Historic England

Land Contamination and Archaeology

Good Practice Guidance

This guidance note has been prepared by AECOM Infrastructure & Environment UK Ltd.

This document is a revised version of *Guidance on Assessing the Risk Posed by Land contamination and its Remediation on Archaeological Resource Management*, Science Report P5-077/SR, published by English Heritage and the Environment Agency in April 2003.

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Front cover:
Remains of drained settling tank with central control building at Steeley Chemical Works, Hartlepool.

Summary

With a national drive to redevelop brownfield land across the country, planners and developers are increasingly faced with sites that may have been contaminated through previous industrial, commercial or agricultural use. Identifying archaeological remains early on within a development site is an important step in understanding how archaeology can influence remediation strategies and affect construction timescales.

This updated guidance offers advice primarily to those involved in the assessment and management of land contamination, but also to archaeologists, planning and archaeological officers, developers and their consultants. The content has been updated in response to the increase in brownfield redevelopment in England, and to reflect current legislation, planning policy and guidance that is relevant to contaminated land and archaeology.

This guidance raises awareness of the need to consider archaeology during land contamination assessment and management, using case study evidence to show how archaeology can be a receptor, a source of contamination or a pathway for the transfer of contamination to another part of a site. It also recommends steps to make sure that the level of risk is identified at an early stage through a systematic process of assessment, site investigation and stakeholder consultation, so that archaeological remains are considered during remediation design.

Contents

Introduction

This guidance is for those involved in the assessment and management of land contamination, archaeologists, planning and archaeological officers, developers and their consultants.

1 Legislation, Planning Policy and Guidance

1.1 Contaminated land

UK legislation aims to address the issue of historic land contamination and the risks it can pose to human health, property or the environment by identifying the presence of a source, a pathway and a receptor. The Environment Act 1995 introduced Part 2A into the Environmental Protection Act 1990, with statutory guidance issued to explain how the Part 2A regime should operate.

In the context of Part 2A, land is contaminated if it causes or poses a possibility of significant harm or pollution in its existing state. Harm is defined as harm to the health of living organisms or other interference with the ecological systems. Part 2A also references the avoidance of harm to property, which includes scheduled monuments.

Current best practice generally follows the approach as set out in Model Procedures for the Management of Land Contamination (Contaminated Land Report (CLR) 11), which provides a specific framework for land contamination management and contains an extensive list of guidance covering most stages of the process. Though superseded in 2012, Annex 1 of Defra Circular 01/2006 provides a useful historic summary of the principal regimes affecting land contamination and how they interact.

The model procedures incorporate existing good technical practice, including the use of risk assessment and risk management techniques, into a systematic process (including producing a hierarchy of documents) for identifying, making decisions about and taking appropriate action to deal with contamination, in a way that is consistent with policy and legislative requirements.

The Local Planning Authority is the principal regulator for assessing ground contamination, and therefore contamination issues are a material concern in development control. Section 11, paragraph 109 of the National Planning Policy Framework (NPPF) states that the planning system should contribute to and enhance the environment by preventing new and existing developments from being affected by unacceptable levels of soil, air or water pollution, and to remediate and mitigate despoiled, degraded, derelict, contaminated and unstable land where appropriate. Therefore, for planning purposes, the NPPF requires risks assessments arising from contamination to be considered in context of the current environmental setting. In this respect, the underlying principle of identifying and dealing with risk to safeguard human health and the environment in a development context is similar to the Part 2A regime.

Policy 111 of the NPPF encourages the effective reuse of previously developed land, which may have implications for the conservation of the historic environment, particularly industrial heritage features. NPPF Policy 120 is of particular relevance to contaminated land risk prevention, and Policy 121 states that a site should be suitable for its new use and take into account pollution arising from previous uses.

Therefore, an objective of assessing contaminated land is to ensure that unacceptable risks to human health, buildings, property and the natural and historic environment are identified and managed, and that planning decisions are informed by adequate site investigation information.

1.2 Historic environment

Guidance to the Part 2A regime specifies that scheduled monuments should be considered as a type of receptor when determining contaminated land.

The Ancient Monuments and Archaeological Areas Act 1979 is the central piece of legislation that protects scheduled monuments. A scheduled monument is a site of national importance and, for the purposes of the Act is defined as 'any monument which in the opinion of the Secretary of State is of public interest by reason of the historic, architectural, traditional, artistic or archaeological interest attaching to it' (Section 61 (12)).

Archaeological assets are also a material consideration during the planning process. The conservation and enhancement of archaeological assets forms an important part of the NPPF and section 12 deals specifically with conserving and enhancing the historic environment which includes archaeology, built heritage and historic landscape.

The NPPF makes clear the importance of being able to assess the significance of heritage assets that may be affected by a development, and states that when determining applications, local authorities require an applicant to describe the significance of assets that may be affected. For sites where there are known heritage assets, or there is potential for heritage assets with archaeological interest, local authorities require developers to submit an appropriate desk-based assessment and, where necessary, field evaluation.

Policy 132 recognises that heritage assets are irreplaceable and that where proposed development may impact on the significance of designated heritage assets, great weight should be placed on its conservation; the more important the asset, the greater the weight should be given. Substantial harm to or loss of assets of the highest significance (scheduled monuments, registered battlefields, grade I and II* listed buildings and registered parks and gardens and World Heritage Sites) should be wholly exceptional. The NPPF notes that alteration or destruction of a heritage asset or development within its setting can harm its significance.

The NPPF states that the effect of a planning application on non-designated heritage assets should be taken into account when considering the application. Policy 135 sets out the need for a balanced judgement between the significance of the heritage assets and the scale of any harm or loss, when considering assets directly or indirectly affected by proposed development. For developments which involve the removal of the significance of heritage assets, or the physical removal of assets, Policy 141 provides guidance to local planning authorities regarding the requirements upon developers to mitigate this.

The identification of archaeological assets, or the potential to encounter archaeological assets, is therefore a material planning concern and planning considerations should be informed by adequate site investigation information.

2 Land Contamination Assessment

Contamination is more likely to arise in former industrial areas but cannot be ruled out in other locations, including in the countryside. In addition, some areas may be affected by the natural or background level of potentially hazardous substances, such as methane, radon or elevated concentrations of metallic elements, and only a specific investigation can establish whether there is contamination at a particular site.

The basic approach to the risk assessment process is described in the following sections. However, detailed guidance should be sought from CLR11, which recommends a tiered approach to risk assessment with the three tiers being:

- Tier 1 Preliminary risk assessment (PRA): a qualitative assessment as part of a Phase 1 report. This is largely an information collection exercise that may include a site reconnaissance and a desk-based study. It may also include limited site investigation, for example, the collection of surface soil samples.
- Tier 2 Generic quantitative risk assessment (GQRA): a quantitative assessment using generic assessment criteria to screen site specific ground condition data as part of a Phase 2 report. This typically includes the collection of further information about the site and can include a staged intrusive site investigation.
- Tier 3 Detailed quantitative risk assessment (DQRA): a quantitative assessment involving the generation and use of site specific assessment criteria. It may include further targeted information collection to support the generation of the criteria and typically involves the use of modelling software to assess the movement of contaminants in the environment and/or the detailed exposure characteristics of the receptor.

Each tier of the risk assessment process is iterative and can be divided into four main steps as shown in Table 1. Fundamental to this approach is the development of a conceptual site model (CSM) and the consideration of the potential pollutant linkages identified.

Steps	Details
Stage 1 Hazard identification	Identifies potential contaminants of concern and the sources of those contaminants in the ground
Stage 2 Hazard assessment Analysing the potential for unacceptable risks (CLR11)	Assesses what exposure pathways and receptors could be present and how these might form pollutant (source-pathway-receptor) linkages at the site. Considers the plausibility of these potential pollutant linkages and their possible adverse effects
Stage 3 Risk estimation What degree of harm or pollution might result, and to what receptors, and how likely is it that this may arise as a result of a hazard (CLR11)	Estimates or predicts the magnitude of the potential effects on the receptor and the probability or likelihood that these might arise as a result of the presence of the contaminant in the ground. This can include the consideration of three aspects of likelihood: (1) the likelihood of an event occurring, (2) the likelihood of a release of the contaminant, and (3) the likelihood that harm might occur as a result of the release
Stage 4 Risk evaluation Deciding whether a risk is unacceptable (CLR11)	Information from the previous stages for each pollutant linkage is analysed, the uncertainties in the process identified and a decision is made as to whether or not the site poses an unacceptable risk to the receptor. If the site is found to pose a potentially unacceptable risk it may be necessary to (a) revisit the earlier steps of the risk assessment to reduce the uncertainty in the risk estimation step or (b) instigate appropriate risk management measures, such as produce an options appraisal and/or remediation strategy

Table 1
Land contamination risk assessment stages.

2.1 Conceptual site model

A risk assessment is based upon a conceptual site model (CSM). A CSM is a textual, diagrammatic, pictorial or graphical representation of the relationship(s) between contaminant source(s), pathway(s) and receptor(s), known as pollutant linkage(s), that are relevant to the site and helps identify gaps in information and understand the site's sensitivity.

The pollutant linkage is developed on the basis of hazard identification, for example, at the start of the risk assessment process, and is refined during the project cycle. The type of contaminant, environmental setting and ground conditions play a key part in identifying the presence of a potential pollutant linkage. It is also important to recognise that for a risk to a receptor to exist, all three elements must be present. The CSM should also include any uncertainties identified and assumptions made about the site.

In the context of archaeological resources, the resource may be present as a potential source of contamination, a potential receptor or as a potential pathway for the transfer of contamination from a source to a receptor. In addition, the archaeological resource present on a site, or adjacent to the site, may not form part of a pollutant linkage but may still need to be considered in terms of the potential impact on works carried out to investigate the pollutant linkages present. In particular, the archaeology of the industrial age provides a significant challenge, since the building fabric and wastes may be significantly contaminated with respect to exposure for archaeologists, development workers, future site users and the environment, including water resources.

One of the key advantages to having a comprehensive, evolving CSM is that it can aid communication within the stakeholder group for the site. Where many different parties are involved with a site, each with their own aims and objectives, the CSM is a valuable tool in ensuring that all have the same understanding, or at least a framework for discussion, of the issues relevant to the site.

3 Archaeological Assessment

The assessment of archaeological assets in land contamination management, may take place within the Part 2A regime, during voluntary remediation by the landowner, or as part of the planning process.

3.1 Identifying Heritage Assets

Understanding a site's history is important for assessing potential impacts of site investigations or remediation on archaeological assets. Also, if the archaeological asset is a potential source of contamination, identifying the asset early on in the process means mitigation can be included in the remediation design, avoiding duplication of effort and saving the developer time and money.

The application of land quality and contamination guidance for new developments is primarily controlled by the planning system, where a staged approach to site assessment and investigation with a risk-based methodology is recommended. A similar approach is applied in the planning system to the identification of archaeological assets, where the developer must submit sufficient information relating to the potential for a site to contain archaeology, so that the likely impact can be determined. This information is gathered through a staged programme of archaeological investigation, consisting of desk-based assessment and, where necessary, invasive and non-invasive methods of field evaluation. The results of these investigations can produce detailed site information which can inform the cost and scope of a site's remediation strategy.

A review of existing archaeological site reports will help identify known heritage assets within a site. Table 2 lists the type of archaeological information that may be available to contaminated land specialists during contaminated land preliminary risk assessment and hazard identification.

Other useful data sources for the identification of heritage assets include the Heritage Gateway and the National Record of the Historic Environment. However, these data sources may not necessarily list all known assets, and importantly they will not state the likelihood of previously unknown heritage assets to be present in the site. In addition, standing buildings on a site may not be statutory listed but may be of local historic interest, and could be a planning consideration. In order to fully understand a site's cultural heritage potential it is recommended that early consultation is carried out with the local authority's Historic Environment Record (HER) Officer. Contact details for all local authority and most national park authority HERs in England are available from the Heritage Gateway. Advice should also be sought from the relevant local authority's archaeologist and historic buildings conservation officer.

Investigation	When is this type of survey carried out?	What type of information is gathered by this survey?	If available, where can I find this report?
Desk-based assessment	For proposed development sites if requested by the local authority's archaeology advisor Part of evidence base to support a planning application and to inform requirement for further investigation	Site/asset identification: location of known heritage assets within the site and within close proximity to the site Historic maps, detailed history of the site including previous and uses Historic aerial photography and recent images and site description from a walkover survey Statement of potential for encountering further heritage assets within the site	Local authority's planning portal – supporting documents associated with planning application Local authority's Historic Environment Record, or search Archaeology Data Service online reports Developer will have a copy on file, either as commissioning body or successor in title
Modern disturbance review	For brownfield sites where significant levels of ground disturbance are expected Part of evidence base to support a planning application and to inform further investigation/scope of planning condition	Detailed site history Historic maps and map regression Historic photos Description of historic borehole logs Cross-section through site showing depths of sediments Plan of site identifying zones of greatest disturbance and zones of archaeological potential	Developer will have copy on file, either as commissioning body or successor in title May form part of planning application evidence base, check local authority's planning portal
Geophysical survey	Usually as part of pre-application site evaluation to inform scope of further evaluation and/or enable a planning application to be determined	Site/asset identification: multiple techniques depending on ground conditions and soil type Will identify and interpret buried archaeological features	Developer Local authority's Historic Environment Record, or search Archaeology Data Service online reports Planning application evidence base, check local authority's planning portal
Trial trenching /test pitting	Usually as part of pre-application site evaluation; also often in response to a planning condition, especially on urban sites where access for evaluation prior to planning consent is problematic	Site/asset characterisation: trenches will target sites of known/potential archaeology in order to gather more information about character and extent of remains Report will provide information about depth and composition of deposit sequence within the site	Developer Local authority's Historic Environment Record (appointment is required), or search Archaeology Data Service online reports Planning application evidence base, check local authority's planning portal

Table 2
Types of archaeological investigation.

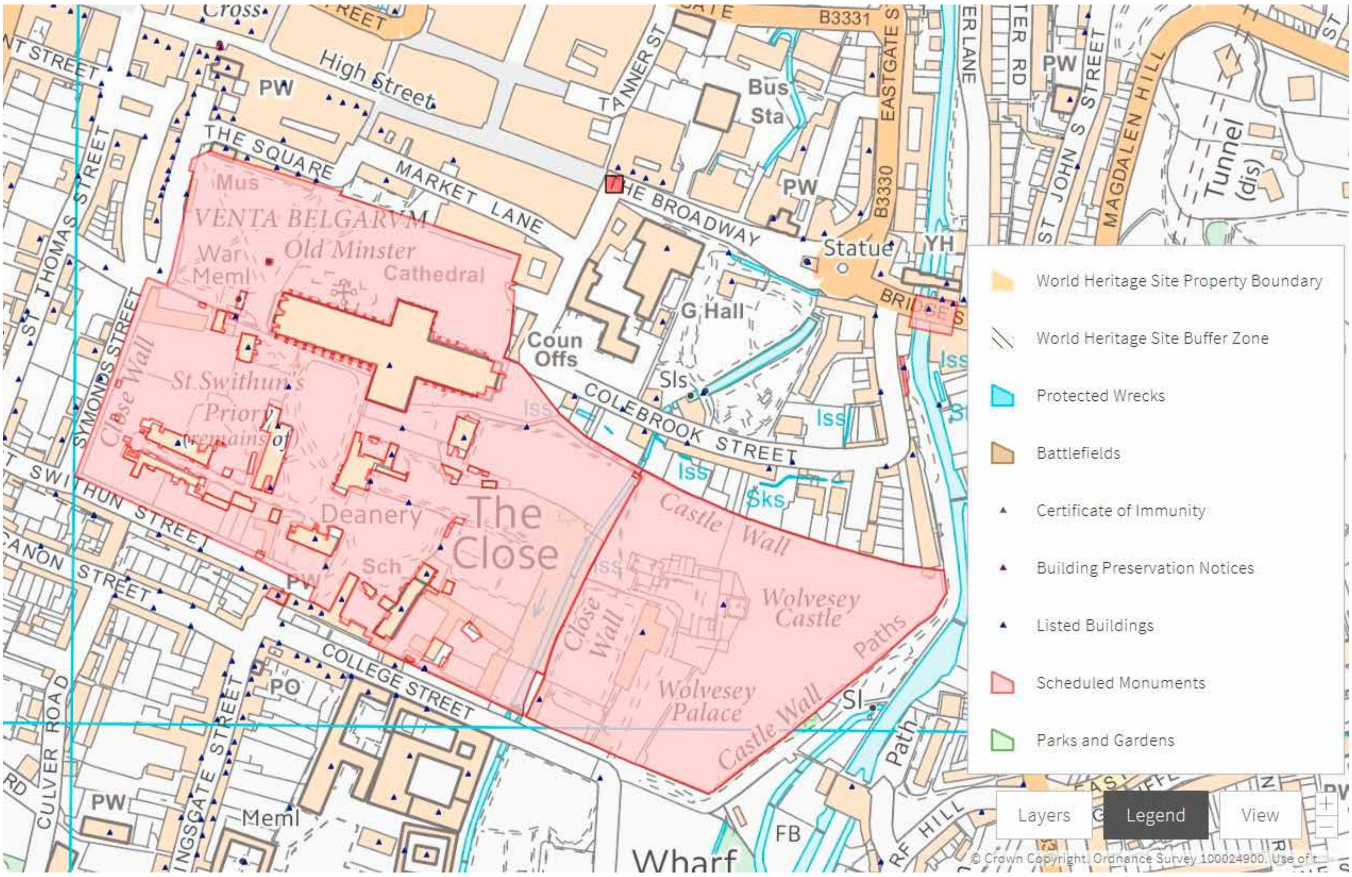

Figure 1
Extract from the National Heritage List for England.

Data sources for identifying designated heritage assets include the Multi-Agency Geographic Information for the Countryside which provides information relating to world heritage sites, scheduled monuments, listed buildings and also non-statutory heritage assets. More detailed information about these asset types can be found by using the map search facility on the National Heritage List for England. This site will provide a reference number for the asset, a description of the remains and the reasons for its designation. The map will locate the asset, including any applicable buffer zone, and the asset's spatial extent can be downloaded as a GIS shapefile.

3.2 Scheduled monument consent

Impacts to a scheduled monument can arise from activities that may alter the monument's physical preservation, resulting in alteration or destruction. This includes damage to and removal or displacement of artefacts and deposits. Impact can also occur from works in the vicinity of a scheduled monument, for example, works that result in changes to local hydrology can affect the preservation of scheduled waterlogged remains.

If a scheduled monument is present within a site, or adjacent to a site, early engagement with the regional officer for Historic England is recommended so that the potential for impacts can be discussed. Contact the relevant Historic England local office.

As with any other scenario, any activity associated with hazard assessment that may affect a scheduled monument will require scheduled monument consent. The timescale for receiving scheduled monument consent can vary; an initial response should be provided within 14 working days. However, a final decision can take up to four months from receipt of the application. It is important, therefore, that scheduled monuments are identified as early as possible in the risk assessment process, so that the timetable for consent (if required) can be accommodated in the programme for site investigations.

Applications for scheduled monument consent are submitted to Historic England and information about how to apply and the level of supporting information required can be found on the Historic England website.

4 Contaminated Land Risk Assessment and Archaeology Assessment

There is evidently a commonality in approach to risk assessment for both disciplines, and information gathered for one discipline may enhance the understanding and management of the other. Archaeological remains can be quite difficult to identify and can range in character from deeply-buried deposits to relatively recent extant structures. Understanding the archaeological issues associated with a site and being able to access available archaeological information is important if best practice in land contamination and remediation is to be achieved.

Table 3 shows the stages of contaminated land risk assessment and how each stage corresponds with the traditional stages of archaeological assessment. The table also illustrates key communication and consultation stages, when engagement with stakeholders could occur. Further information on the consultation stages is presented in Table 4.

Contamination risk assessment process				Archaeology assessment	Consult
Tier	**Step***	**Process**	**Activity**	**Activity**	**Stage**
Preliminary Risk Assessment	Hazard Identification	Develop initial CSM Identify potential Source Pathways and Receptors Identify uncertainties and gaps in information the CSM	Establish former uses of the site and identify potential contaminants by consulting historical maps, aerial photos, geological maps, historical documents, trade directories etc	**Assess:** Establish known and potential archaeology in site. Review existing archaeological records, National Heritage List, Local Planning Authority HER, Historic England Archive, local Records Office/archives Examination of historic mapping and other primary/secondary documentary sources Review grey literature including archaeological assessment and fieldwork reports Determine whether risk requires further work, ie site investigation	C1 C2
Preliminary Risk Assessment	Hazard Assessment	Identify plausible pollutant linkages and refine CSM	Analysing potential for unacceptable risks (what pathways and receptors are present, what pollutant linkages could result and potential effects) Consider plausibility of the pollutant linkages May include basic site investigation.		C3
Generic and/or Detailed Quantitative Risk Assessment	Risk Estimation	Design and undertake main site investigation to investigate plausible pollutant linkages and uncertainties identified in the CSM Estimate the risk to the receptor by using generic risk assessment criteria and/or undertake a detailed specific assessment Further refine the CSM	Detailed site investigation, collection of samples (soil, water, gas), further characterisation of the site including extent and nature of contamination, determination of representative contaminant concentrations in relevant media, comparison with generic guideline values or site-specific assessment criteria	**Evaluate:** Gather more evidence to inform nature of constraint and level of risk May entail non-intrusive site investigation techniques such as geophysical survey and field walking Results of non-intrusive will inform suitability and scope of intrusive techniques such as test pitting or trial trenches	C4
Generic and/or Detailed Quantitative Risk Assessment	Risk Evaluation	Identify and evaluate uncertainty Identify unacceptable risks from pollutant linkages Identify and evaluate risk management options	Evaluate uncertainty in risk assessment process. Determine acceptability of risk to the receptor Is risk unacceptable? Do you need to return to the risk assessment process to reduce uncertainty, or investigate risk management options, and develop remediation strategy?		C5

* Note: Individual tiers can include one or more of the 4 risk assessment steps. Steps selected that best align with process and activities

Table 3
Summary of contaminated land assessment and archaeological assessment processes.

C1	**Early consultation – pre-assessment process** ■ Early engagement is key to delivering a successful project ■ The stakeholder group involved with a site will vary.Where both contamination and archaeology issues are present/suspected, the parties involved may include the developer/site owner, regulator, land contamination (and geotechnical consultant), subcontractors, engineer/architect, local authority archaeologist and, when dealing with a scheduled monument, the inspector of ancient monuments ■ Early multi-disciplinary consultations allow the various parties to take account of concerns raised by others, which can be incorporated at the beginning of the assessment process
C2 C3	**Hazard identification and hazard assessment stage** ■ Consultation at this stage of the process between multi-disciplinary technical specialists including heritage professional and contaminated land consultant is critical ■ The presence of archaeological Evidence/contamination is likely to have time and cost implications for the project in subsequent phases of works and the earlier these are identified, the easier it is to accommodate them in the development plans for the site ■ Early consultation allows development of a more robust CSM and a reduction in the uncertainty associated with the site ■ There is the potential for information transfer between the land contamination and the archaeological assessment at this stage, for example, data sources to be consulted in the hazard identification stage of the land contamination assessment and the desk-based assessment stage of the archaeological evaluation
C4	**Risk estimation stage** ■ Based on the robust CSM, continued communication and coordination will enable the development of a coherent site investigation and mitigation strategy to address the potential contamination issues and, where possible, protect the archaeological assets in situ, reducing the likelihood of accidental impacts and harm to archaeological remains or the wider environment ■ Communication at site investigation design stage can lead to more effective management of the site investigation and can result in cost and time efficiencies. These may include, where possible, using the same investigative techniques for both contamination and archaeological purposes although the specific objectives may vary. Management efficiencies may include designing contamination investigation to minimise vehicle and/or people movements in areas of the site that are particularly vulnerable in terms of archaeological resources ■ As per hazard identification and hazard sssessment stage, there is the potential for sharing information at this stage, to aid the design of future remediation and/or archaeological mitgation strategies
C5	**Risk evaluation stage** ■ An appropriate remediation strategy for a site should take account of archaeological assets in addition to the requirement to break any pollutant linkage, whether or not the archaeology is part of the linkage. Communication between the archaeologist and contaminated land consultant should take place in order for an appropriate remediation strategy to be developed for the site (refer to Remedial Options section)

Table 4
Consultation stages referenced in Table 3.

5 Site Investigation Techniques

5.1 Site investigation combined survey

If a development site is believed to have both contamination and archaeological issues, then there may be scope to combine site investigation surveys. This will generally involve an archaeologist monitoring the excavation of geotechnical test pits and producing their own site records. It can also entail a geotechnical engineer retrieving intact cores for an archaeologist to assess off site.

There are many benefits in combining surveys; the most obvious including cost and efficiency savings. Other benefits include the quality of the primary record. Descriptions given to deposits by geotechnical engineers can be very different to the descriptions given by archaeologists and, therefore, a less ambiguous and more relevant record will be collected if surveys are combined. For example, the term 'made ground', can be used in borehole logs to describe ground that is something other than substrate, and is suggestive of relatively recent deposits with relatively low archaeological potential. However, made ground may contain features of historic interest, in particular floor surfaces, and foundations or cellars associated with former structures, which would be identified by a monitoring archaeologist as being of potential archaeological interest.

Combining geotechnical site investigation works with archaeological monitoring could enhance the quality of the site data, inform the risk assessment process for both contaminated land and archaeology, avoid duplication of effort and cost in terms of repeat site investigations and help inform both the site's remediation strategy and the scope of archaeological mitigation.

The output from a combined survey can produce a 3D stratigraphic model of the development site incorporating both geotechnical and archaeological data. This will show the areas of greatest archaeological potential and can therefore show where development will impact archaeological remains [Figure 2].

However, a combined survey will not be applicable to all sites and the suitability of a combined survey will depend on several factors, including the nature of the underlying sediments, the type of information trying to be retrieved and the nature of the site conditions. The decision to proceed with a combined survey when designing a site investigation should only be made following consultation between the developer's geotechnical engineer and archaeologist.

5.2 Site investigation design

When combining geotechnical and archaeological works, a good understanding of the risk of contamination is necessary. As the case studies have shown, archaeological remains can form part of a pollutant linkage and comprise a source, pathway or receptor.

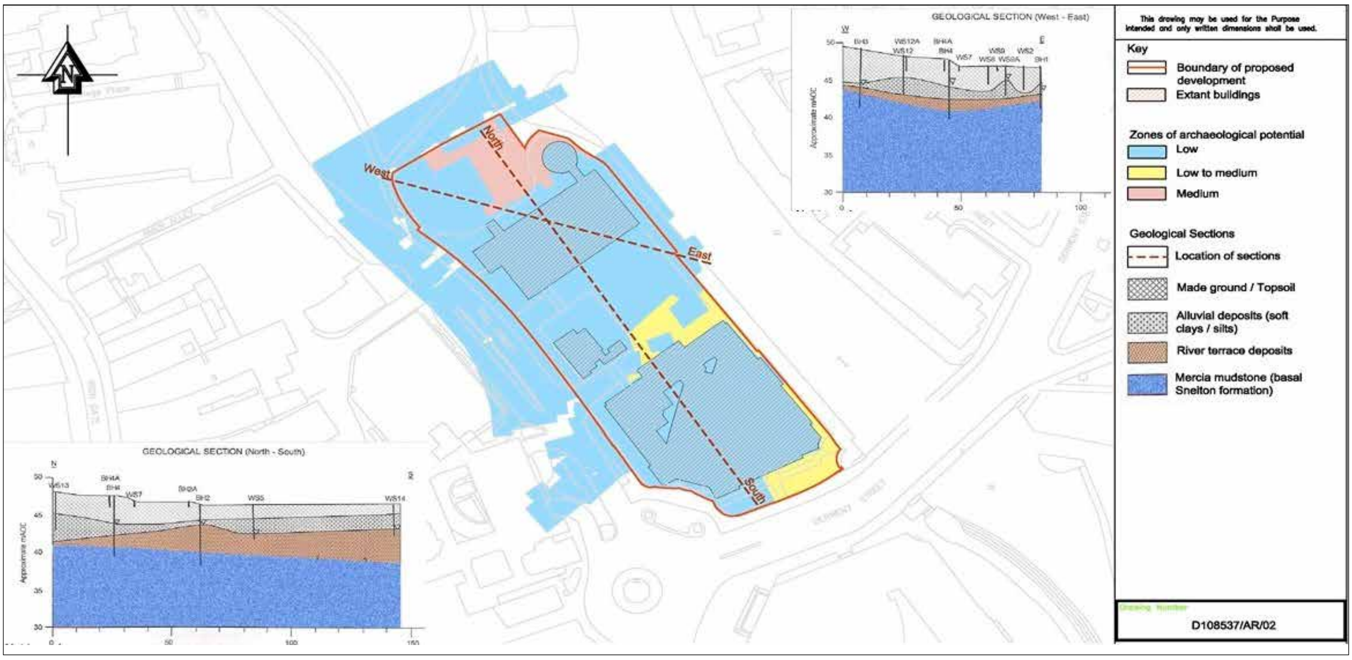

Figure 2
Deposit model using geotechnical and archaeological data.

The design of any site investigation should be site-specific and driven by the conceptual model of the site. Some of the factors likely to influence the selection of investigation method(s) for both land contamination and archaeological assessments include:

- The objectives of the investigation and the effectiveness of the methods to achieve them, taking account of issues including ground type, sampling requirements, nature of archaeological asset and contaminant type.
- Environmental impact, for example, potential effect on archaeological assets present on site or adjacent sites.
- Health and safety implications.
- Climate and wet/dry weather constraints.

There is a range of intrusive and non-intrusive methods of site investigation techniques that can be used in both land contamination and archaeology assessments. However, in land contamination assessments, non-intrusive techniques tend not to be as widely used as intrusive methods, and where they are used, it is generally in conjunction with, or as a precursor to, an intrusive investigation.

The principal techniques are listed in Table 5 and information relating to the advantages and limitations is available in Environment Agency (2000b and 2002c), Nathanail *et al* (2002) and CIRIA (2002).

Investigation type	Land contamination information obtained	Useful data for archaeologists
Non-invasive surveys		
Geophysical survey: Radar (ground penetrating radar)	Utility mapping, detection of voids and chambers, bedrock location and structure and mapping of made ground and landfill thickness	Particularly effective for detecting buried structures, such as walls, and for location of voids such as culverts or crypts
Geophysical survey: gradiometer or magnetometer	Detection of buried structures and underground pipes. Characterisation of landfill depth and extent. Detection of certain geological formations and discontinuities	Sub-soil cut features may be identified by difference in magnetic properties of their fill. Strongly heated features such as hearth and kilns produce strong, readily detected signatures
Geophysical survey: soil conductivity	Detection of buried structures, voids, former landfill sites, contaminated ground and leachate plumes	Provides rapid overview of sub-surface character
Geophysical survey: soil resistivity	Detection of structures and voids, disturbed ground, contaminant spills and leachate plumes	Will identify structures that differ strongly in resistance to subsoil, such as walls and ditches
Geophysical survey: resistivity tomography	Location of foundations, infilled ditches and ponds. Landfill character	Profiling buried features with strong resistance contrast to subsoil, such as walls, pits or ditches
Microgravity surveys (gravity surveying)	Detection of buried voids or tanks	Detection of buried structures or features, such as walls
Topographical survey	Site characterisation, identification of uses and structures	Site characterisation. Mapping of structures and earthworks, areas of past disturbance and intrusive damage to archaeological deposits
Soil chemical survey	Surface soil sample collection	Identification of past occupation or activity areas, industrial practices, etc
Invasive surveys		
Trial pits or trenches	Visual inspection of the soil profile and geology. Collection of soil samples Determine depth to the water table. Use of in situ tests	Visual inspection of stratigraphy Assessment of artefact concentration Assessment of the extent, character and preservation of archaeological remains Collection of artefacts and soil samples
Drilling – cable percussion, rotary cored/open hole, hand or power auger, flight auger, window sampling	Visual inspection of the soil profile and geological succession. Collection of samples Depth to the water table. Use of *in situ* tests	Assessment of soil and sediment stratigraphy, particularly in deep alluvial sediments Recovery of samples

Table 5
Types of site investigation.

5.3 Potential issues to consider

When planning or carrying out site investigation works, in addition to the consideration of the impact of the site investigation on archaeological assets, it is also important to mitigate the potential impact of other activities to make sure that archaeological resources are not impacted. Examples include:

- Vehicle and plant movement: the weight of heavy plant or other imposed loads may cause soil failure through shearing or compaction resulting in the displacement of, and physical damage to, archaeological remains. The use of loading plates, low pressure tyres or geotextile mats could all be considered.

- Radial stresses that can damage archaeological assets, including vibration impacts that can cause physical damage to structures of archaeological interest.

- Design of site investigation to make sure that no pathway is created from the investigation works; for example, using auger boring to assess the soil stratigraphy could create a pathway for the transfer of mobile contaminants to an underlying aquifer.

- Weather conditions, for example, avoid carrying out site investigation in wet weather when soil strength is lower, leaving any archaeological deposits more prone to impacts from wheel rutting or compaction.

To achieve mitigation of the site specific risks, it is important that all parties communicate with each other early on, and consider potential risks from the site specific design elements of the investigations. Measures, such as ensuring site personnel (including sub-contractors) are aware of the archaeologically sensitive nature of the site, provision of accurate site plans showing the location of proposed intrusive investigations, adequate supervision on site, the use of appropriate equipment and the proper reinstatement or disposal of waste arising, should all assist in ensuring that the archaeological resource is not impacted unnecessarily.

6 Remediation

The design and implementation of an appropriate remediation strategy for a site should take account of the archaeological resource in addition to the requirement to break any pollutant linkage, whether or not the archaeology is part of the linkage. The selection of appropriate remedial measures on a site must be made on a site-specific basis and will be dependent on a range of factors, including:

- The nature of the pollutant linkages present.
- The contaminant(s) and receptor present, including archaeology.
- The nature of the pathway linking the contaminant and the receptor.
- Time and cost implications.
- Local issues such as noise, dust, lorry movements etc.
- Regulatory controls: why is the work being carried out? Remediation requirements under Part 2A must be reasonable.
- The remedial technology including the track record, requirement for regulatory control of the technology. For example, some remedial technologies require planning permission, discharge consents, waste management controls or Scheduled Monument Consent.
- Aftercare and monitoring requirements.

6.1 Remediation design and impacts to archaeology

The design of an effective remedial strategy for a site can be complex in terms of achieving required standards and minimising the potential impact on the environment within the allocated time frame. The presence of more than one pollutant linkage and varying ground conditions may also lead to more than one remedial option within the overall strategy. Where archaeological assets are also a consideration, early consultation between the contaminated land consultant and the developer's archaeologist is essential to avoid or reduce potential impacts to archaeological remains.

Most forms of remediation have the potential for some adverse archaeological impact. This may be either a direct physical impact or an indirect impact, for example, on the burial environment. Methods that involve physical disturbance or removal of archaeological deposits will normally be totally destructive. Where important archaeological deposits exist, the need for physically intrusive remediation must be very clearly demonstrated. *In situ* remediation almost always involves a level of physical disturbance and will have a varied impact on the burial environment.

Some of the potential impacts of remediation techniques upon archaeological assets are summarised in Table 6.

Impact of remediation	Effect on archaeology
Soil disturbance	Will destroy features, artefacts and archaeological context
pH	Changes in pH levels can affect the preservation of archaeological data and artefacts resulting in: ▪ Corrosion of iron and copper-alloy (bronze) artefacts ▪ Decay of organic remains such as leather, wood, textiles and bone ▪ Degradation of environmental evidence, such as molluscs with rise of acidity ▪ Glass may be affected by a rise in pH ▪ Compromise integrity of DNA evidence which is best preserved at neutral pH
Addition of organisms	May affect degradation of organic artefacts and could promote corrosion of metals, for example, sulphate-reducing bacteria May promote the degradation of organic materials Effects on scientific analysis: organic chemicals, bacteria and fungi may affect results of radiocarbon dating, carbon/nitrogen ratios and DNA analysis etc. the redox and pH of the burial environment
Redox	Change in redox may affect preservation of organic materials. Aeration causing shift in redox from anaerobic to aerobic conditions, resulting in a potential loss of preserved waterlogged remains
Addition of substances or transformation	May react with archaeological metal artefacts, for example, iron, copper and organic artefacts, such as leather, wood and textiles, including those with the addition of sulphide (S^{2-}) Effects on scientific analysis: organic chemicals, bacteria and fungi may affect results of radiocarbon dating, carbon/nitrogen rations and DNA analysis
Changes in groundwater level	May affect archaeological metals, such as iron, copper and organic artefacts, including leather, wood, textiles, and bone. Fluctuations in groundwater level may affect stone surfaces

Table 6
Remediation impacts and effects on archaeology.

6.2 Measures to mitigate impacts to archaeology

Two principal mitigation options are commonly used:

- Retention of the archaeological remains: the identification of archaeological assets early in the planning and development process can increase the success of preserving remains within the development, as a suitable design solution may be achieved. For example, if there are areas of high archaeological sensitivity, these areas can be chosen for low sensitivity end uses, thereby removing the need for remediation and avoiding archaeological impacts. Where an *in situ* remedial technique is selected, additional measures to protect the remains may be required, for example, creating an effective barrier. Further information about preserving archaeological remains has been published by Historic England.

- Archaeological investigation and recording: remediation techniques that are more intrusive may be mitigated by an appropriate programme of archaeological investigation, which can be performed in advance of, during, or after remediation. Reports produced as part of an archaeological investigation should be submitted to the local HER in line with NPPF Policy 141.

Both mitigation options should be discussed with the developer's archaeologist and agreed with the local authority archaeologist and, if designated, the relevant Historic England officer.

7 Case Studies

7.1 Archaeology as a Source of Contamination

The following three case studies demonstrate how relatively recent industrial structures can have an archaeological value and can also be a significant source of contamination. In these cases, early engagement between the developer's archaeological and contaminated land consultants was essential for ensuring that archaeological mitigation was considered alongside contamination issues.

Former industries can be an important part of a town's economic history and development, and this heritage interest can contribute to the significance of a heritage asset. Any land use will leave behind remnants of its former use. However, in the case of some sites, such as former industrial buildings, these remnants can also be sources of contamination that are harmful to health if not identified and managed appropriately.

In addition to industrial heritage remains, other types of activity may also result in sources of contamination. For example, biological hazards may arise from the disposal of animal remains or from human interment. Biological substances are not recognised by the Part 2A regime, however, the need to manage biological contamination arises increasingly where there is pressure to redevelop brownfield sites, and this is dealt with under the NPPF.

Case Study 1
Steetley Chemical Works, Hartlepool

Site history

The Steetley Chemical Works in Hartlepool, known previously as the Magnesia Works, was built on the site of the Cemetery Battery and the Palliser Battery and shell store. These were coastal defence structures dating to the late 19th and early 20th century.

Hartlepool was a prime target during the First and Second World Wars. At the start of the First World War, over 1,000 shells were fired at the town and the Cemetery Battery during a 40 minute bombardment by three German Battle Cruisers. An error resulted in the incorrect calibre ammunition being used which meant that the Battle Cruisers' main guns had to fire with no elevation, causing the unexploded shells to skim across the ground or bury in the sand dunes. It is recorded that the local garrison spent several weeks collecting shells that were lying on the surface.

The Magnesia Works played a key role during World War II, during which the town was bombed on 43 occasions. The Works became the world's first commercially viable producer of magnesia by extracting magnesia from sea water and reacting it with dolomite to produce British magnesia.

Redevelopment and remediation of the site had the potential to impact buried structures associated with the Palliser Battery, and remove more recent industrial archaeology structures associated with the Magnesia Works.

Figure 3
Drained settling tank with central control building. Reacting chambers are visible in background.

Contamination issues

Site geo-environmental investigations recorded elevated background concentrations of metals with several hotspots identified with levels exceeding the site average. In addition, large quantities of bound asbestos cement were present across the site. Other contamination issues included ground gas and elevated levels of hydrocarbons from historic landfill, the potential for unexploded ordnance across the site and Magnesia Hydroxide residue in the tanks and chambers.

Managing contamination and archaeology

An extensive programme of remediation was planned, involving the demolition of buildings of archaeological interest, including the Palliser Battery Shell Store, settling tanks and reacting chambers associated with the later Magnesia Works. A control plan was produced following early consultation between the developer's archaeological and contaminated land consultants and the local authority's archaeologist, resulting in an agreed programme of archaeological mitigation works that were to be carried out alongside demolition and remediation.

The programme of remediation and archaeological works comprised:

- Asbestos removal from extant buildings and from existing rubble stockpiles.
- A programme of archaeological building recording of extant buildings in advance of main phase remediation.
- An archaeological watching brief during demolition and remediation.

Figure 4
Remediation exposes the shell store.

The control plan set out personal protective equipment (PPE) requirements comprising hi-vis clothing, safety boots, hard hats, eye protection, gloves and face masks. It also specified that a qualified unexploded ordnance (UXO) engineer be on site for the duration of the demolition and remediation, and that an environmental manager be in attendance to carry out soil testing of areas of previously unknown contamination. In addition, gas monitors were used in the areas of known contamination hotspots.

Due to the high levels of contamination, the agreed archaeological mitigation comprised a Level 2 photographic record only. All structures and archaeological finds were photographed and located on plan. No finds were retained due to the risks from contamination and to archaeological staff, who would process the finds off site.

Lessons learned

- Early consultation with project stakeholders allowed for remediation and demolition to be planned in conjunction with the necessary archaeological works, avoiding delays to the programme and reducing site risks to an acceptable level.
- The methodology for the archaeological works was informed by a contaminated land control plan, minimising risks to site personnel during groundworks and off site staff involved in processing stage.
- The control plan enabled the discovery of unforeseen contaminated remains within the site to be dealt with in a safe manner whilst still fulfilling the requirements of the archaeological works.

Case study 2
Former York Union Gas Light Company site, Hungate, York, North Yorkshire

Site history

York Archaeological Trust (YAT) carried out two excavations in advance of development of the former York Union Gas Light Company (YUGLC) gas works site in Hungate, York. The site had also been occupied by a sawmill and a flour mill. The industrial remains were assessed to be of historic interest, and archaeological mitigation, comprising a detailed investigation in advance of demolition and development, was required of the site's retort house, associated condensers, purifiers, gas holders and connecting pipe networks.

Contamination issues

The archaeological desk-based assessment identified the location and use of the former structures within the site, and the geotechnical desk study identified the potential sources of contamination. Due to the likelihood of archaeological remains being present that were also a source of contamination, initial site investigations were designed to target the site of known heritage structures. The results provided an assessment of the level and type of contamination at the site, which informed the scope of archaeological mitigation and measures to protect human health. The site investigation identified elevated levels of hydrocarbon and heavy metals contamination. In particular, the area associated with the condensers and purifiers was found to be significantly contaminated by benzene. The condenser removed volatile tars, ammonia and other by products from the gas and it was assessed that an *in situ* feature, buried below the condenser, was likely to contain high levels of contamination. The material in this buried feature had contaminated an area of ground water around it, which had migrated across the site.

Figure 5
Archaeologist wearing personal Photo Ionisation Detector (on hip).

Managing contamination and archaeology

The results of the geotechnical intrusive site investigation informed the method statement and risk assessment for the archaeology works. The investigations had highlighted that the local ground water had been contaminated by the *in situ* material beneath the condensers and as a result the archaeology team had to follow strict health and safety protocols which included the wearing of protective suits and gloves, which met the following specifications: EN14605 Type 4 Spray Tight, EN13982-1(&2) Type 5 Particulate protection, and EN13034 Type 6 Reduced Spray. Each member of the team was also issued with a ToxiRAE personal Photo Ionisation Detector (PID) (Figure 5).

The PIDs were set to detect low levels of dangerous Volatile Organic Compounds (VOCs), such as benzene, and to alarm if they recorded readings in excess of strict minimum levels stipulated in HSE guidelines, EH40. Procedures for site evacuation in the event of a serious alarm were communicated to the archaeology team in advance of work starting and formed part of the site induction for new staff and site visitors.

Very little evidence for significant contamination was encountered during the excavations, although a continuous low-level presence of VOCs was recorded. The PIDs recorded both exposure levels and duration of exposure and at no time did these levels exceed the limits specified by HSE guidance, EH40. There were only three occasions during the archaeological work that the alarm built into the PID was activated, indicating levels of VOCs in excess of the short term exposure limit. In all three encounters the work was immediately abandoned, the material left *in situ*, and the client informed of the incident. Analyses of the PID data revealed that the long-term exposure limit for the three individuals concerned was not exceeded and de-contamination steps were carried out to clean the equipment and PPE used in these encounters.

Lessons learned

- Early appreciation that contaminated remains were also of industrial archaeological interest allowed the site investigations to be designed for both contaminated land and archaeology.

- Collaboration between the developer's archaeologists and contaminated land consultants enabled information to be gathered which informed the scope of archaeological mitigation and made sure safeguards for staff were put in place in advance of work starting.

Case Study 3
The Royal Arsenal, Woolwich, London

Site history

The Royal Arsenal in Woolwich, which covers over 30 hectares, has been a site of ongoing major urban regeneration since 1999. It includes a conservation area and is a site of national importance in terms of its history, architecture and archaeological remains.

The core of the site was purchased by the crown in 1671 and was then steadily expanded and developed into a significant centre of armament manufacture and military stores. Works included the development and testing of new technologies, and the Napoleonic and Crimean wars added extra impetus and funding to the Arsenal's activities. During the First World War, over 80,000 people were employed at the site, with 32,000 people still working there during the Second World War. The site contains a large number of listed buildings of national importance associated with the site's military industrial past as well as industrial archaeology features and archaeology from the Roman and medieval periods.

Contamination issues

During its history, the Arsenal manufactured cannons, mortars, large guns for battleships, bullets and shells, making it a site of significant industrial activity. It also contained extensive smithy workshops, steam engines and hammers and quenching pits filled with oil, and even had its own site railway system for transportation. Areas of the site were reserved for casting metals and various chemical processes associated with the manufacturing, resulting in the production of large quantities of contaminated waste. Adjacent marshland was reclaimed as part of the expansion of the Arsenal, and the made ground came from industrial waste material generated within the site, which also included potentially explosive charges. The potential for archaeological remains to be a source of contamination, or a receptor of contamination, was assessed to be very high.

Figure 6
Recording the brass furnace.

Managing contamination and archaeology

Geotechnical surveys collected general information on contamination and also targeted specific areas to test levels of contamination and archaeological survival based on the results of the desk study. The geotechnical surveys were monitored by an archaeologist so that the depths of made ground and archaeological levels could be recorded to inform the scope of archaeological mitigation.

Following a site-wide archaeological trial trench evaluation, a programme of remediation was instigated, which combined the archaeological mitigation works with the removal of contaminated deposits. When the source of contamination was also of archaeological interest, the archaeology team had to work in accordance with the methodology approved by the contaminated land consultant. This entailed routine testing of areas of potential contamination by an on-site environmental manager, resulting in a reduced scope of archaeological recording for areas where elevated levels of contamination were recorded.

Figure 7
Casting house and pits.

Routine risk management measures included all site personnel wearing PPE, such as masks, gloves and hazard suits in some parts of the site, following strict hygiene procedures, exclusion zones and dust suppression measures. In some contamination 'hot spots' no archaeological work was possible due to the potential hazards, and in these cases mitigation was restricted to a photographic record and plan where possible.

In order to manage the risk of contamination being transported offsite, a finds and environmental strategy was developed which focused on appropriate levels of artefact and sample retrieval to inform the archaeology being recorded. The archaeology team adopted a 'record and discard' policy on site for certain categories of finds in order to reduce the quantity of potentially contaminated material removed to Oxford Archaeology's offices. Specific mitigation protocols were employed for office-based staff who were to be involved in the processing of finds and environmental samples from the site.

Lessons learned

- Carrying out archaeological work in contaminated conditions was time consuming and expensive. Therefore, it was therefore essential to maintain an open dialogue between the remediation team, archaeological contractor, developer and Historic England, to make sure that decisions regarding the scope of work were made quickly.
- Collaborative working and use of appropriate specialists: due to the potential for UXO, all staff were briefed by a munitions specialist on how to identify potential hazards, particularly from discarded charges and gunpowder-filled mortar shells. The specialist maintained a watching brief on site for the duration of the works.

7.2 Archaeology as a Pathway for Contamination

In some cases, archaeological assets may provide a pathway for the transfer of contamination from one source to a potential receptor. For example, archaeological excavation may disturb naturally formed lagoons or voids that have acted to contain contaminants, or breach structures such as buried pipes, reservoirs or storage tanks, containing contaminated material. The risk is particularly high on brownfield sites and highlights the need for detailed documentary research to confirm the presence and location of such structures prior to the start of site investigation.

In addition, buried structures, such as culverts, may provide a pathway for contamination to another part of the site. The following case study illustrates the importance of site workers being aware of the presence of archaeological assets within a development site; even after all agreed archaeological recording has been completed.

Case Study 4
Proposed development site, Penistone, South Yorkshire

Site history

Structures of archaeological interest, including a 19th century paper mill and a race (Figure 8), were present within a proposed development site. The race was associated with the mill's power transmission. It was a part-buried structure which carried water from the river to power the water wheel, which then re-entered the watercourse via a sluice (Figure 9).

An archaeological investigation, carried out in advance of construction, targeted the earliest phases of the paper mill, including the water wheel pit and a section of the mill race. The archaeological works comprised a Level 2 building report and archaeological excavation and recording. The investigation area was left open upon completion and the site was handed over to the developer to enable construction to start.

Contamination issues

On the same site, to the north-west of the mill, was a former petrol station. The buried fuel tanks associated with the former garage site had corroded, and the desk study and site investigation report carried out by the developer's geotechnical engineer concluded that a significant degree of hydrocarbon contamination had migrated into the soils around the tanks and would require extensive remediation.

The tanks and backfill material around the tanks were excavated and isolated in a part of the site pending disposal later that day. However, the remediation contractor had unknowingly stored the tanks above a section of the buried mill race (Figure 9). The weight of the stored material caused a breach in the roof of the mill race resulting in contaminated material entering the course of the race and being transferred to another part of the site. The contaminated material exited the race and migrated to topsoil bunds which had been stored in the southern part of the site, downslope from the race.

Figure 8
Section through the mill race.

The topsoil had been stockpiled for re-use in gardens, roadside verges and planting schemes within the development site; however, due to the level of contamination and potential risks to end-users, the material had to be removed from the site and new topsoil material was imported to fulfil the landscaping design.

Lessons learned

- The archaeological works were completed in advance of development, and before the appointment of a principal contractor. Archaeological information, including the trial trench report and excavation report, was included in the tender package for the site; however, it was not referenced because archaeology was considered to have been 'dealt with' and was therefore not an issue for the contractor.

- A review of all site reports should be carried out as part of the bid preparation for a site. Archaeological reports can contain useful site information relating to the depth of soils across a site and will identify the location of known heritage assets.

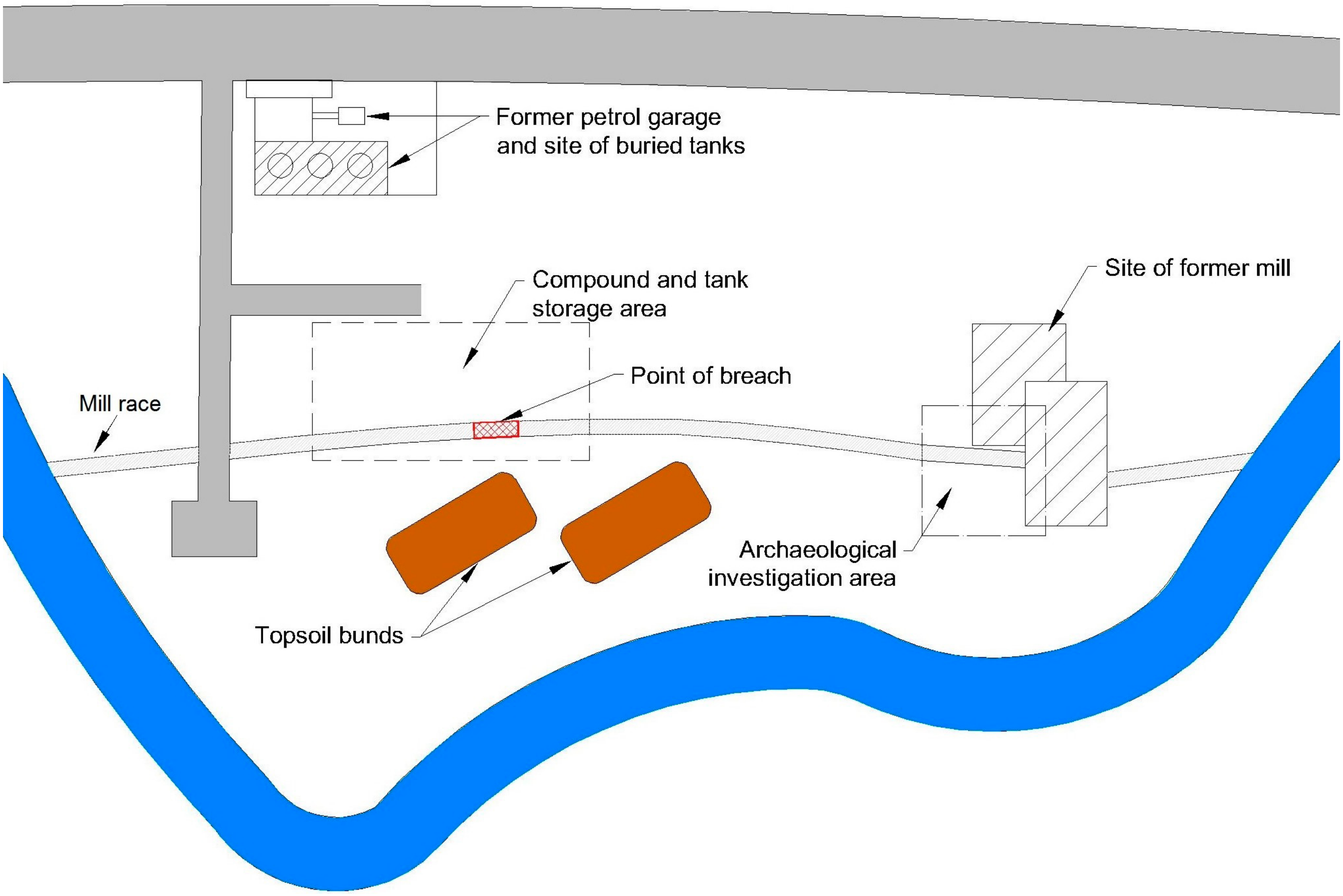

Figure 9
Location of contamination, receptor and pathway.

7.3 Archaeology as a Receptor of Contamination

Archaeological remains can be affected by much later land use. Rural areas can contain deeply stratified sequences of archaeological deposits, particularly in areas where the surface topography has been altered by alluvial and colluvial processes, marine transgressions and regressions. In wetland areas, such as the Fens, in eastern England, and upland areas, such as parts of the South Pennines, in northern England, waterlogged land surfaces, structures and features can be preserved beneath blanket peat formation.

In urban environments, which can have hundreds of years of settlement-related history, archaeological deposits can also survive to significant depths. Often the most deeply buried deposits may include well-preserved organic materials if buried below the water table.

In order to avoid or minimise impacts to deeply buried archaeological deposits, it is critical that a site's underlying sedimentary sequence is understood in advance of a site investigation or remediation design. Further advice relating to the preservation of archaeological sites and their long-term management has been published by Historic England.

In urban environments, buried heritage assets are susceptible to contamination either by downward movement or leaching of contamination from overlying deposits. Trench and piling foundations, cable systems, underground fuel storage and remediation works may introduce contamination into previously-undisturbed archaeological remains sealed beneath contaminated ground.

As part of a flood defence scheme for Newhaven, in Sussex, flood defence foundations had the potential to transfer contamination to underlying alluvium layers, which had been assessed as being a source of palaeoenvironmental potential.

Case Study 5
River Ouse, east and west banks, Newhaven, Sussex

Site history

The site comprised a 2km stretch of the east and west banks of the River Ouse. The principal sources of contamination derived from the site's maritime heritage and industrial uses, fuel tanks, areas of landfill and recycling and waste facilities, and included evidence of elevated polycyclic aromatic hydrocarbons (PAHs), benzo(a)pyrene, benzo(a)anthracene and total petroleum hydrocarbon (TPH), along with elevated levels of carbon dioxide and methane.

The environmental statement, which was prepared to support the scheme, suggested that piling and remediation proposals may have a two-fold adverse effect on buried waterlogged remains. Piling through contaminated ground may result in the migration of contaminated groundwater into the alluvial deposits, increasing pH levels and altering levels of archaeological preservation as a result. In addition, sheet piling along sections of the scheme, in advance of remediation, could result in changes in local hydrology which would have a dewatering effect on Holocene peat deposits with the potential to contain preserved archaeological data.

Managing contamination and archaeology

Site surveys were carried out to inform the design of the proposed flood defences, which comprised new embankments and flood walls above sheet piling foundations.

In order to inform the impact assessment process and archaeological mitigation design, it was decided that the planned geotechnical site investigations should also be monitored by a geoarchaeologist. The geoarchaeologist produced detailed archaeological descriptions and generated a deposit model of the underlying sedimentary sequence and identified deposits of archaeological interest (Figure 11).

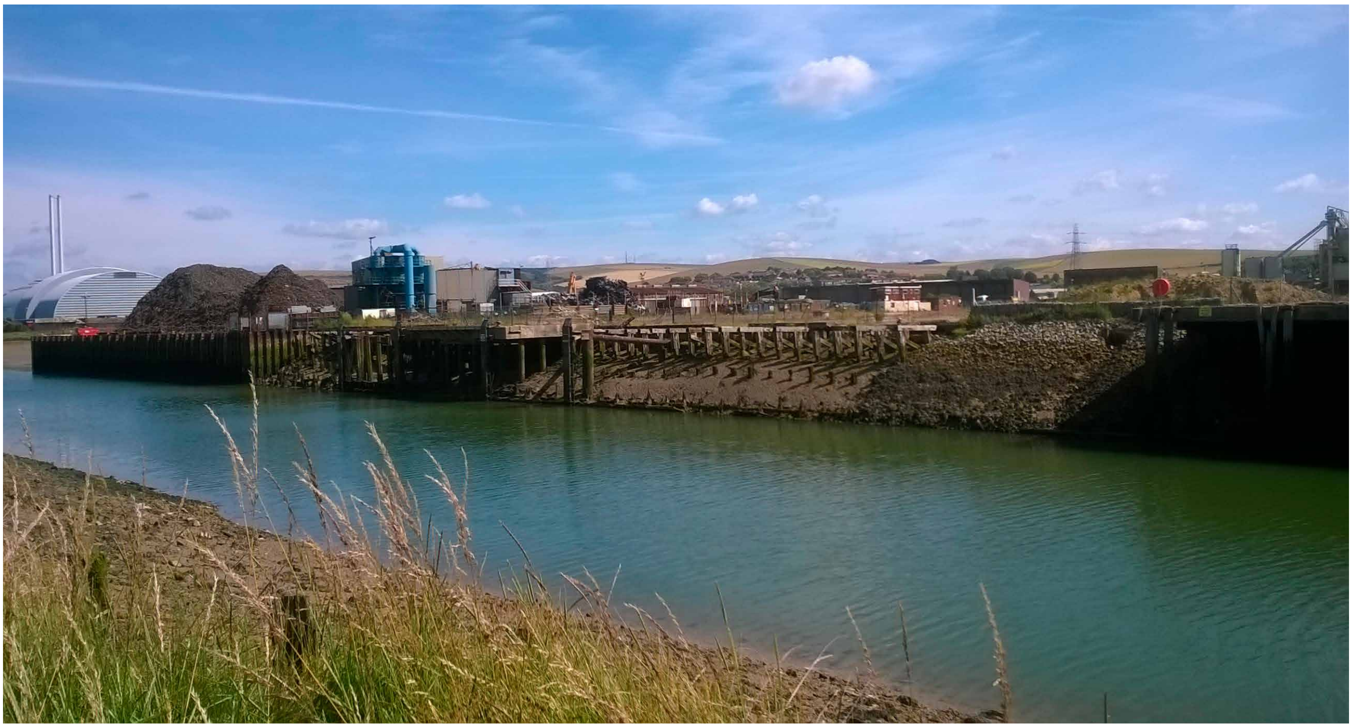

Figure 10
Industries along the River Ouse east bank, Newhaven, Sussex.

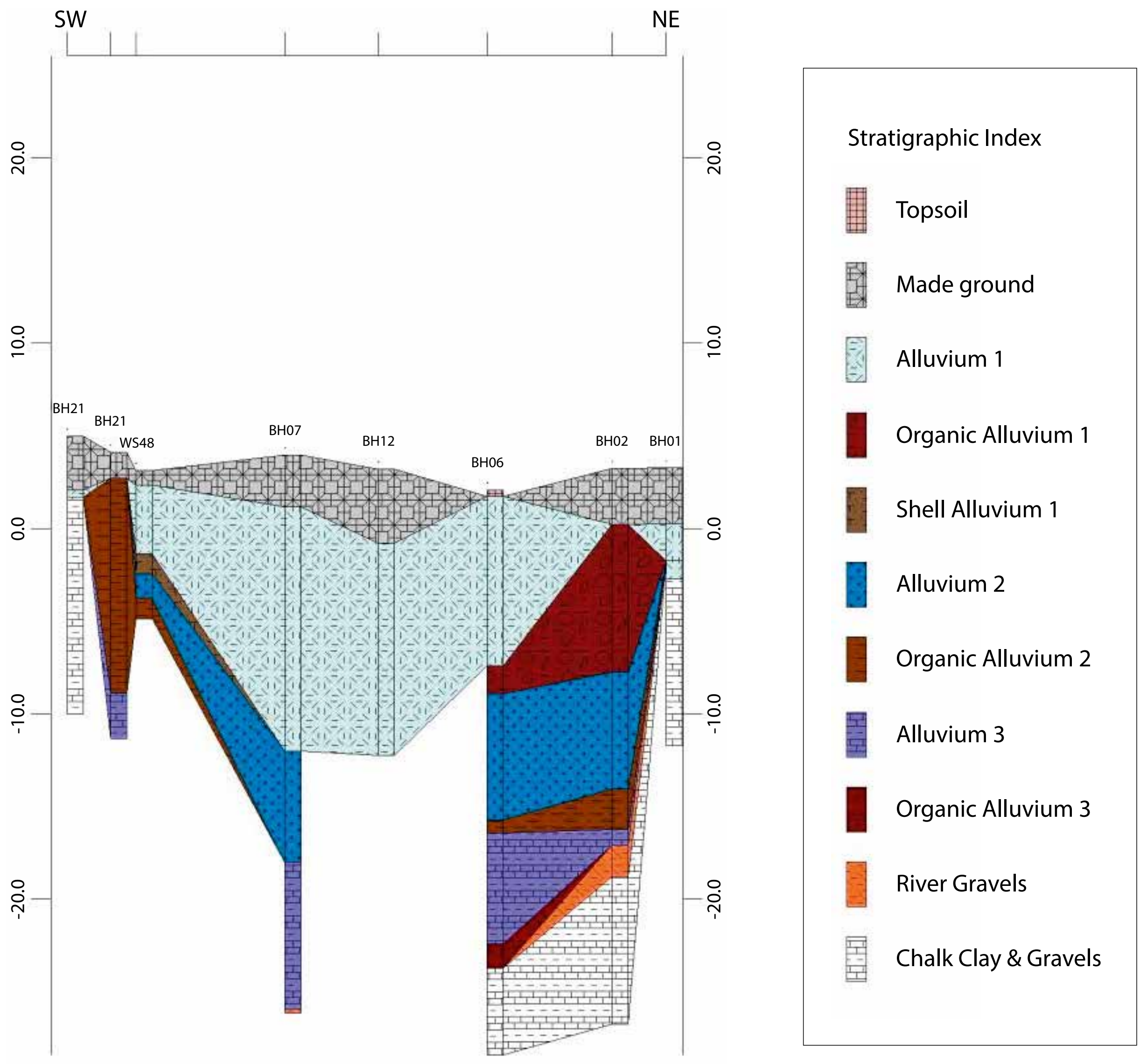

Figure 11
Archaeological deposit model produced from geotechnical investigation.

The soil testing data from the geotechnical works confirmed the levels of contamination within the made ground deposits, and it was concluded that sheet piling driven through the made ground may transfer hydrocarbons contamination to underlying alluvium and have an adverse effect on the preservation of palaeoenvironmental remains.

The construction plan concluded that contaminated made ground deposits would be excavated and disposed of in advance of the construction of flood defences, removing the source of contamination and avoiding impacts to buried archaeological deposits.

The results of the geoarchaeological assessment also noted that the insertion of interlocking sheet piling could cause displacement and compression of sub-surface archaeological deposits. In addition, the permanent installation of sheet piles in parts of the scheme would create a continuous barrier, which may result in de-watering impacts to waterlogged archaeological deposits. Design solutions, including artificial recharge, were proposed to mitigate potential impacts. Further information about piled foundation designs and their potential impact on archaeological assets has been published by Historic England.

8 Key Points

Early assessment: a principal theme of archaeological and contaminated land assessments is the early identification of site constraints and characterisation of the underlying sedimentary sequence. To conserve archaeological assets, and to avoid impacts that could result in loss or harm, it is essential that the below-ground environment is understood.

Early consultation: early contact with the regulator, local authority's contaminated land officer and archaeologist, and Historic England, if applicable, will help identify the key issues associated with a site and inform the scope, suitability and feasibility of further investigation and avoidance/preservation options.

Information sharing: archaeological information can be vital for the construction programme in informing levels of risk and cost. Similarly, information about the type of contamination at a site is important for informing the scope of archaeological investigation and for protecting the health of on-site archaeologists and off site archaeologists who may be handling or processing contaminated remains during post-excavation stages.

Collaborative working: better collaboration between technical teams will enhance the site record and promote better understanding of site issues. The developer is often the common link and should make sure that site information is made available to all. In addition, it is essential that communication between disciplines is encouraged; pertinent information may be lost if a contaminated land specialist attempts to interpret an archaeological report. Similarly, an archaeologist is not qualified to understand the implications of the hazards identified in a contaminated land report.

Combined surveys: combine geotechnical site investigation works with archaeological monitoring to enhance site data, inform risk assessment process for both contaminated land and archaeology, promote time and fee efficiencies by avoiding duplication of work.

9 Where to Get Advice

This page lists some of the mandatory and advisory guidance issued by the Environment Agency and other government departments along with useful sources of information. Other relevant documents are available on GOV.UK and from the archived Environment Agency page. Other documents referenced in CLR11 published by other organisations should be accessed through their web sites directly, or many feature on CL:AIRE's Water and Land Library (WALL).

Planning

DCLG 2012 *National Planning Policy Framework (NPPF).* Department for Communities and Local Government. [Online] Available from: https://www.gov.uk/government/publications/national-planning-policy-framework--2

DCLG 2014 *National Planning Policy Framework (NPPF) Planning Practice Guidance (PPG). Conserving and enhancing the historic environment and Land affected by contamination*. Department for Communities and Local Government. [Online] Available from: http://planningguidance.planningportal.gov.uk/

Planning Portal – UK Government online planning and building regulations resource for England and Wales: http://planningguidance.planningportal.gov.uk/

Land contamination

CIRIA 2001 Contaminated land risk assessment – a guide to good practice C552

CIRIA 2002 Non-biological methods for assessment and remediation of contaminated land. Case studies report RP640

CL:AIRE/EIH 2008 Guidance on Company Soil Contamination Data with a Critical Concentration

Contaminated Land (England) Regulations 2006 (as amended)

Contaminated Land (England) (Amendment) Regulations 2012 http://www.legislation.gov.uk/cy/uksi/2012/263/made?view=plain

Defra Circular 01/2006 www.defra.gov.uk (superseded in 2012 by Defra 04/2012)

Defra 04/2012 Environmental Protection Act 1990: Part 2A. Contaminated Land Statutory Guidance https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223705/pb13735cont-land-guidance.pdf

DETR 2011 Guidelines for Environmental Risk Assessment and Management. Green Leaves III

Environment Agency 2004 Model Procedures for the Management of Land Contamination CLR11
CLR11 provides details of many other guidance documents and a full glossary of terms http://webarchive.nationalarchives.gov.uk/20140328084622/http://publications.environment-agency.gov.uk/pdf/SCHO0804BIBR-e-e.pdf and http://www.claire.co.uk/information-centre/water-and-land-library-wall/45-model-procedures/187-model-procedures

Environment Agency 2000 Technical aspects of site investigation Volumes I and II
http://www.claire.co.uk/information-centre/water-and-land-library-wall/41-water-and-land-library-wall/194-general-info-sc1

Environment Agency 2002 Guidance on the selection of non-intrusive techniques for groundwater pollution studies

Nathanail, J., Bardos, P., and Nathanail, C. P. 2002 Contaminated land management

The Environment Act 1995
http://www.legislation.gov.uk/ukpga/1995/25/contents

The Environmental Protection Act 1990
http://www.legislation.gov.uk/ukpga/1990/43/contents

Historic environment

Archaeological and Historic Pottery Production Sites
https://historicengland.org.uk/images-books/publications/archaeological-and-historic-pottery-production-sites/

Archaeological Evidence for Glassworking
https://historicengland.org.uk/images-books/publications/glassworkingguidelines/

Historic England National Heritage List for England (NHLE)
https://historicengland.org.uk/advice/hpg/heritage-assets/nhle

Historic England National Record of the Historic Environment (NRHE)
http://www.pastscape.org.uk

Historic England Archive
http://archive.historicengland.org.uk

Industrial Heritage as Risk
https://historicengland.org.uk/advice/heritage-at-risk/industrial-heritage/

Piling and Archaeology: Guidelines and Best Practice
https://historicengland.org.uk/images-books/publications/piling-and-archaeology/

Preserving Archaeological Remains: Decision-taking for Sites under Development.
https://www.historicengland.org.uk/images-books/publications/preserving-archaeological-remains/

Science for Historic Industries
https://historicengland.org.uk/images-books/publications/science-for-historic-industries/

Archaeology Data Service
http://archaeologydataservice.ac.uk/archives/archives.jsf

Historic mapping

Historical Map Archive
https://www.old-maps.co.uk

Old Maps Online
http://www.oldmapsonline.org

Miscellaneous

Durham Mining Museum
http://www.dmm.org.uk

British Geological Society geology mapping
http://mapapps.bgs.ac.uk/geologyofbritain/home.html

British Geological Society borehole data
http://mapapps.bgs.ac.uk/geologyofbritain/home.html?mode=boreholes

Multi-Agency Geographic Information for the Countryside
http://www.magic.gov.uk/MagicMap.aspx

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Images

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