Playing On Difficult Ground

The identification and assessment of risks associated with upgrading playing fields located on suspected Brownfield sites.

Jonathan Smith BSc Hons MSc CBIOL MIBIOL MCIWEM

Introduction

Industrial change and demographic shift during the 20th century has resulted in the reorganisation of our towns and cities. Heavy industries have moved out leaving large areas of dereliction in our urban landscape – so called Brownfield sites. During this period changes in domestic heating methods and the advent of the consumer society have had a significant effect on the type and volume of refuse needing to be disposed of as landfill. These developments have left a legacy of contaminated and landfill land, which is potentially harmful to both human health and the environment. The Environment Agency estimates that there are some 300,000 hectares of land in the UK affected to some extent by contamination left by industrial activity.

Cities and towns have "green space" allocated for natural turf sports use. At first glance such land appears to be benign, but there may be a good reason why it has not been developed. It must be recognised that the land may not have been developed for housing or retail because it has a history of industrial use. Brownfield sites are difficult to develop due to the high cost of remediation and so remain as prime sites for recreational use. In the past they may well have been converted to grassland at minimal cost, without the removal or stabilisation of contaminants which still lurk beneath an otherwise innocent looking surface.

Playing fields sites which have had no former industrial use may also be contaminated to a degree. Contamination could have resulted from the innocent application and accumulation of certain turf maintenance chemicals over decades of use. Sites with innocuous former uses, such as allotments, could be contaminated with materials such asbestos which was used as a shed roofing material.

If there is a need to upgrade or develop existing natural turf sports facilities it is important that the environmental status of any proposed site is investigated and fully understood prior to site works commencing. As a first step, research into the sites former history and geology should be undertaken. This may take the form of a Phase 1 Desktop Study which will collate and assess pertinent information relating to the sites former use. To assist with the study information can be purchased from specialist organisations such as the Landmark Information Group. Landmark can supply an "Envirocheck" report for the site, which gives site centred information relating to it's former history. The report will include a site sensitivity map, site data sheets and historical maps which will assist in ascertaining whether the site is potentially contaminated and whether it has been subjected to landfill activities.

Based on the findings of the desktop study and Envirocheck report it may be necessary to undertake a Phase 2 geo-environmental site investigation. The site investigation would normally involve a site reconnaissance walkover, sampling of soils, geo-environmental laboratory testing, and the assessment and reporting of findings relevant to the proposed end use of the site.

With any development there are a number of potential receptors that can be adversely affected by exposure to contamination. The following is a typical list of receptors which should be included in the assessment:

- Site end users.
- Construction and maintenance workers.
- Surface and groundwater features.
- Grass plants

Assessment of Risk to Site End Users.

The Phase 2 assessment will use UK government guidelines on the assessment of contaminated sites. These relate specifically to the health and safety of site end users (DEFR/Environment Agency, 2002). The new CLEA (Contaminated Land Exposure Assessment) guidelines provide a model from which acceptable levels of individual contaminants can be generated to assess the risk to site end users. These recently published guidelines replace the now out of date ICRCL guidelines. The Environment Agency has run the CLEA model for a number of determinants using selected generic end users to produce Soil Guidance Values (SGV's). At the time of writing the new SGV's have been published for only seven heavy metals (arsenic, cadmium, chromium, inorganic mercury, nickel, selenium and lead) and for four generic site uses:

- Residential with edible plants.
- Residential without edible plants.
- Allotments.
- Commercial and industrial.

Additional Soil Guidance Values (SGV's) for other contaminants and site uses will be published in due course. No SGVs have been published as yet for recreational open spaces for two reasons. Firstly, sufficient information to generate and document an acceptable conceptual exposure model for this standard land-use has not yet been compiled. For example, 'Who visits parks and playing fields?', 'How long is an average visit?, 'Is there a difference between summer and winter visits?' and so on. Secondly, the diversity in leisure land-uses such as city parks, playing fields and golf courses may not be suited to the production of a single standard land-use scenario.

As part of the Phase 2 investigation work a Tier One Risk Assessment may be undertaken. This will help to establish whether levels of any contaminants identified on site will pose a potential risk to future site users. The Environment Agency has undertaken to compile and review of information on a wide variety of leisure land-uses in order to develop new models. This technical guidance will be useful to assessors undertaking a detailed risk assessment, and may form the basis of any subsequent Soil Guidance Values for this type of land-use. Until these specific SGV's are available for recreational open spaces, the Tier One Assessment may use SGV's for one of the generic site uses listed above, possibly in

conjunction with other soil contamination criteria published such as the Dutch Intervention Values (DIV 1996) and the Australian Health Investigation Levels (HIL 1999). The development of the CLEA model and the Soil Guideline Values is an on-going programme of work supported by the Department for Environment, Food and Rural Affairs, the Environment Agency, and the Scottish Environmental Protection Agency.

If the results of the Tier One Assessment conclude that the site may be a risk, then a Tier Two Assessment should be undertaken to further define and quantify the risk. The Tier Two Assessment is more detailed in that it is site specific, and new site specific SGV's will be generated for the site itself. The levels at which these values will be set may take account of the age and sex of the site users, and the degree of exposure anticipated. The SGV's produced will be compared with the soil sample test results, to establish whether there is a significant risk. If so, then remedial site works may be required. These remedial measures may include importing a specified depth of "clean cover" over the contaminated soils to prevent exposure, and to cut the link between the source and receptor. The depths and design of the "clean cover" system will be dependant on the nature, degree and extent of contamination found. In some instances significant contamination may be limited in extent to a single "hotspot" and the most cost-effective remediation solution may be to simply excavate and remove the contaminated soil off site to an appropriately licensed landfill site. The excavated material would then be replaced with an approved and validated inert fill.

An example of ash/clinker drainage material commonly found below the top soil. This could potentially be contaminated with heavy metals, poly-aromatic hydrocarbons, sulphates and sulphides.

The contamination identified may be present in areas which will be covered by hard-standing, such as a car park area. In this instance a clean cover system as described above may not be required as exposure to the contamination will be reduced by the presence of the hard standing. The hard standing may also form a suitable barrier to prevent clean water from coming into contact with the underlying contamination.

If a clean cover system is required to remediate a sport fields it is important that specialist geo-environmental engineers work closely with sports turf designers so that the most cost-

effective, and suitable remediation design is developed. Typically, clean cover systems may range from 300mm to 400mm in depth. For the remediation of landfill sites the clean cover layer may include a granular layer to assist with venting of landfill gas if present, and possibly the installation of a geo-synthetic mesh or membrane within the granular layer. The mesh or membrane will act to reinforce the clean cover system. This will help to mitigate the effects of any differential settlement which may occur as a result of biodegradation of any underlying waste mass. Other options for stabilisation works could be considered. These could include dynamic compaction of ground materials prior to placement of the ground stabilisation layer. Although this is most likely to provide optimum compaction of underlying material, the likely required easements to nearby buildings and any services beneath the site may make this option technically impossible. Other options include the placement of vibro-stone (ground reinforcement) columns within the in-situ ground materials prior to placement of the stabilisation layer. This option should be approached with caution as it could increase surface infiltration of water. This could in turn increase leachate production from any underlying waste materials.

Assessment of Risk to Construction and Maintenance Workers.

Workers employed on sports field upgrade projects and future maintenance workers may be exposed to contamination possibly by inhalation of dust or vapours or skin contact. These potential hazards tend to be more controllable for the end users. Control can be implemented through Health and Safety legislation such as the Construction (Design and Management) Regulations 1994 (CDM). As part of these Regulations the Principle Contractor will be required to undertake Risk Assessments and to implement their method statements to minimise the health risks to their workers.

The CLEA model discussed above has been generated to assess the long-term risk to site end users only. It is not designed to assess the more short-term risks to construction workers. The Environment Agency is due to publish guidelines covering these workers in the near future.

Assessment of Surface and Groundwater Contamination.

Upgrading playing fields often involves the installation of a new drainage system. If installed into ground which is potentially contaminated this could increase the soil/water contact and the risk of clean water becoming contaminated with inorganic or organic contaminants by leaching. Clean water which becomes contaminated will be discharged off site via surface water features such as, streams and rivers, surface water sewers or to underground aquifers via on site soak-aways. To assess the potential risk to these receptors soil samples should be tested for leachate potential. A number of acceptance criteria are available for use in assessing the possible risk to ground and surface waters. The UK Drinking Water Standards cover groundwater or surface water that is to be abstracted or potable. The Statutory Environmental Quality Standards (EQS) published for both salt and fresh water relate to levels of contaminants within surface waters. Dutch Intervention Values are also often used to assess possible risk to groundwater. If the potential for leachate generation is high then remedial measures may be required. These measures may include lining drainage trenches with impermeable high density poly-ethylene geo-membranes or a geo-composite material to prevent contact between clean water and contaminated material.

An example of new drainage installation. The ground might be contaminated with chemicals which could be leached off site to controlled waters.

Assessment of Soil Phytotoxicity.

The assessment of potential risk to human health is presently primarily based on total levels of contaminant within a soil. The potential phytotoxic risk to grass plants of heavy metals contaminant, especially boron, copper, nickel zinc and certain hydrocarbons is a question of bio-availability as apposed to total levels of contaminants. The availability of a heavy metal to a grass plant will depend on a number of factors including, soil Cation Exchange Capacity and pH, soil redox potential, organic matter and moisture content values. Soils with total levels of contaminants which are deemed to be a risk to human health may not be phytotoxic, as they could be chemically bound up and unavailable to the plant. Alternatively total levels of contaminants which may not posses a risk to human health, could be readily available to the plant at phytotoxic concentrations.

When assessing a soil for the bio-availability of a contaminant it is important to assess levels of contamination at increasing depth intervals throughout the soil profile. A top soil which appears to be uncontaminated and capable of supporting a healthy grass sward could, if disturbed or cultivated, become potentially phytotoxic. An example of this situation became evident on a site when the initial site investigation revealed slightly elevated total levels of two heavy metals within the top soil. This prompted further investigation for bio-available levels of the contaminants at various depths through the soil profile. Numerous hand auger soil samples were obtained across the extent of the site to a maximum depth of 200mm. Each sample was divided in to maximum of four sub-samples at 50mm depth intervals. The sub-sample obtained at each depth interval was then combined and the resulting four samples produced were sent for laboratory testing.

The laboratory results showed that levels of available contaminants increased almost exponentially with depth. At a depth of between 0-50mm in the soil profile the soil was classed as uncontaminated, and at a depth of between 150mm to 200mm the level of a specific contaminant was over five times the phytotoxic threshold value for grass. This top soil had for decades maintained a generally healthy grass sward, although rooting depth was

restricted to the top 50mm. If the profile had only been visually inspected one might have concluded that shallow rooting could have been due to the poor physical condition of the soil, and no further investigation would have been undertaken. If the elevated levels of phytotoxic contaminants had not been identified at an early stage the soil would have been stripped and stockpiled for re-use. The process of stripping, stockpiling and replacing the top soil would have redistributed the available contaminants possibly throughout the full depth of the soil profile. This could have resulted in a top soil which could not sustain grass plant growth and rendered the site effectively useless without undertaking major remedial works. The detailed analysis and assessment of top soil properties prior to construction works commencing, enabled the implementation of an effective remediation solution at relatively low cost.

Summary

The main objective of this article is to highlight some of the hidden risks associated with upgrading a natural turf sports facility, and the procedures which should be undertaken when assessing a site to mitigate those risks. If the environmental status of a site is not fully investigated and understood before site works begins then the works could :-

- Increase the quantity of contaminated water discharged off site to controlled waters
- Increase the concentration of contaminants present in water discharged off site to controlled waters
- Increases the risk of exposing end users to contamination
- Increase the risk of exposing construction workers to contamination
- Increase the risk of top soil becoming phytotoxic

If remedial works need to be undertaken later in the development of a project this could be very disruptive and costly. It is very important that the appropriate investigations are undertaken during the design stage so that cost effective remediation solutions can be integrated into the proposed design prior to works commencing.

The remedial measures mentioned in this article are typical examples and site investigations, remedial works designs and implementation must be undertaken by appropriately qualified and experience specialist geo-environmental consultants. GEO Turf Consulting Limited regularly assess sites for risks associated with soil contamination and landfill activates. We work closely with specialist geo-environmental engineers in assessing sites. If required effective remedial solutions are designed and implemented. Prior to implementation any remedial works required are discussed and agreed with the Environmental Services Department of the Local Authority and the Environment Agency.

Author

Jonathan Smith, BSc (Hons) Msc CBiol MCIWEM

Director GEO Turf Consulting Limited