

ABERDEEN CITY COUNCIL

GUIDE TO SITE INVESTIGATION

The objective of a site investigation is to gather the information necessary to create a conceptual model in order to assess the significance and presence of contamination in, on or under the land. The contaminants present (if any) will require to be characterised and pathways and receptors will need to be identified.

The investigation of land is driven by the need to assess the risks associated with the site, and the objectives are determined by the purpose for which the risk assessment is required.

Phases of the Investigation

There are typically four phases to a full investigation, namely the Preliminary Investigation, the Exploratory Investigation, the Main Investigation, and Supplementary Investigations. These phases are detailed below

Preliminary Investigation

A comprehensive preliminary investigation should always be carried out before any systematic sampling or analysis is undertaken. Its principal aim is to obtain information in order to:-

- Evaluate the likelihood of finding contamination, its nature and its extent.
- Evaluate the environmental setting of the site and to identify sensitive receptors.
- Provide information from which likely contaminant-pathway-receptor linkages can be identified;
- Determine the requirements for further investigation (if any);
- Identify any special procedures and precautions that will be necessary during subsequent sampling and examination of the site.

The following two steps are the basis of the preliminary investigation.

- 1 Data collection, which again is in two parts.
 - a) Desk study, which should cover the following topics:-
 - The history of the site and adjoining areas. Particular attention should be paid to the nature of any industrial process or other activities on the site that could have been potentially contaminative or could have modified the ground structure to create migration pathways;
 - Any previous desk study or site investigation;
 - The geological, geochemical, hydrogeological, hydrological, archaeological and ecological setting of the site;

- Potential receptors of contamination (for example, current and intended users, trespassers, surface waters, groundwaters, nearby water abstractions, property);
- The proximity of any licensed or unlicensed waste disposal sites or other sources of contamination, including hazardous gases, that could have an impact on the site;
- The existence of naturally occurring harmful materials such as radon or naturally enhanced concentrations of harmful substances;
- The presence of any mining activities;
- Any constraints on an intrusive site investigation (access or height limitations, underground services or obstructions, noise, working hours etc).

Information pertaining to the desk study would include, for example, historic maps, aerial photographs, documentary records held by current/former landowners, interviews with local resident etc. The Local Authority may be able to provide information on previous site remediation, historic environmental nuisances, conditions of planning consents, closed landfill sites and private water abstractions. SEPA may be able provide information on groundwater and surface water quality, pollution incidents, IPC and IPPC authorisations, groundwater abstraction licences, operational and closed landfill/waste treatment sites and “special sites”. Other organisations who may provide useful information would include British Geological Survey, HSE, Fire Authorities, Water Authorities, Petroleum Officer, Coal Authority, National Radiological Protection Board, Local Community Councils and Heritage Associations.

- b) Site Reconnaissance.** A visit should be made to the site, neighbouring land and the local area, with the purpose of:-
- Validating the information collected during the desk study;
 - Collecting additional information about the site, its environs, and any potential contaminants, pathways and receptors;
 - Record observations of aspects of the site not revealed by the desk study;
 - Assist in the planning of any subsequent phases of field investigation (taking into account any constraints to assess).

Where possible, the site visit should be in the company of someone familiar with the site and photographs of salient features should be taken where possible.

2 Interpretation and Reporting

The information from the desk study and reconnaissance visit should be collated and evaluated to formulate an initial conceptual model, which should identify:-

- Potential types and depths of contaminants;
- The likely vertical and horizontal stratification of natural and manmade layers beneath the site;

- Strata variability (occurrence and thickness) in different areas of the site, and their relevant permeability, both vertically and horizontally;
- Potential migration routes (including airborne dispersions);
- The presence of service trenches, drainage runs, underground storage tanks, former foundations, and any other physical features which might influence the occurrence or migration of contamination;
- The occurrence of any biological, chemical or physical processes that might affect contaminant concentrations and migration (including natural attenuation);
- The characteristics of groundwater bodies beneath the site, groundwater levels and flow directions;
- The presence of surface water bodies on, or adjacent to the site;
- Other potential receptors.

The conceptual model should be refined following further investigations. The findings of the preliminary investigation should form the basis upon which the requirement for, scope of, and phasing of, subsequent investigations are decided. It should be completed by the issue of a report including presentation of the conceptual model.

Exploratory Investigation

This may involve the collection and analysis of soil, surface water, groundwater and soil gas samples dependent on the information required appropriate to the objectives. An exploratory investigation may be used to obtain an indication that the initial conceptual model is generally correct before carrying out a main investigation to provide detailed confirmation.

Where the conceptual model identifies the likelihood of localised contamination and the direction of groundwater flow is a “guesstimate” an appropriate strategy would be to carry out an intrusive exploratory investigation to provide information on the actual presence of contaminants and groundwater flow and quality. Hence, targeted sampling is normally undertaken.

Alternatively non-intrusive investigation techniques may be employed to locate below ground structures or other features of the site prior to intrusive examination as part of the main investigation.

It may become apparent following the exploratory investigation that, for example, the contamination is greater or more complex than anticipated. In such cases, the information obtained is likely to be inadequate to make decisions with the necessary degree of confidence, and it will be necessary to review the initial conceptual model and the requirements of the risk assessment. Further investigations may be required to refine the conceptual model and provide robust information for the risk assessment.

The review of the exploratory investigation may allow a decision to be made that no further investigation is required, or, alternatively, the information may be used to design the main investigation.

The sampling strategy for the exploratory investigation should identify the following:-

- The objectives of the investigation and the possibility of zoning the site;
- The location, pattern and number of sampling points;
- The depths from which samples should be collected, the samples to be collected and any monitoring requirements;
- The methodology by which samples should be collected, stored and preserved, taking into account any off-site analysis to be undertaken;
- Any safety measures needed to protect personnel or the environment.

The following should be taken into account;

- The potential heterogeneity of distribution of contaminants;
- Ensuring the sample submitted to the laboratory is representative of the location and depth from which it was taken;
- Although water bodies tend to be more homogeneous in composition than soil, stratification can still occur in groundwater and surface waters;
- Soil gas samples can be representative of a large zone, however the ability of soil gases to migrate in all directions should be borne in mind;
- The possibility of creating routes for migration during sampling.

Either targeted or non-target soil sampling may be carried out dependent on the conceptual model. Exploratory investigations can place greater emphasis on the confirmation of suspected sources of contamination by targeted sampling, with limited non-target sampling to allow consideration of general areas of the site.

When sampling groundwater, information on groundwater flow will help decide the best locations and depths for monitoring wells. A phased approach can then be implemented in which flow patterns are first established and then further monitoring wells installed where they are considered most likely to produce useful information. Where there is no clearly defined source, groundwater monitoring wells should be installed on a non-targeted basis. However, where a potential source is known, monitoring wells should initially be installed directly underneath.

Where there is possibility of soil gas contamination, it is necessary to determine its composition and migration potential. Again, monitoring well locations should be determined based on the conceptual model and may be targeted or non-targeted. Subsequent monitoring wells can then be positioned on the basis of the information from the initial installations. The direction of possible migration both vertically and laterally, should be given consideration, and spacing determined given the nature of the strata. The measurement of both gas concentrations and flow rates is recommended on multiple occasions giving consideration to atmospheric pressure.

Main Investigation

This will involve the collection and analysis of samples of soil, surface water, groundwater and soil gas in order to obtain all the information necessary for the assessment of human and environmental risks. The detail required will depend upon the objectives of the investigation. This will require a carefully designed

investigation, which should take into account the information developed in the earlier stages of investigations and the objectives at this stage of the work.

The further information and data should enable a full assessment of the risks presented by the contamination and also enable any containment or remedial actions to be properly designed with more accurate quantification of the costs.

During the subsequent assessment of risks and hazards, all possible migration routes relevant to the contamination should be considered and a four dimensional picture (in space and time) of the contamination established. These requirements should be borne in mind when designing the main investigation, since to reach defensible conclusions, detailed knowledge of physical and chemical soil properties and of the local hydrology is essential.

The amount and nature of the information required from the main investigation will vary depending on the nature of the site, the possible requirements for remedial action and the confidence required in the decision making process.

The main investigation may involve some further targeted sampling points, for example, at areas of specific concern or to achieve delineation of contamination confirmed/detected in the exploratory investigation. However, the greater proportion of sampling points are normally non-targeted.

Supplementary Investigation

A review of the main investigation may still identify aspects where there is a deficiency of information, and, hence, a supplementary investigation will be required. This will be designed to produce quite specific information and will therefore utilise targeted sampling.

When considering remedial options, it should be borne in mind that each method is likely to have its own data requirements and a supplementary investigation will be necessary to product this additional data.

The ongoing monitoring of groundwater and ground gas wells is also sometimes classed as supplementary investigation. The situation may arise where the results of monitoring as part of the main investigation indicate that longer term monitoring will be beneficial in enabling a better assessment of the risks to be achieved.

Validation sampling carried out to confirm the efficiency of remediation may incorporate some targeted sampling, located at areas of specific remediation, but will generally be non-targeted.