the overarching plan to achieve the remediation options outlined in the Remediation Options Appraisal, and will vary depending on the type and number of significant contaminant linkages identified.

The options appraisal may have included an initial design, this needs to be developed into a detailed design including the preparation of detailed design drawings, specifications and contract documents as required.

The document should set out monitoring objectives and criteria to track performance of the remediation, as well as being a record of how you will meet and carry out the remediation objectives.

The remediation strategy will also outline the verification plan, specifying all the data requirements, including compliance criteria and monitoring details. This will establish a 'lines of evidence' approach that will verify remediation is working or has worked.

When the remediation strategy has been agreed with the regulator (this may be the EA, SEPA, NRW or a local authority), remediation can begin.

2) Remediation

Remediation requires the implementation of the approved strategy and detailed design and must collect all relevant data as set out in the verification plan to ensure verification reporting will accurately reflect the works undertaken.

Tracking and systematic evaluation of verification data is required to confirm that remediation criteria are being met and for early identification of any difficulties in meeting criteria. This enables the performance of the works to achieve the remediation objectives.

Remediation objectives and criteria should be continually reviewed and assessed with modifications considered as necessary.

Remediation works must be carried out in line with the remediation strategy and regulatory controls, method statements must be correct and up to date. Remediation can be an iterative process and allowance must be made for the assessment of data and contingencies for different solutions if the remediation is not working.

When the line of evidence show that the remediation objective have been achieved the remediation works can be considered to be complete, this may required agreement with regulators.

3) Verification

Upon completion of remediation the party responsible for remediation is required to produce a verification report. Verification demonstrates that the risk has been reduced and that the remediation objectives and criteria have been met, and should be based on the quantitative assessment of the remediation performance using the lines of evidence approach set out in the verification plan.

The verification report will need to provide a complete record of all remediation activities and evidence that it has been successful.

The conclusion that remediation is acceptable may need approval or agreement from the relevant regulator.

4) Monitoring and maintenance

Post remediation monitoring and maintenance will be required if this was defined as part of the selected remediation option, or for verification purposes.

A suitable frequency, scope and reporting format will need to have been agreed considering aspects such as;

- Stakeholder and regulator acceptance
- Site access
- Availability of power supplies
- Maintenance plans for emergencies, breakdowns, vandalism or accidents

To conclude step four and complete the monitoring and maintenance works, all objectives need to have been met and reported. Agreement that the objectives have been met and works are completed may need approval or agreement from the relevant regulator.

2.9 MATERIALS MANAGEMENT AND WASTE

Waste Soil Classification

Contaminated land assessment and remediation can result in the production of material which is classified as waste.

Please ensure that any works that produce waste are undertaken in accordance with all NR policies and standards relating to waste and sustainability, including;

- NR/L2/ENV/120 Waste Management
- NR/L3/ENV/044 Track Maintenance Renewal or Alteration – Used Ballast and Excavation Waste Handling

Waste classification in England, Wales and Scotland follows the UK technical guidance WM3. Under this guidance, waste soil can be classified in two different categories; (i) soil and stones containing hazardous substances (waste code: 17 05 03); and, (ii) soil and stones not containing hazardous substances (waste code: 17 05 04).

To understand which code is the most appropriate, several steps of assessment need to be considered, which are linked to the different stages of the risk assessment process:

- Identification of past uses of the site, and if they include industrial processes;
- Design and implantation of a surface and subsurface sampling strategy;
- Analysis of the samples and subsequent environmental and/or human health risk assessment identifies areas of the site that require remediation or soil removal;
- Hotspots of contamination were identified based on their characteristics, classified as hazardous or non-hazardous, accordingly, and stockpiled separately, with minimal incidental mixing; and,
- All the information relating to the site investigation is retained and passed to the subsequent waste holders.

Once waste soil has been classified as hazardous, and landfill is identified as the disposal route, further standardised analysis of the material is required to ensure it meets the waste acceptance criteria (WAC) for hazardous landfill. It is important to note, that landfill WAC testing (specifically leaching test results) is not to be used for waste classification and hazardous assessment purposes.

Materials Management

A materials management plan (MMP) governs the way in which site derived excavated materials are used, to minimise the amount of waste generated. The document should include a description of the site, proposed operations, the materials that will be used and key performance indicators. Plans should also be provided, detailing the materials used and their movement on site, including stockpiles, the quantities and specifications for placement.

Within Scotland, the MMP should conform to the SEPA publication “Regulatory guidance – Promoting the sustainable reuse of greenfield soils in construction (March 2010). In England and Wales, an MMP also helps to comply with the principles of the CL:AIRE voluntary Definition of Waste Code of Practice (DoW CoP), which enables:

- The direct transfer and reuse of clean naturally occurring soil materials between sites;
- The conditions to support the establishment/operation of fixed soil treatment facilities; and,
- The reuse of both contaminated/uncontaminated materials on their site of origin and between sites within defined Cluster projects

Use of the DoW CoP supports the sustainable and cost-effective development of land, and can provide an alternative to Environmental Permits or Waste Exemptions.

The CoP has a more formalised risk based approach than SEPA guidance, and relates to a wider range of excavated and treated materials and reuse scenarios.

CL:AIRE defines good practice materials management as consisting of three steps:

1) Ensuring that an adequate MMP is in place covering the use of materials on a specific site;
2) Ensuring that the MMP is based on an appropriate risk assessment, that underpins the Remediation Strategy or Design Statement, concluding that the objectives of preventing harm to human health and pollution of the environment will be met if materials are used in the proposed manner; and,
3) Ensuring that materials are actually used as set out in the MMP, and this is demonstrated in a Verification Report.

In England and Wales, to confirm that Steps 1 and 2 have been taken, a qualified person must review the documents and provide a declaration to the Environment Agency prior to use of the materials.

QUALIFIED PERSON

The Qualified Person is required to be suitably qualified and experienced to review various documents, and confident in signing declarations, but is not expected to be an expert in all of the disciplines associated with a development project. A high standard of professionalism and integrity is required, with disciplinary action or prosecution possible for false or reckless signing of declarations.

CONTENTS OF THE MMP

Prior to excavation of material, the MMP must be complete, detailing the preliminary categorisation of the materials, which may be refined with testing once the works are underway.

- Details of the parties that will be involved with the implementation of the MMP;
- A description of the materials in terms of potential use and relative quantities of each category;
- The specification for use of materials against which proposed materials will be assessed, underpinned by an appropriate risk assessment related to the place where they are to be used;
- Details of where and, if appropriate, how these materials will be stored;
- Details of the intended final destination and use of these materials;
- Details of how these materials are to be tracked;
- Contingency arrangements that must be put in place prior to movement of these materials; and,
- A verification Plan.

If several separate sites involved within a project, individual MMPs are required for each site.

CLASSIFICATION OF MATERIAL

All excavated materials should be capable of being categorised as either that which is either:

- Capable of being used in another place on site without treatment or following ex-situ treatment;
- Capable of being used in another development without treatment or following ex-situ treatment on another site (for example a hub site);
- Not capable of being used on site or elsewhere and requires recovery or disposal off site as waste; or,
- Material that will be surplus to requirements and requires recovery or disposal off site as waste.

It is important to note, that the relocation of material must be done with regard to the CSM, (pathways and receptors), and an appropriate risk assessment must be undertaken.

Appendix A

LEGISLATION AND STATUTORY/NON-STATUTORY GUIDANCE

Legislation and Statutory / Non-statutory Guidance

Section 57 of the Environment Act (1995) was enacted to create Part 2A of the Environmental Protection Act (1990), which establishes the legal framework for dealing with contaminated land in England, Wales and Scotland. Section 78A(2) of Part 2A defines Contaminated Land as:

'any land which appears to the Local Authority in whose area it is situated to be in such a condition, by reason or substances in, on or under the land, that –

(a) Significant harm is being caused or there is a significant possibility of such harm being caused; or

(b) Pollution of controlled waters is being, or is likely to be, caused [England & Wales] */ Significant pollution of the water environment is being caused or there is a significant possibility of such pollution being caused* [Scotland]*.'*

The following statutory guidance for the implementation and enforcement of Part 2A is applicable:

- England: Contaminated Land Statutory Guidance, April 2012 (Department for Environment, Food and Rural Affairs)[1]
- Wales: Contaminated Land Statutory Guidance 2012 (Welsh Government)[2]
- Scotland: Contaminated Land: Statutory Guidance Edition 2 (Scottish Government)[3]

The statutory guidance and enabling legislation differ between England, Wales and Scotland, resulting in some key variances in terminology and approach to contaminated land investigation and assessment.

Part 2A involves a risk-based approach to identifying contaminated land by recognising possible contaminant-pathway-receptor linkages and sensitive receptors which could be affected. The statutory guidance documents referenced above provide definitions of contaminants, pathways and receptors for each country, however in general terms:

- A contaminant is a substance which has the potential to cause harm to a sensitive receptor, i.e. human health, controlled water / water environment, property or ecology

Under Part 2A the following approach to contaminated land identification and risk assessment is required:

- To identify and remove unacceptable risks to human health and the environment.
- To seek to ensure that contaminated land is made suitable for its current use.
- To ensure that the burdens faced by individuals, companies and society as a whole are proportionate, manageable and compatible with the principles of sustainable development.

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[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/223705/pb13735cont-land-guidance.pdf
[2] https://gov.wales/sites/default/files/publications/2019-08/contaminated-land-statutory-guidance-2012.pdf
[3] https://www.gov.scot/publications/environmental-protection-act-1990-part-iia-contaminated-land-statutory-guidance/

In many instances land contamination is dealt with through the Planning process, as summarised below for England, Wales and Scotland.

England

The National Planning Policy Framework (NPPF) (February 2019)[4] seeks to prevent unacceptable risks from pollution and land instability, and planning decisions should ensure that new development is appropriate for its location. The effects (including cumulative effects) of pollution on health, the natural environment or general amenity, and the potential sensitivity of the area or proposed development to adverse effects from pollution should be taken into account. Key paragraphs which relate to contaminated land are 118, 170, 178 and 179.

Wales

The Environment (Wales) Act (2016) introduces the Sustainable Management of Natural Resources[5] (SMNR) and sets out a framework to achieve this as part of decision-making by local authorities. Planning Policy Wales (PPW) Edition 11 (February 2021)[6] translates the principles of SMNR into use for the planning system. The key section of PPW which relates to Contaminated Land is 6.9 (Unlocking Potential by Taking a De-risking Approach), and in particular paragraphs 6.9.16 – 6.9.28.

Scotland

Planning Advice Note 33 (PAN 33) (December 2017)[7] provides advice on the implications of the contaminated land regime for the planning system in Scotland.

Key Variations Between England, Wales & Scotland

There are several differences in approach to controlled waters and human health risk assessment between each of the devolved nations within the UK that need to be taken into consideration when undertaking contaminated land risk assessments.

Groundwater and Surface Water

For groundwater and surface water, there are few differences in guidance and legislation between England and Wales, with the majority of variations in approach occurring in Scotland. Several key differences are pointed out below:

Water bodies subject to regulation are termed the “water environment” in Scotland and controlled waters in England and Wales.

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4 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/810197/NPPF_Feb_2019_revised.pdf

5 https://gov.wales/sites/default/files/publications/2019-06/sustainable-management-of-natural-resources-guide.pdf

6 PPW: https://gov.wales/sites/default/files/publications/2021-02/planning-policy-wales-edition-11_0.pdf

7 PAN 33: https://www.gov.scot/publications/pan-33-development-of-contaminated-land/

Within England and Wales, aquifers are classified as principal, secondary A, secondary B, secondary undifferentiated or unproductive. Within Scotland, the aquifers are classified according to their flow rate.

Source protection zones in England and Wales are used to provide a general level of protection for all drinking water sources. These do not apply within Scotland as all aquifers are considered to represent a potential source of drinking water.

Within Scottish guidance, it is stated that existing soil/dissolved phase contamination is deemed legacy contamination and the 'prevent' obligation of the WFD does not apply, however, the presence of free-phase product, whether recent or legacy in origin represents an ongoing source of contamination that should be prevented as far as reasonably practicable. The guidance is less well defined in England and Wales, but free-phase product of historical origin is classed as legacy contamination, with the obligation to only limit further impact.

Department of Environment, Food and Rural Affairs (Defra)[8] published updated statutory guidance which introduced a four category approach to determining whether land in England and Wales is contaminated or not on the grounds of significant possibility of significant harm (SPOSH). This was not adopted in Scotland, where the risk assessment is based on minimal risk.

It should be noted that the four category approach has not been adopted in Scotland under Part 2A or the planning regime. The Part 2A statutory guidance applicable in Scotland (Paper SE/2006/44 dated May 2006) does not reflect the changes introduced by Defra in April 2012 which allow for the use of C4SLs within Part 2A risk assessments. Additionally, it is considered that the principal of ‘minimal risk’ should still apply under planning in Scotland, based on current guidance.

The differences in approach highlight the importance of consulting the specific national guidance based on the site location prior to completing any risk assessment.

[8] Defra ‘Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance’. April 2012

CIRIA C552

Risk associated with contaminant linkages

Level	Description
Severe	Acute risk to human health; Major pollution of controlled waters (surface waters of aquifers)
Medium	Chronic (long-term) risk to human health; Pollution sensitive controlled waters (surface waters or aquifers)
Mild	Pollution of non-sensitive water resources.
Minor	Requirement for protective equipment during site works to mitigate health effects; Damage to non-sensitive ecosystems or species.

Probability of the risk occurring

Likelihood	Description
High likelihood	Contaminant linkages may be present, and risk is almost certain to occur in the long-term, or there is evidence of harm to the receptor.
Likely	Contaminant linkages may be present, and it is probable that the risk will occur over the long term.
Low likelihood	Contaminant linkage may be present and there is a possibility of the risk occurring, although there is no certainty that it will do so.
Unlikely	Contaminant linkage maybe present but the circumstances under which harm would occur are improbable.

An overall evaluation of the level of risk is gained from the comparison of the severity and probability as presented in the table below.

		Severity			
		Severe	Medium	Mild	Minor
Probability	High Likelihood	Very high risk	High risk	Moderate risk	Moderate / low risk
	Likely	High risk	Moderate risk	Moderate/ low risk	Low risk
	Low Likelihood	Moderate risk	Moderate/ low risk	Low risk	Very low risk
	Unlikely	Moderate / low risk	Low risk	Very low risk	Very low risk

A description of the typical consequences and potential actions required following each risk definition is provided below.

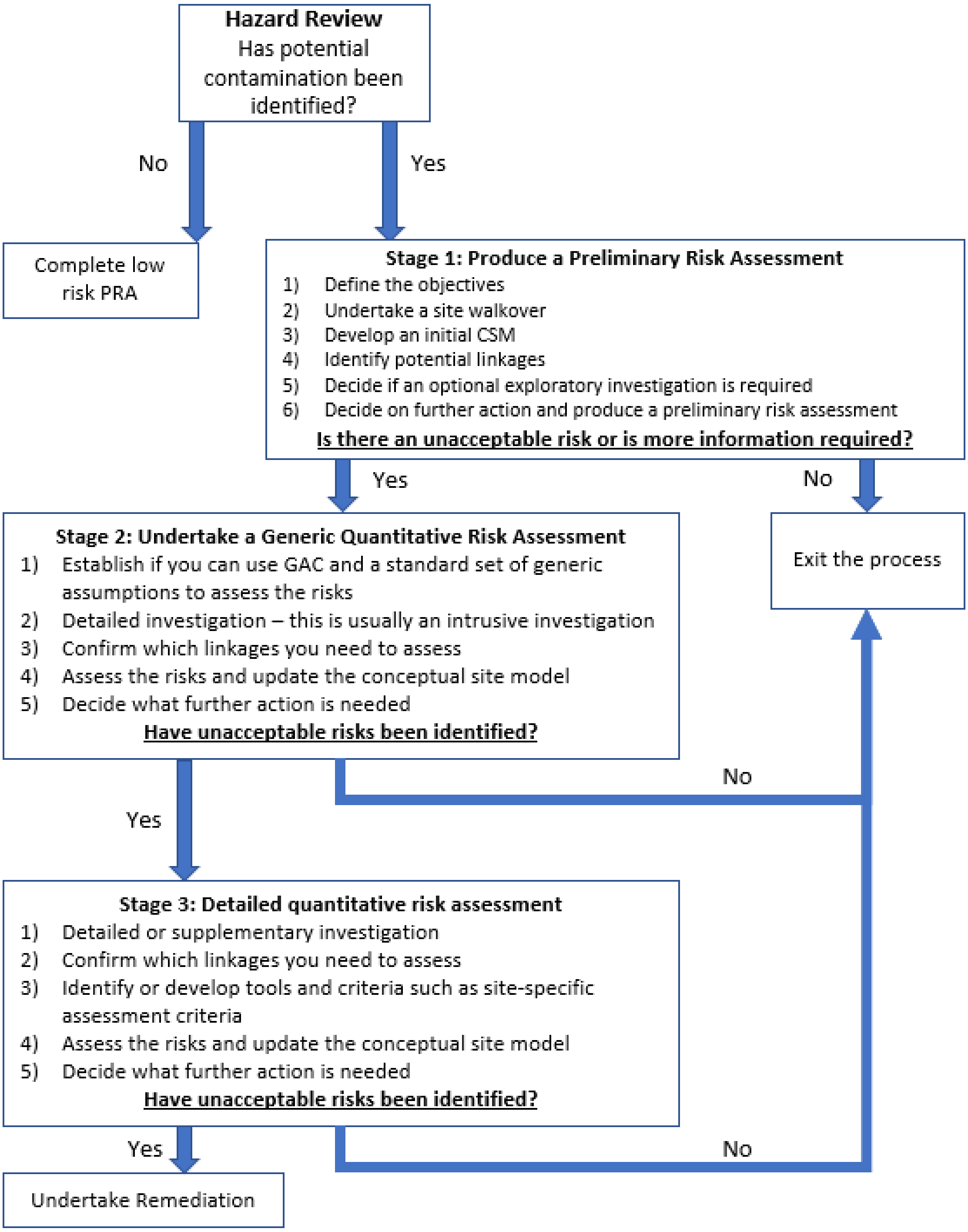
Classification	Definition
Very High Risk	Severe harm to a receptor may already be occurring, or a high likelihood severe harm will arise to a receptor, unless immediate remedial works / mitigation measures are undertaken.
High Risk	Harm is likely to arise to a receptor, and is likely to be severe, unless appropriate remedial actions / mitigation measures are undertaken. Remedial works may be required in the short-term, but likely to be required over the long-term.
Moderate Risk	Possible that harm could arise to a receptor, but low likelihood that such harm would be severe. Harm is likely to be mild. Some remedial works may be required in the long-term.
Moderate / Low Risk	Possible that harm could arise to a receptor, but where a combination of likelihood and consequence results in a risk that is above low, but is not of sufficient concern to be classified as mild. Limited further investigation may be required to clarify the risk. If necessary, remediation works are likely to be limited in extent.
Low Risk	Possible that harm could arise to a receptor. Such harm, at worst, would normally be mild.
Very Low Risk	Low likelihood that harm could arise to a receptor. Such harm is unlikely to be any worse than mild.

It should be noted that the identification of potential contaminant linkages does not indicate that they are significant. Task specific risk assessments for groundworkers, which may include stipulations regarding work control procedures and personal protective equipment (PPE), may need to be completed prior to works commencing.

Appendix B

PRA PROCESS DIAGRAM

Stages of the Preliminary Risk Assessment Process.



Appendix C

SAMPLING TECHNIQUES

Sampling Techniques:

Soils

With soils in which volatile organic compounds (VOC) are considered likely to be present, techniques that involve the least amount of disturbance and contact with the atmosphere are preferable to minimise the loss of contamination to the atmosphere. Hence, methods such as trial pitting, cable percussive or rotary drilling techniques are not considered to be appropriate, while methods such as lined windowless samplers will likely yield a more representative sample.

During intrusive investigations, consideration must also be given to the effects of disturbance, the potential to create a vertical pathway for contaminant migration, and the use of flushing media that can mobilise or alter the status of contamination within the soil. Similarly, samples must not be collected from below the water table, as these are not considered representative of contamination within the soil. Soil samples have limited holding times, beyond which the results of the chemical analysis are considered void due to the potential for degradation of the sample. It is important the samples are dispatched to the laboratory and analysed quickly.

Groundwater

With groundwater sampling, a variety of methods can be used, such as purging three well volumes, low flow sampling or passive techniques [9], however, the chosen technique must be appropriate for the type of monitoring well (guidance on well installation is provided in Environment Agency Science Report SC020093[10]) and the laboratory analytical testing required. For example, in cases where VOC contamination of groundwater is expected, techniques that minimise disturbance and exposure of the sample to air need to be used. Once gathered, preservation of the sample should take priority. Samples should be refrigerated (at 5±3°C) to prevent degradation of the sample prior to analysis. Guidance on the risk assessment and analysis of petroleum hydrocarbons in groundwater is provided by CL:AIRE[11]. For metals, field filtering and preservation is required for dissolved metals to prevent their precipitation out of solution. Further information is provided in BS ISO 5667-11 and BS 5667-3[12]. As with soils, groundwater samples have limited holding times, beyond which the results of the chemical analysis are considered void due to the potential for degradation of the sample.

Gasses and Vapour

[9] Further information is provided in BS ISO 5667-11:2009 Water Quality. Sampling. Guidance on sampling groundwaters

[10] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/290727/scho0106bkct-e-e.pdf

[11] https://www.claire.co.uk/component/phocadownload/category/22-important-industry-documents?download=573:petroleum-hydrocarbons-in-groundwater-guidance

[12] BS EN ISO 5667-3 Water Quality. Sampling. Preservation and handling of water samples

Gasses and vapour generally fall into two categories, (i) VOC, and (ii) permanent gases. Guidance on the investigation of ground gas and VOC is provided in BS 8576[13], CIRIA 665[14] and the VOC Handbook[15]. Permanent gases are usually collected by pumping directly from a gas manifold or tap, with collection in either a Gresham tube or Tedlar bag. In the case of a Gresham tube, a hand pump is used to pressurise a re-usable steel or aluminium cylinder with the sample gas and should ideally be purged using nitrogen gas before use. A Tedlar bag is a single use fluoroplastic film coated bag which does not require purging. However, like the Gresham tube, some form of pump usually needs to be fitted to the manifold or tap to provide a positive pressure to fill the bag. Neither Gresham nor Tedlar bags are suitable for vapour sampling.

Vapour sampling involves the use of active or passive approaches. Active sampling using the TO-15 methodology involves Silonite canisters or bottle vacs which are supplied under vacuum from the laboratory. The sample train restricts the flow of sample uptake.

Passive samples are collected by exposing a sorbent to the environment being sampled and allowing passive diffusion of contaminants onto the sorbent. Passive sampling approaches typically provide semi-quantitative results. The laboratory reports time weighed average concentrations in $\mu g/m^3$ for VOCs with published uptake rates.

[13] BS 8576 (2013) Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds
[14] Construction Industry Research and Information Association. WILSON S et al. Assessing Risk Posed by Hazardous Ground Gases to Buildings C665. London: CIRIA 2007
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Appendix D

DRILLING TECHNIQUES

Drilling Techniques

Method	Advantages	Limitations
Cable Tool A rig with a winch is used to repeatedly drop a weighted tool. A number of tools are available which can chisel, cut, crush and remove material. Due to the action of the tool there is a risk of instability and temporary casing is often advanced as the hole deepens. Installation of the casing and backfill materials takes place within the string of temporary casing (where this is used) which is removed in stages. Drilling depths are limited by rig size (commonly depths of <50 m in the UK) and diameters are a minimum of 150 mm.	Widely available Suitable for all soil and some rock types. Good sample return Rapid and relatively inexpensive set up. Temporary casing prevents collapse of loose strata and reduces risk of cross contamination	Progress will be slow in most consolidated deposits. Difficult to penetrate cobbles and boulders. Many downhole geophysical methods will not work inside temporary casing. Water is often required to aid drilling in unsaturated strata. Installation and removal of the temporary casing can cause smearing of borehole walls.
Rotary A cutting bit is mounted on a rotating drill pipe with a circulating flushing fluid to remove debris and cool the bit. The fluid and bit have a number of variants and there is a wide range of rig sizes. In unstable formations a flush can be chosen that invades the borehole wall and provides temporary stability. Drill-bit and flush choice depend upon the expected strata and the borehole depth. A range of borehole diameters can be drilled. In conventional drilling, the flush is injected into the hole through the drilling string, and discharges from the vicinity of the drill bit. The returning fluid and drill cuttings are forced upwards within the annulus of the hole to the surface where they are collected. The flush may be recirculated.	Drilling rates can be very rapid (even in strong rock) and can reach to considerable depths Cores can provide excellent strata information Boreholes can be left open in stable deposits to facilitate geophysics and other downhole testing methods (e.g., packer testing) The addition of specialist equipment to the rig can allow drilling in strongly artesian conditions	Fissured strata has the potential to slip into the borehole and trap the drill bit. Loss of flush (into fissures/ voids) can slow drilling rates and compromise subsequent samples. Initial set up and mobilisation can be expensive. Sample recovery can be poor. If liquids are used as the flush there is a need for storage and re-circulation on site. This may be significant if contaminated groundwater is present or space is limited. A long section of open hole may lead to contaminant mobilisation from one aquifer system to another.

Method	Advantages	Limitations
Rotary (air flush) Air flush can be used as a drilling fluid to aid the return of drill cuttings to the surface. The addition of small amounts of water to an air flush provides a mist flush. Reverse circulation using air can be used	Air flush can be used in fractured strata Readily available. Flush does not require treatment or disposal	Introduction of large quantities of air to groundwater may produce significant changes in chemistry. In unstable strata temporary casing will need to be used May mobilise VOCs.
Rotary (percussive) The addition of a hammer bit powered by compressed air allows a much more rapid rate of penetration when rotary drilling. Reverse circulation cannot be used when using percussive drilling.	Rapid penetration	Poor sample returns Introduction of large volumes of air into the aquifer.
Rotary (water flush) Water is used in place of air to lubricate the drill bit and return cuttings to the surface. This requires the provision of circulation tanks or pits on site and a suitable water source Reverse circulation drilling is commonly undertaken using a water flush	Reduces the generation of dust. Readily available	The addition of water will affect groundwater chemistry in the immediate vicinity of the borehole. In unstable strata temporary casing will need to be used.
Rotary (mud flush) Mud is a drilling fluid comprising water with an additive to provide additional viscosity and density. Mineral (such as bentonite) and chemical (e.g., guar gum) muds are available.	Loose borehole walls can be stabilised. The use of ‘heavy’ muds can aid drilling in artesian conditions. Restricts fluid invasion of the formation.	The addition of mud (and any degradation products) will affect the hydraulics of the borehole wall and the aquifer and groundwater chemistry.
Window sampling The sampler uses one-metre long extension rods and is driven into the ground by a percussion method using a drop hammer, obtaining one metre long plastic lined cores to a depth of up to 10m in suitable conditions (generally 6m), providing a full soil profile.	Low cost drilling method Relatively lightweight, compact, mobile rig on rubber tracks for easy access on and to site and is ideal for sites with restricted access	It is generally suitable for cohesive strata and some sands only.

Appendix E

GENERIC ASSESSMENT CRITERIA

APPENDIX E

Examples of Soil GAC- C4SL for Commercial and public open space end uses, values are in mg/kg

PLEASE NOTE GAC MUST BE SET ON A SITE SPECIFIC BASIS, THE FOLLOWING SCREENING LEVELS ARE FOR GUIDANCE ONLY

Substance	Commercial	Public Open Space 1	Public Open Space 2
Arsenic	640	79	170
Benzene	98	140	230
Benzo(a)pyrene	77	10	21
Cadmium	410	220	880
Chromium VI	49	21	250
Lead	2300	630	1300

Appendix F

INITIAL HAZARD REVIEW TEMPLATE

Example of an Initial Hazard Review format (contaminated land):

Table A: Is a desk study required (without an IHR)?

SCHEME type / features		Trigger for preparing an IHR?
Substantial earthworks (e.g. embankment, cutting, scouring protection).	Yes / No	Yes = proceed to desk study No = IHR sufficient
Installation of above-ground ducting / cabling	Yes / No	Yes / No = IHR sufficient
Installation of below-ground ducting / cabling	Yes / No	Yes = proceed to desk study No = IHR sufficient
Installation of new feeder station or electricity substation on concrete pad?	Yes / No	Yes / No = IHR sufficient
Removal of pre-1990s electricity infrastructure e.g. substation, cabling	Yes / No	Yes = proceed to desk study No = IHR sufficient
Installation of OLE stanchions on concrete pads (minimal excavation)	Yes / No	Yes / No = IHR sufficient
Structure (e.g. bridge, footbridge, viaduct, tunnel, platform)	Yes / No	Yes = proceed to desk study No = IHR sufficient
Building (e.g. office, station, depot)	Yes / No	Yes = proceed to desk study No = IHR sufficient
Drainage asset (e.g. track drainage, culvert, etc.)	Yes / No	Yes = proceed to desk study No = IHR sufficient
Civils work with minimal excavation (e.g. fencing, walkway)	Yes / No	Yes / No = IHR sufficient
Other civils work (e.g. foundations).	Yes / No	Yes = proceed to desk study No = IHR sufficient
New or modified sidings	Yes / No	Yes = proceed to desk study No = IHR sufficient

Table B: IHR

Feature	Applicable?	RAG status*
Potential SOURCES of contamination		
Landfill within scheme boundary?	No	
Landfill within 250m of scheme boundary?	No	
Hazard Directory entries?	Crosses Babbling Brook River at Ch.146	
Obvious contamination observed, e.g. staining of the ground	No	
Contaminant spread PATHWAYS		
Surface water (rainfall) running off the site to drains or stream / ditch	Drain noted	
Sensitive RECEPTORS		
Aquifer status – superficial	Secondary undifferentiated	
Aquifer status – bedrock	Principal	
Superficial SPZ?	No	
Bedrock SPZ?	Yes – Zone 1	
Distance to nearest surface water receptor	<10m	
Residential properties adjacent to scheme?	No	
Residential receptors within 100m of scheme?	Yes	
Residential receptors within 250m of scheme?	No	

* Using the CIRIA C552 appendix descriptions of receptor sensitivity

RAG Status:

Green = low risk, unlikely to trigger the need for a detailed desk study

Amber / Red = moderate / higher risk, detailed desk study is recommended

Appendix G

REFERENCES

APPENDIX G: REFERENCES

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- CAR-SOIL™ Control of Asbestos Regulations 2012: Interpretation for Managing and Working with Asbestos in Soil and Construction and Demolition Materials: Industry guidance- CL:AIRE (2016)
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