

Cleaning up your own back yard

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ABSTRACT: Although not a new problem, the general issues associated with contaminated sites are becoming more widely known. Active steps are now being taken, on many sites, to identify specific problems and remediate contaminants to safe levels. This paper provides a basic introduction for geotechnical professionals who are encountering their first contaminated site project. Issues are considered from the prospective of the site owner and project manager, including discussion of legal, political, financial, contractual and technical aspects.

1 INTRODUCTION

Site contamination can be either water or soil based or commonly a combination of both. The interactions between the soils, contaminants and hydrology are very complex and site specific.

The topic is extremely diverse and the average site requires a team effort to adequately address all the issues. The combined skills of engineers, scientists, geologists and hydrologists are often required to gain an adequate understanding of a site; while estimators lawyers and politicians are sometimes required to deal with the resulting problems.

There have been unhealthy site problems for as long as the world has existed as the natural environment is a unlimited source of potentially hostile materials. For humans, contamination of potable groundwater downstream from graveyards was recognised as a problem in medieval Europe (Roach 1976). In Australia; however, it has only been since 1987 that major contaminated sites have generated significant attention and action (Keet, 1993). These problems are not new but the wider community awareness has grown to the point of common knowledge and most of the States have enacted specific legislation (which varies significantly) to deal with the issues.

Most contaminated sites are reasonably simple to define as they result from one period of polluting activity, while others have been a general industrial area or dumping ground for decades.

The problems on many sites in Australia date back over fifty years as the rule of "out of site and out of mind" held true. Once a substance was buried, it was generally deemed to be no further difficulty. As a corollary to this belief, the obvious signs of contamination were mostly ignored or treated as anomalies.

Today; however, the public is more aware and legislators have attempted to ensure that owners and managers of contaminated sites face significant

penalties if they fail to manage the risks in an effective way.

1.1 Case studies

Defence is currently managing approximately 20 contaminated sites, and has been leading the Commonwealth in some aspects of their management. The author has been involved in several sites and this experience is partially reflected in this paper.

2 QUALITATIVE ASSESSMENT OF POLLUTION POTENTIAL

Most potentially contaminated sites are easily identified with a limited historical study. Visual evidence can provide a good indication in some cases as, for example:

- spongy ground can identify landfills,
- coloured soil or water can identify surface contamination, and
- dead or distressed vegetation can identify contamination in buried soil or groundwater.

In extreme cases, hydrocarbon ooze welling up from the ground and trapping birds can provide the necessary clue.

A valuable resource for data gatherers can be long term staff who can remember the locations of activities or processes undertaken and what was buried. Further information can be obtained from previous government approvals and old site and engineering services plans.

Many organisations will not keep adequate records to allow exact identification of potentially polluted locations and once a general location is known then aerial photographs can provide a significant amount of data. Through photo-interpretation, the location and extent of landfills can often be accurately determined, as can the presence of storage yards and isolated buildings which may have housed hazardous materials.

Although as much information as possible should be gathered by internal staff, the assistance of external, professional advice can quickly focus on

core and missing information which will greatly assist the later stages of the investigation processes.

2.1 Common causes of contamination

Although almost any land use can result in contamination, common causes are:

- Industrial or rural industry;
- Mining activity;
- Industrial waste dumping;
- Industrial storage (above and below ground);
- Pipelines;
- Domestic waste dumping; and
- Natural soils (sic).

In the majority of cases, substances that will cause a problem are related to industrial usage due to the greater concentrations and volumes present.

Specific examples from Defence include:

- A scientific laboratory where used solvents were tipped down a tube behind the laboratory which lead to an unlined pit.
- A battery workshop where lead acid batteries were tipped upside down on pallets outside to drain.
- An unfenced "hard construction materials dump" where uncontrolled disposal occurred.
- An unlined burning pit for official disposal of surplus materiel.
- "secure" dumps of low grade radioactive materials.
- PCB oils used to control weeds along fence lines.
- Leaks from above and below ground fuel installations.

2.2 Definition of contamination

Contamination is not simply an excess of a substance in the ground/water, as contaminating levels of some materials are accepted because they are naturally occurring. Arsenic is a common example and whole towns in Victoria are built on high arsenic soils.

The use a site is put to also plays a significant role in the decision making process as to whether it is considered to be contaminated. For example, sensitive uses such as domestic residences, child care centres or food crops, will generally have stricter requirements than industrial sites.

Most of the States have their own guidelines on what constitutes acceptable levels of contaminants for a given land use. These levels are presented in the documents administered by the EPA or equivalent. The defacto standard is the *National Guidelines for the Assessment and Management of Contaminated Sites, 1992* which is produced by the Australian and New Zealand Environment and Conservation Council (ANZECC). Unfortunately, most of the State guidelines include criteria which are partly different from these.

As an aside, there is likely to be a trend towards standardisation of levels towards those presented in this document due to action by ANZECC and a general push for standardisation following the formation of the Commonwealth EPA and evidenced by the recent signing of the Intergovernmental Agreement on the Environment.

The guidelines only form a basis upon which decisions can be made. The levels that are acceptable for each contaminant are very dependant of the chemistry of the soil and other site specific factors such as hydrology and the potential receivers of the contaminant. These factors change so markedly that a standard set of values for all conditions is inappropriate as the highest level would need to be set for all sites even when not justified for most.

Many of the standards have been derived from overseas where soil conditions and uses are different. The Dutch standards, in particular, have played a central role in the setting of acceptance levels. None of the levels should be regarded as absolute and research is continuing to determine acceptable levels for Australian conditions.

3. QUANTITATIVE ANALYSIS

3.1 Site investigations

After the qualitative or historical research has been completed a risk assessment based site investigation should be undertaken (as explained below).

3.2 Auditors

The Victorian EPA has requirements that site contamination works be certified by registered auditors and therefore this requirement should be considered prior to any quantitative investigations being commenced.

3.3 Investigation costs

The cost of these exercises can be extreme with simple water bores and soil test samples costing around \$100 each, with analysis costing at least another \$75. To perform a shallow sampling program on a grid at 10m spacings on an industrial site of 200m square, would cost over \$80,000 for testing of one substance and subsequent reporting.

In most cases there will be several potential contaminants of concern and these will occur at several depths. The costs of such grid sampling can be reduced in cost by compositing samples (ie mixing several samples and gaining an average reading). However, this approach must be tempered by the realisation that a high reading on a composited sample of ten locations does nothing to define the

specific problem. A maximum of four samples, in a similar area, per composite is recommended. A more effective way to reduce costs is by performing a comprehensive site history and targeting testing points via risk assessment as discussed below.

For small volumes of soil, say up to 250 tonnes, the most cost effective course of action is probably to remove to landfill without significant testing of soil parameters.

Competitive tendering will reduce the cost of sampling and testing; however, reliable quality is an important criteria. Additionally, as there is often many stages to a project, some contractors will bid low for the first stage and attempt to catch up later. This tactic can increase the final cost of the project.

3.4 Risk assessment

Risk assessment is a very complicated field; however there is an increasing number of contractors willing to claim the necessary skills. No site investigation can ever totally clear a site, as to do so would require testing every piece of soil. Risk assessment is based on the risk to the environment and humans from the substances likely to be found and their distribution across a site. A small patch of hydrocarbon contamination from a leaking underground tank represents a totally different risk to pesticide residues over many hectares.

The risk assessment combines numerical assessment with information concerning:

- the land use being sought;
- the mobility of contaminants; and
- the physical characteristics of the site.

The land use is critical to the risk assessment as this provides assumptions of the kind of receiver (age, occupation) and nature and duration of exposure. The most sensitive land uses are potable water recharge and children playing directly in the soil for extended periods, as is possible in domestic situations. These cases contrast with open parkland where direct contact with the soil by receivers is assumed to be irregular and of limited duration.

The mobility of the contaminants is strongly influenced by the site hydro-geology and rainfall as well as the ability of the contaminants to be released from the soil. Soil/contaminant interactions can be very complex and vary with factors like acidity of the soil (which increases mobility).

In summary, the risk assessment process endeavours to determine what is safe for a given distribution of contaminants at a site if a certain land use is undertaken. When this assessment is undertaken prior to sampling, the aim is to reduce costs by predicting where unacceptable contamination will be present and biasing the sampling program in those locations rather than employing a simple grid approach.

4. MANAGEMENT ASPECTS

The management of a contaminated site project is in most respects similar to standard demolition or civil site works and most of the techniques from these projects are applicable. Specific aspects that may be of particular relevance to site contamination projects are outlined below.

4.1 Publicity

The role of publicity in the management process depends on many internal and external factors. Particularly where a site is in continuing operation, adequate information flow is vital to manage staff concerns and expectations. Seeing contract workers drilling holes in full protective gear will cause most staff to be concerned and imagine disasters.

Conversely, remote, disused sites may have no publicity requirements. The role of publicity is dependant on the approach being taken to the remediation process. For example, where contaminated soil is to be trucked through residential streets, prior consultation is recommended rather than risking a public outcry.

4.2 Security

Once a site is suspected of being contaminated, a security risk assessment should be undertaken. Complete cyclone wiring or hoarding of the boundary of the site may be necessary to control public access and reduce the visibility of activities. Obviously the costs must be weighed against the risks, including publicity factors. Defence has had difficulties with trespassers even when warning signs have been erected.

4.3 Occupational health and safety

All sites should be covered by a comprehensive site safety plan. This goes beyond the scope of most workplace plans as the risks may be less obvious to the staff and general public. Site sampling crews will generally be dressed in appropriate protective equipment and will be more aware of the potential hazards. However, all staff working on site (including contractors and consultants) should be covered by a OH&S plan, as liability for accidents may partially fall with the site owner/manager. Despite security measures, steps should be taken to protect the general public from themselves.

4.4 Time management

Time management is difficult for contaminated site projects. At the start of the project there is generally insufficient knowledge to form a reliable plan. The most simple investigations will require at least a month as contractors will require a week to

review the history, mobilise and sample; a week to receive testing results, and a week to report.

Financial management dictates that a staged approach is often the best and therefore there can be several rounds of testing programs, sample remediation trials, government approvals, full remediation, validation testing, and possibly further clean-up works. Many of these stages are time elastic and weather dependant making time management difficult.

Large and complex sites can take several years to fully remediate and this will prove unpalatable for many organisations. Defence experience on most sites has been to expect the unexpected and having external deadlines set can unsettle the management process due to unrealistic expectations or unexpected complications.

As site remediation is relatively new in Australia and the pool of specialist personnel in some fields is limited, there may be cases where a time delay occurs because a relevant specialist is not available to assist.

4.5 Third party interests

Third party interests in contaminated sites should be minimised or at least managed strongly. Strict communication links should be established between the owner/manager and the other parties. Possible other parties involved in the process include the State and Local governments, the auditor (in Victoria), the public and prospective owners. In one case, Defence was preparing a site for another organisation to purchase and the new owner was allowed to change their boundaries and communicate directly with the remediation contractor. This resulted in two sets of work area designations, which caused contractual confusion, and eventually led to the unacceptable situation of an area of the site being handed over prior to final certification.

4.6 Political aspects

For public sector organisations, in particular, the local political climate can have a significant impact on the management process. There have been cases where local politicians have promised that ex-Defence land would be released for residential use by a certain date, prior to site investigations being carried out. This situation leads to difficulties as politicians can start to drive the agenda. In this situation, cost effective and appropriate management can become subordinate to meeting timings and inefficient land use objectives.

When presented with this situation, staging of the works can supply a steady stream of milestones achieved to maintain the illusion of progress. This may lead to extra costs as the consultants supply reports for each stage.

Conversely if the identification of a contaminated site is likely to embarrass the government then progress can be significantly delayed due to reduced funding and the requirements to minimise publicity which may impact on the selection of consultants and contractors and otherwise impede general progress.

As a result, political awareness and diplomacy can be vital ingredients of a successful site rehabilitation program.

5. LEGAL ASPECTS

The management of legal aspects can be critical to the satisfactory processing of a contaminated site. As the remediation costs may be heavy, involved parties will try to avoid liability and clean-up action may be subordinated to attempts to determine responsibility.

5.1 Legislation

Significant site remediation legislation has been developed in the last few years as governments try to protect themselves from the costs and adverse publicity in addition to protecting the public from health risks.

The new legislation moves towards the "polluter pays" philosophy which may indeed be the polluter, but may also be the occupier or owner of the site if they have the capacity to pay. Finance companies can be drawn into the web in this way if they take possession of a polluted site.

One of the strictest pieces of legislation is the NSW *Environmental Offences and Penalties Act, 1989* which includes provisions to prosecute individual directors and managers (including public sector) and freeze the assets of corporations in anticipation of a clean-up. Penalties include up to \$1 million for companies and \$250,000 or 7 years imprisonment for individuals. While these are maximum penalties, there have been some significant penalties ordered by the courts, indicating strict enforcement of the Act.

State legislation may also have strict reporting requirements such as the Queensland *Contaminated Land Act, 1991* which requires notification of contaminated land for its contaminated sites register within 30 days of the owner becoming aware of the likelihood of contamination. The format for notifications and investigation reports is also specified.

5.2 Legal advice

Environmental lawyers are actively pushing their services and in particular they have suggested that professional privilege may extend to site contamination studies undertaken by them on behalf of clients. If this is true then it could give

companies more confidence that any report they have undertaken will not be "discovered" by the government and used against them.

This allows a report to be undertaken and a clean-up strategy developed prior to approaching the government with official notification. However, any delay in reporting may not comply with the legislation in some States.

In addition there will be situations where the fact that a report incriminates the polluter or owner may not stop it being used as evidence.

5.3 Liability

There are moves in Victoria and New South Wales towards strict and absolute liability for polluting activities and therefore taking reasonable precautions is not an adequate defence to avoid liability for damage and any clean-up costs.

There may also be liability arising from common law torts where a polluting activity causes damage to a neighbour or the general public.

If land is sold where the vendor was aware of the contamination but didn't disclose this information to the purchaser, then liability may derive from a common law or Trade Practices action may on the basis of misrepresentation or fraud. The Queensland *Contaminated Land Act, 1991* includes a declaration of status as a requirement of sale.

Site owners and managers should be wary of leasing their land for potentially contaminating activities as they may be left with the clean-up bill once the lessee moves on.

5.4 Contractual provisions

There are several important contractual aspects of site contamination projects that need consideration. Most owners/managers will require outside technical assistance to investigate and manage projects and these professionals need to protect themselves to stay in the industry. One potentially contentious issue involves the disclaimers that consultants often include in their reports in an attempt to protect themselves from liability. This is a necessary part of the industry; however, owners and managers need to ensure that the consultant has added value to the process. While the consultant is not, and should not be held responsible for the contamination, they should be required to provide an expert opinion, based on solid reasoning that they are willing to justify in court if necessary.

Many projects are undefined at the commencement of works and until a good picture of the contamination is gained (at least) the true cost of remediation is unknown. This contrasts markedly to most construction projects where the brief is far more defined. Special contract provisions need to be

incorporated to facilitate extensions of work and verification of requirements.

In most cases the owner/manager is reliant on the expert to provide the necessary advice. Where this expert is also the contactor undertaking the works a strong conflict of interest arises. More clean-up works means there will be less risk to the consultant of a claim and more payments; which is unlikely to be in the owners best interests. For some projects this situation is unavoidable and managers should realise that while the bulk of the industry appears to be honest, exceptions do exist.

6. INTERPRETATION OF RESULTS

The interpretation of results from testing programs can be extremely difficult as many factors impact on the assessment process; some of which are discussed below.

6.1 Quality assurance and control

A sampling and testing quality assurance and control process should be instigated before commencement in the field, as there are many ways in which the results can be rendered useless.

Field sampling and testing for chemicals is a technical operation which requires more skill and knowledge than normal soil sampling for geotechnical purposes. The experience of companies in this regard should be a significant selection criteria.

Chain of custody records should be implemented to ensure that the appropriate samples are treated and tested as required. The testing of volatile substances, in particular, is very susceptible to sampling techniques and poor return rates are common. The use of a hand held photo-ionisation detectors is now favoured by many consultants because of this problem.

A good basic quality control method that is available for most testings is to use the services of a NATA accredited laboratory. Managers should ensure that the results include NATA certification on each page and the report is reproduced in full.

Even NATA labs have occasional difficulties and spiked samples (samples of known concentration), duplicate samples are usually sent to the primary lab. Additionally check samples can be sent to different laboratories as a further check on the reliability of the testing processes used.

Even with these procedures there will be differences in the results obtained for identical duplicate samples because of the many variables involved. These differences should be accepted up to certain limits which, as a guide, are 20% absolute or 50% relative standardised difference. A series of poorly correlated results reduces confidence in all of the tests and consultants will try hard to justify their

results rather than redo the testing - which should be at their expense.

6.2 Contamination criteria

If the testing results achieved have acceptable accuracy from the quality checks then the levels of contaminants need to be compared to the published levels for the State and land use proposed. Any readings above the levels specified indicate that further investigation is required rather than stating that a site is unacceptably contaminated.

Further sampling and risk assessment is undertaken to gain a fuller appreciation of the specific site characteristics and risks factors.

7. REMEDIATION OF SITES

7.1 Aims

Prior to remediating the site, the owner/manager needs to determine the aim of the process. Possible remediation agendas include:

- Minimising cost
- Minimising publicity
- Maximising sale yield value
- Achieving a fixed date deadline
- Achieving a fixed land use
- Achieving regulatory compliance
- Maximising public safety

These aims can produce totally different approaches and will impact significantly on the time and cost of the project. Even after field sampling, prediction of the end cost can be extremely difficult and a staged approach is often justified to provide some control of the process.

7.2 Remediation options

The options for remediation obviously depend on many site related factors and the options need to be separated by time, cost and reliability considerations to facilitate the best choice to meet the aims.

As the industry is new in Australia, many of the companies have imported knowledge and techniques. This is necessary to reduce the learning curve, but may favour a pre-packaged solution which the consultant has experience in. These solutions may not be the most cost effective choice and consultants should be made to compare and justify their proposals.

Until recently, there has been a prevailing tendency to remediate by moving the soil to another location and hence not treating the contamination. Due to the realisation that this only creates another problem and the growing expense of space in contaminated landfills there is an increasing tendency to treat the soil on site, either to reduce its

concentrations (cheaper landfill) or to achieve complete remediation.

There are many techniques for control or remediation which include:

- groundwater pump and treatment
- slurry walls for groundwater control
- soil washing
- air stripping of volatiles
- soil removal to secure landfill
- bio-remediation
- soil burning
- chemical binding of contaminants
- soil farming (for hydrocarbon spills)

These and other techniques are discussed in the References and other publications. Inexperienced owners/managers are recommended to seek professional advice as to the most appropriate methods to be employed.

7.3 Taxation

Some companies may advise that their new clean-up technology may be eligible for a tax deduction, but this must be balanced against the risk associated with unproven methods.

Action taken for the sole or primary purpose of reducing or mitigating pollution may also be eligible for tax deductibility.

8. CONCLUSIONS

Site contamination investigation and remediation is a complex field which can involve the interaction of personnel from many fields of expertise.

Consideration of the full process of investigation, remediation and redevelopment of the site early in the process, is vital to the effective management of contaminated sites.

Uncertainty is a major factor in these projects, which can create difficulties for managers with respect to time and cost control in particular.

Owners and managers are strongly recommended to obtain reliable, professional assistance to avoid quick fix solutions and other costly mistakes.

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