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Abstract Book

THE JANET WATSON MEETING 2017

The Future of Contaminated Land Risk Assessment: stakeholder perspectives

6-7 November 2017

The Geological Society, Burlington House, London

Convenors:
The early-career sub-committee of the Contaminated Land Specialist Group

Katherine Hunt (Jacobs) Chair
Amy Juden (Arup) Secretary
Molly Brown (Integra Consulting)
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Janet Watson Meeting 2017: The Future of Contaminated Land Risk Assessment; stakeholder perspectives

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Monday 6th November 2017

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10:30	**KEYNOTE: Contaminated Land Bioremediation: Harnessing the power of subsurface microbial processes**	*Prof. Jon Lloyd (University of Manchester)*
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11:30	**KEYNOTE: PerfluorAd Case Study: An efficient and cost effective treatment process for PFAS contaminated waters**	*Quentin Hulm (Cornelson)*
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POSTER PROGRAMME

Monday 6 November 2017
The Impact of Asbestos on Construction Projects: A Risk-Based Management Solution in Practice Laura Garland (Arcadis)
Integrated hydrogeophysical modelling for contaminated land risk assessment Michael Tso (Lancaster University)
Tuesday 7 November 2017
Electrokinetic-enhanced removal of toluene from physically heterogeneous granular porous media Richard Gill (Shell Global Solutions B.V.)
EPS' Fuel Feasibility Decision Matrix Sam Setchell (Environmental Protection Strategies Ltd)

ORAL ABSTRACTS
(in programme order)

Risk Assessment – what you don't know!

Claire Dickinson
Independent

Most conferences seek to show knowledge and advances in a particular field of interest. This conference is no exception but considering my career in geology, geotechnics and contaminated land much of my 28 years has been spent explaining what I don't know, or to be more precise, the variabilities and uncertainties that are inherent in applied environmental geology decisions. Contaminated land risk assessments may be simple qualitative assessments but more often are quantitative with complex geological/hydrogeological settings with increasingly difficult and emerging contaminants of concern such as asbestos and PFOS. A sound risk assessment which considers and clearly communicates uncertainty is essential. This talk sets the context contaminated land risk assessment and is a reminder that understanding what we don't know is just as important as what we do!

NOTES

Why the conceptual site model is (should be) at the heart of contaminated land risk assessment

Judith Nathaniel
Land Quality Management Ltd

The Conceptual Site Model (CSM) is the central tool for contaminated land management. It draws together the relevant features known about the site at each phase of work and highlights those that are assumed or remain sufficiently unknown to require further work. In particular it analyses and then communicates the contaminants, pathways/ barriers and receptors that combine to form contaminant linkages posing a risk at a site and in its vicinity now and in the anticipatable future. It is used both by the consultant as a means to capture and consider the key information about the site and more widely to summarise and communicate the relevant features of a site in respect of contaminated land management.

The need for a CSM is clearly stated in many industry guidance documents. Whilst most practitioners would agree that there should be a CSM for each phase of investigative works, there is some disagreement, at least in practice, about what should be in a CSM. Too many are text based, incomplete, lack detail on subsurface features and need updating with new information. Many CSMs assume that geological materials are homogeneous, horizontal layers separated by straight boundaries. The reality on site is that soils, strata or bodies may be discontinuous, weathered, altered, fractured, contain pockets of other materials, be internally heterogeneous or separated by uneven or even gradational boundaries.

Movement of contaminants through the subsurface is inherently bound up with the nature of the subsurface materials and crucially the soil and rock mass. The risk posed to the various receptors is estimated using models which, of necessity, simplify reality but such estimates aid the evaluation of the risks. Understanding the nature and distribution of the material and mass beneath the site is essential to select and parameterise an appropriate risk assessment tool and appreciate the limitations of its outputs.

The talk will cover what a CSM is, what should be in a CSM, how CSMs should change through the different phases of investigation and how a CSM drives the risk assessment from Phase 1 all the way through to verification of remediation. The talk will include good and bad examples of CSMs to illustrate the points, particularly in relation to understanding the geology and the interaction of contaminants with the materials beneath the site. We will close with a look forward for the role of CSMs in selecting, implementing and ultimately validating remediation works.

NOTES

Ground Gas: Moving forward Site Investigation, Monitoring & Risk Assessment Techniques

Sarah Mortimer
The Environmental Protection Group Ltd

The UK has plenty of ground gas guidance. But, does this guidance ensure that quality criteria for ground gas risk assessments in the UK are always achieved? Key questions that risk assessors should be considering are;

- Is the information used to inform the assessment of gas risk relevant to the context of the risk assessment?
- Is there sufficient information for the required level of confidence?
- Is the data reliable, reflecting true or likely conditions?
- Is the risk assessment transparent?

Many gas "risk assessments" simply involve multiplying peak gas concentration by peak gas flow rate, without any consideration of the Conceptual Site Model. This is not complaint with CLR11, which aims to ensure that the quality of information used, and the overall degree of confidence associated with the analysis of that information, provides a robust basis for decision making.

The aim of this presentation is to pick up on some key aspects associated with the gas risk assessment process. Specifically, we will look at gas risk within the context of a '*multiple lines of evidence approach',* focusing on some key watch points which are critical when developing a Conceptual Site Model for the assessment of ground gas risks:

1. Understanding the source(s) of ground gas, including Made Ground and/or waste. To help practitioners with this aspect of site assessment a new framework is described which has been developed to try and achieve consistent and replicable logging of anthropogenic material.
2. Understanding potential pathways for gas migration, specifically consideration of gas flow along piled foundations. The presentation will summarise the latest research in relation to this.
3. Understanding on which sites continuous monitoring can help increase data confidence, and on which sites it really is quite an unjustifiable expense. Also understanding the difference between 'continuous monitoring' and 'complete continuous monitoring', and the added benefits the latter can bring, including continuous flow rate monitoring.
4. Understanding the intrinsic relationship between gas risk assessment and engineering / construction. Specifically, the presentation will discuss how the engineering construction of a buildings' floor slab / foundation construction influences assumptions within the gas CSM.

In addition to the above, throughout the presentation there will be *watch points* for practitioners – elements which are consistently seen to be influencing the assessment of gas risks, where caution should be exercised.

NOTES

Detailed and innovative site investigation of a complex radiologically contaminated site - Harwell Liquid Effluent Treatment Plant (LETP)

Melanie Wright
Jacobs

Additional author: Duncan Anderson (Jacobs)

On behalf of Magnox, Jacobs designed and carried out a detailed site investigation of the Liquid Effluent Treatment Plant (LETP) at the Harwell Nuclear Licensed Site in Oxfordshire.
The works are part of a Magnox led project to decommission the Harwell former nuclear research site with the overall purpose of delicensing and releasing the land for redevelopment.

The LETP, which covers 2.6 hectares of land in the north of the nuclear licensed area, operated from 1948 to 2014, storing and treating radioactive effluent from the wider Harwell site. The LETP is a complicated site, in terms of both: infrastructure comprising large below ground tanks and associated pipework, and varied radiological contamination relating to the complex research history of Harwell involving a large number of different radionuclides.

For the first phase of the project, Jacobs produced a detailed desk study to confirm the land quality risks and to establish where the highest levels of contamination could be expected. The second phase was to design and undertake a very detailed intrusive site investigation. The site was separated into 26 zones based on the desk study, and the historical processes undertaken in each area. A key element of the investigation was to obtain samples from a range of complex structures, including underground tanks, pipework and extremely thick concrete building foundations with different layers of concrete, brick and bitumen. To obtain samples from these structures a range of innovative investigation techniques were used, including: brick and concrete coring both above and below ground within the tanks and diagonal drilling through tank walls. Windowless sampling, trial pitting, and rotary drilling were also undertaken.

To obtain the best samples, on site radiological monitoring was undertaken during the works, to help target areas of elevated radioactivity. In addition, the concrete cores collected were cut by the laboratory to prevent radionuclide dilution. The data from gamma spectrometry and detailed radiochemical analyses of selected samples will enable radiological fingerprints (percentage of different radionuclides present) to be established to characterise materials for disposal.

Due to the complexity of the site there were a number of additional health and safety measures required, compared to an ordinary investigation. These included mitigation of radiological risk with full time health physics monitoring and the wearing of dosimetry monitors. Methods to reduce the received doses were employed throughout the project. For work in the treatment tanks, risk assessments considered safe methods for access and working within the tanks. Scaffold stairs were constructed and safe extraction methods put in place.

The data collected from the investigations will help to reduce the cost of waste disposal, and provide a greater understanding of the contamination risk in different areas of the site prior to the remediation works. In addition the data has helped confirm the existing understanding of radionuclide mobility within the underlying chalk geology.

NOTES

Use of Compound Specific Stable Isotope Chemistry in Groundwater Risk Assessments

Matt Riding
WSP

Additional author: Russell Thomas (WSP)

Compound Specific Isotope Analysis (CSIA) is a highly sensitive, rarely performed, specialist method that can be used to evaluate the degradation of dissolved phased hydrocarbon contamination within groundwater. In their pure product form, commercially available petroleum hydrocarbons contain a well characterised ratio of carbon (^{13}C-^{12}C) and hydrogen (^{2}H-^{1}H) stable isotopes. When biodegradation occurs, microorganisms preferentially degrade the lighter isotope fractions (^{12}C and ^{1}H), resulting in a relative enrichment of the heavier ^{13}C and ^{2}H isotopes. This process is known as isotope fractionation. When enrichment of the heavier isotope fractions exceeds the known range for commercially available products, degradation of site contamination can be inferred.

The technique provides both categorical evidence for *in-situ* biodegradation, together with accurate *in-situ* measurements of biodegradation rates, for which data can be rapidly acquired via a groundwater sample. Furthermore, it can be easily applied to a range of low molecular weight (LMW) hydrocarbons at limited additional cost and time, with no additional sample collection requirements.

WSP applied the CSIA to groundwater beneath a petrol filling station (PFS) site, which was impacted with elevated concentrations of Benzene, Toluene, Ethylbenzene and Xylene (BTEX). The technique was considered applicable due to the suitability of the existing wells, which were located within the contaminant plume, eliminating the need for additional drilling works and disruption to normal forecourt service operation. Samples of groundwater were obtained from six on-site wells, and sent to the laboratory for analysis. To ensure the highest quality data, WSP chose to analyse for both carbon and hydrogen isotope fractionation.

Clear evidence of in-situ BTEX biodegradation on-site was given where isotopic fractionation exceeded the known ratios of pure petrochemical products, and locations down-gradient of the assumed source were sufficiently enriched in heavier isotopes. Using this data, the quantity and rate of BTEX degradation occurring along different flow paths (between the source area and downgradient locations) was calculated.

The data provided was substantially in excess of the requirements outlined by the Environment Agency to assess risk from groundwater contamination. An *in-situ* biodegradation half-life of 23 days was derived for benzene, with the rates for toluene, ethylbenzene and xylenes ranging between 8 and 84 days. The technique was also used to differentiate between biodegradation and processes such as dilution and diffusion, which reduce contaminant concentrations, but do not reduce the total (plume wide) contaminant mass.

This data was particularly important at the site, due to large differences in contaminant concentrations between the source zone and immediately downgradient wells, together with complex hydrogeology. The data provided evidence that the observed loss of contamination in groundwater, was due to biodegradation, and not as a result of contaminant dilution, or migration via an unidentified groundwater flow path.

The site specific half-life values derived through the CSIA were used to provide highly accurate data input to a Detailed Quantitative Risk Assessment, and in the generation of appropriate site specific assessment criteria.

NOTES

Communicating the unseen and unfamiliar: using our differing ideas about the subsurface to improve effective communications.

Hazel Gibson
The University of Plymouth

More and more often the work of geologists and geotechnical engineers who operate in the geological subsurface, is being brought to the attention of the general public. Whether it is through large controversial projects like deep geological disposal of radioactive waste or projects that may initially seem more peripheral to the non-specialist, such as the large construction projects of HS2 or Crossrail, people are increasingly being asked to participate in a discussion about a realm that is often unseen and that many find deeply unfamiliar. For geoscientists communicating with the public, this perceived unfamiliarity has a profound impact and many use science communication strategies such as framing and use of correct language to overcome barriers, but there is a more fundamental difference at work; the influence of different conceptualisations of the subsurface. One of the main, and most important, differences between geology experts and non-experts is the way that geoscientists conceptually link the familiar surface and the unfamiliar subsurface with ease, but non-experts do not find this connection as logical and instead use varied conceptual tools to help them penetrate that boundary. This has implications for how geoscientists can use a growing understanding of the different conceptual models both they and the public's use to improve effective geoscience communications.

NOTES

Managing a Portfolio of Brownfield Sites – hundreds of sites, thousands of stakeholders.

Matthew Pearce
National Grid

National Grid Property owns over 300 surplus sites, and also manages brownfield risks for National Grid's regulated businesses. The objective being, to manage liabilities, sell surplus land, and bring brownfield sites back into beneficial use.

Managing a large portfolio of sites brings challenges over and above those associated with an individual brownfield site. There is always the question of where to start – it is not possible to address every environmental risk straight away. A consistent way of assessing risk is needed for prioritisation. NGP have developed and use a spreadsheet known as the 'prioritisation of risk tool' which is completed by our consultants, supports decision making, and helps us explain our prioritisation approach to our stakeholders.

National Grid Property has thousands of stakeholders both on individual sites and at a portfolio level, alongside business and regulatory stakeholders. Decisions made on one site, or impacting one stakeholder can have wider repercussions for the entire portfolio. Experience has shown us that early, proportionate and frequent engagement with all relevant stakeholders is essential to deliver on the businesses goals.

NOTES

The Use of GIS to Improve Geoenvironmental Reporting Efficiency

Harriet Wood
Jacobs

Geographic Information Systems (GIS) allow large amounts of data to be linked to geographic locations. Although various forms of GIS have been around for decades, they are now becoming increasingly commonplace in both work and home environments. At Jacobs we have been exploring how GIS can be used for a number of different geoenvironmental applications, and present three case studies on how simple GIS techniques have been applied to real projects.

The first case study shows how GIS has been used to organise and amalgamate ground investigation data for a large infrastructure project comprising a new water supply pipeline spanning a distance of over 100 km. Over 740 individual logs from 20 separate ground investigations were linked to a map, allowing easy assessment of sub-surface conditions in relation to the proposed scheme.

The second case study highlights how the use of digitised environmental GIS data can be significantly more efficient than traditional PDF data when used for the production of Phase 1 desk studies. GIS was used to assess the potential environmental constraints for a proposed highways scheme, comprising upgrades to a 30 km length of existing highway. As well as providing significant time and cost savings, the use of GIS also provided increased accuracy and greater flexibility in terms of data presentation.

Through these case studies we demonstrate how the adoption of GIS techniques in our work processes has resulted in significant efficiencies by reducing the time spent producing reports. Embracing a more digital approach has also allowed for more accurate site characterisation, whilst allowing data to be more accessible and easily understood by non-technical colleagues, clients and stakeholders.

NOTES

Understanding uncertainty and the limits of knowledge that govern the outcome of risk assessments - Case studies exploring the role of traditional analogue modeling techniques

Mike Plimmer
Geotechnical & Environmental Associates Ltd

A variety of complex numerical models are available to model the flow of contaminants within the groundwater and soil vapour pathways, but like all analytical models these represent a simplification of the 'true' on-site ground conditions which ultimately govern these pathways. On all sites in the real world, budget limitations will result in inevitable knowledge gaps regarding the uncertainties associated with the actual flow paths; natural soils are not homogeneous and isotropic and the permeability and contaminant flow path are heavily influenced by anisotropy and fissure flow. Furthermore, as much of the critical pathway may be within anthropogenic deposits, significant material variability on the local scale and the presence of preferential pathways, will have a dramatic effect upon the risk pathway.

Understanding the scale and implications of the uncertainties in the contaminant flow pathway within the Conceptual Site Model is vital. However, quantifying the variability of the parameters affected by these uncertainties is often not economically possible. Therefore, no matter how complex a model is, it will always represent a simplification of the 'true' contaminant flow path. Whether the degree of this simplification will detrimentally affect the output of the model may however, not be clear at the outset. Therefore, where the effect of such uncertainties may be significant, the economics of attempting to develop and calibrate a complex model can be questionable, and there may be a role for a more simplistic, albeit limited, model such as an analogue flow model. Such simple models have the advantage of being relatively quick a set up and are easy to visualize, and if an iterative approach is adopted, they can be easily amended or re-modelled to assist in their calibration.

A case study is presented for a site where knowledge of local contaminant flow pathways was required to design a remedial scheme in complex ground conditions, but where the in ground uncertainties would have limited the reliability of a complex digital model. An iterative approach, using a series of basic analogue models, based on electrically conductive Teledeltos paper, was utilised to provide a low cost, general over-view, of the likely local contaminant flow paths. Further targeted investigation was then carried out to allow refinement and calibration of the model, to the extent that it could provide a 'sufficient approximation' of the contaminant flow path to allow the conservative design of the injection points for the remedial scheme. Whilst a complex digital model would have permitted a greater degree of refinement, the scale of the remaining uncertainties could not have justified the cost of such potentially more accurate modelling and thus the simple analogue model, with an understanding of the its limitations due to the uncertainties, proved a cost effective approach to the contaminant flow path modelling.

NOTES

Characterising the Haystack of Geogenic Organics arising from Hydraulic Fracturing

David Blyth
Imperial College

Additional Authors: Dr. Adrian Butler and Dr. Geoff Fowler (Imperial College), and Dr. Rai Kookana and Dr. Mike Williams (CSIRO)

Currently the global energy landscape is shifting towards cleaner sources of energy, with the intention of aiming at having energy sources being both zero carbon and renewable in the near future. However, in order to both reduce current emissions, keep economies on track and being energy self-sufficient natural gas in becoming an increasingly important bridging fuel.

The hydraulic fracturing boom in the USA has lead other countries to invest into the sector. Australia, in particular has managed to increase unconventional gas output to be projected to become the second largest natural gas exported in the world over the next year. Unfortunately, with this vast amount of exploitation is occurring relatively little is known about the organic pollutants that arise. If this industry is expected to continue to grow at the current projections it is imperative to understand what the potential consequences could be.

To this end we are investigating the potential organic compounds that could leach from different unconventional gas formations by investigating various subsurface conditions. In order to explore this, we systematically exert samples to the different temperatures and pressures that the targeted formations are found in the deep subsurface. The conditions in the deep subsurface are unlike those that are found at room temperature and pressure. As a result, the waters found in the targeted formations and the additional stress imparted to them during the fracturing procedure can drastically alter the solvent behaviour of the waters. This means that due to their changing solvent properties we may extract compounds that were otherwise not thought to be leached. We investigate this relationship between temperature and pressure by using waters dielectric constant, by altering this constant under different conditions we can begin to build up a bigger picture of fracking as a whole.

However, characterising large quantities of unknown and unknown unknown organics in a sample is traditionally hard. Currently, in analytical chemistry we are good at finding needles in haystacks but not understanding the haystacks themselves. Consequently, in order to characterise the large numbers of organic compounds that we find an Ultrahigh Pressure Liquid Chromatography – Ion Mobility Spectroscopy – (exact mass) Mass Spectroscopy (UPLC-IMS-MS) method is employed. Combining the extra dimension of IMS allows for an increased ability to characterise unknown organics, by combining theoretical calculations with the empirical data gained.

In order to quantify the potential impacts on human populations we need to define categories of compounds that have the potential to cause harm. The two classes of compounds that were investigated were bioavailable PAHs and bioavailable PAH derivatives compounds that fulfil Lapinski's rule of 5. To date we have found 1000s of compounds that are both polyaromatic and fulfil Pfizers rule of 5 for drug design. These results show that it is imperative to continue investigating ways of characterising unknown organics in the environment that aren't targeted but could have the potential to do significant harm to humans.

NOTES

Benefits of professional qualifications and accreditation: A view from industry

Simon Cole
Aecom

Professional qualifications and accreditations – are they worth it? A simple sounding question with maybe a straightforward answer. But is it more subtle or complex than that? Demonstration of competency is all the rage but are qualifications and accreditations fit for this specific purpose? Is someone without an accreditation somehow less competent than someone with? Or is this missing the point – is there much more to professional recognition through qualifications and accreditation? This talk looks at the benefits and importance of professional recognition of knowledge, skills and experience throughout your career (both for employers and employees) and looks to unpick some of the options available; but also looks at the importance of professional development outside of specific organisational schemes and the challenges in demonstrating that such schemes make a difference.

NOTES

From Laboratory to Site: the development and deployment of an innovative Liquid Activated Carbon technology to target contaminant plumes

Gareth Leonard
Regenesis

Demonstrating the ability to provide a rapid and sustained reduction in dissolved phase contamination to concentrations previously through unachievable through biological degradation alone; this presentation will explain the mechanisms behind this innovative remedial approach, citing laboratory studies used in the development of the technology.
The technique will be exemplified by the latest European case studies discussing the site details and performance data obtained. Data collated and compared from more than 20 field applications will also be presented, addressing chlorinated solvent and hydrocarbon impacted sites and encompassing a variety of geological settings within both Europe and the US.

Ongoing research into the treatment and mitigation of the effect of contaminant back diffusion will also be presented. Here, Liquid Activated Carbon has shown unprecedented penetration of low permeability media through diffusion, following emplacement in the permeable flux zone. This allows adsorption and enhanced biological degradation of contamination therein, preventing poor remedial performance or contaminant 'rebound' due to back diffusion; something that is crucial in the treatment of plumes within heterogeneous sites.

NOTES

Putting subsurface microbes to work; harnessing natural biogeochemical processes for the remediation of land and water

Professor Jonathan Lloyd
University of Manchester

The subsurface represents a rich source of novel microorganisms, able to couple the biodegradation of toxic organics to the utilisation of a wide range of electron acceptors including minerals and toxic metals. The subsurface therefore represents a tremendous resource that can be harnessed for the treatment of contaminated land and water via the careful manipulation of microbial metabolism, either via the addition of nutrient amendments or remediation agents, or in extreme cases the augmentation of indigenous microbial communities with novel microorganisms.

I will talk about our recent work on the bioremediation of soils and waters contaminated with metals, radionuclides and organics, encompassing the latest advances in spectroscopy, imaging and genomic analyses. A new focus on revalorising metal-containing wastes will also be discussed, illustrating how waste-containing materials and effluents can be used a resource for the biorecovery and biosynthesis of novel functional materials. Extension of this work to support energy sectors relying on subsurface disposal scenarios will also be discussed, including the safe disposal of nuclear waste, carbon dioxide and dealing with the potential impacts of shale gas exploitation.

NOTES

PerfluorAd Case Study– An efficient and cost effective treatment process for PFAS contaminated waters

Quentin Hulm
Cornelson

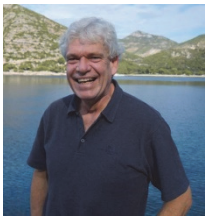
PFAS compounds, otherwise known as PFCs constitute a global problem. Persistent and bio-accumulative they are an emerging contaminant with growing toxicity evidence. Developed for their thermostability, chemical stability, surfactant and anti-adhesion properties, they have been used widely from fire-fighting foam to textiles and food packaging. These properties also render PFAS compounds difficult to treat. Current treatment processes are ineffective or of limited efficiency with consequential high costs and low performance.

PerfluorAd is an innovative solution entailing the generation of microflocs followed by precipitation and/or filtration. This approach significantly reduces waste and can be optimised for different concentrations and treatment targets and for widely different groundwater chemistries and co-contaminants. The treatment process can operate independently or it can be added to an existing treatment process as an optimisation measure.

This presentation takes a brief look at a couple of case studies in Germany with a particular focus on Nuremberg airport.

NOTES

Old age problems – emerging technology needs to address risks from increasingly aged solvent-contaminated sites



Michael O. Rivett, *GroundH_2O plus Ltd*, Birmingham, UK / *University of Strathclyde (Department of Civil and Environmental Engineering)*, Glasgow, UK

Jim Wragg, *Geosyntec Consultants, Delph, Oldham, UK*

Gary P. Wealthall, *Geosyntec Consultants, Inc.*, Guelph, Ontario, Canada / *University of Toronto (Department of Chemical Engineering and Applied Chemistry)*, Toronto, Canada

Contamination of groundwater resources by chlorinated solvents is an old problem. Many solvent sites will have become contaminated during the *c*. 1930–85 window, prior to the emergent onset of problem recognition. As such, the majority will contain contamination that is at least 30 years old, but, more likely greater than 50 years based on the peak of solvent usage in the 1960-70s. Most of these sites will have or likely still contain persistent, DNAPL (dense non-aqueous phase liquid) solvent in the subsurface. In modern times, it is critical to consider the consequences of such old age upon the contamination risks posed and the credentials of remediation technologies necessarily required. Problems of old age include: simply locating the source area from poor records or investigation constraints; dissolved plumes that are already be widespread, even off-site, albeit with the potential to be naturally attenuated, even shrinking; permeable parts of the source zone will have largely dissolved by natural groundwater flow leaving source zone remediation technologies needing to surgically target the, increasingly heterogeneous, persistent mass that remains; diffusion over decades into low permeability units or rock matrix will have resulted in significant mass accumulation there that may serve as a secondary, long-term, source zone. We present data that illustrate the field-scale nature of these old age problems and explore the needs and abilities of emerging technologies to address these problems and manage risks posed. Technologies discussed include: in-situ bioremediation of DNAPL source areas; electro-kinetics to manage the flux of aqueous chlorinated solvent back diffusion; technologies to manage mixtures and the impacts of co-contaminants that inhibit degradation and require specific microbial cultures. Also, we consider the re-emergence of MNA (monitored natural attenuation), highlighting the array of forensic tools that may provide quantification of degradation processes, including abiotic MNA.

NOTES

Local Authorities: Why guidance should be at the heart of everything we do but isn't

Rob Ivens[1] and Rachel Thomas[2]

1 Mole Valley District Council
2 Pembrokeshire County Council

Rob Ivens and Rachel Thomas are local authority practitioners; Rachel was a senior contaminated land consultant in the private sector and now works for Pembrokeshire Council. Rachel's background is mainly ex nuclear and blue chip PLC but now works as a full time Contaminated Land Officer and is chair of the Welsh Land Contamination Working Group. Rob has worked for Mole Valley District Council for over 20 years, he has completed Part 2A inspections for his home authority but has worked for a number of other authorities as an official subcontractor through MVDC. Rob has also worked for a number of London Boroughs

Rob and Rachel will talk about the overarching regulatory regime and the pressures local authorities face in the current times of austerity. They will discuss the relative perspectives of the small, the large and the hard pressed. How to get the most out of your reports and use the valuable guidance that you have paid for to try and reduce friction to get the best outcome for you, your client and the regulator.

NOTES

Environment Agency: Promoting best practice, developing guidance and improving standards for land contamination: a Regulators perspective.

Angela Haslam
The Environment Agency

Angela has worked for the Environment Agency for 19 years and is a Chartered Waste Manager and a Chartered Environmentalist (SocEnv). She has over 25 years' experience of working in environmental management, mostly with the Environment Agency focusing largely on waste, groundwater protection and land contamination work. She started out initially with the British Geological Survey before moving into Local Government (Waste Regulation) and then into Environmental Consultancy. She is currently a Senior Advisor in the Land & Contamination Management National team focusing on land contamination issues and represents the Environment Agency at a number of industry groups and forums and has recently joined the Geological Society committee for the newly formed Land Contamination Specialist Group.

Angela will give an overview of the work she is involved in regarding development of new guidance for the brownfield sector, supporting industry initiatives, raising standards and professionalism and the challenges these opportunities provide.

NOTES

British and International Standards and Codes of Practice – Origins and application to contaminated land investigation and assessment

Mike Smith
Independent

British and International Standard codes of practice and guidance documents such as BS 10175, BS 8576 and the BS ISO 18400 series of standards are “good practice” guides to be used with professional judgement and with a willingness to justify deviation from them in court should the need arise. They have been prepared, as are all Standards, by an open process to which anyone can contribute. The origins of BS 10175 can be traced to guidance on site investigation and assessment first published by the Scientific Branch of the Greater London Council over forty years ago, i.e. this is now a mature field of technical activity. An amended version of BS 10175 taking into account the publication of the BS ISO 18400 series will be published by the end of 2017. Consideration will then be given by the relevant BSI Technical Committee (EH4) as to whether a full revision of BS 10175 is required. Revision will not occur unless there are clear indications that users of the standard think that it should be revised and that there are “experts” willing to contribute to the revision. Technical Committee EH4 is currently considering the possibility of producing a standard procedure for taking soil samples for determination of volatile organic compounds (VOCs) based on guidance at present buried within analytical (BS EN ISO 15009: 2016, BS EN ISO 22155: 2016) and sample storage (BS ISO 18512: 2007) standards.

NOTES

Managing the Risk of Coal Mining Legacy for 21st Century Development

Helen Bennett
The Coal Authority

Around a quarter of properties in Britain are located on the coalfield, with approximately 1.5 million properties situated above coal mine workings which are less than 30m deep.

The Coal Authority is a statutory consultee on planning applications in England, Scotland and Wales and considers that mining legacy features can pose a significant risk to development activities – the Coal Authority manages around 1,000 safety and subsidence projects each year, many relating to properties which have been affected by nearby coal mine workings or mine entries. However, with the need to address the UK's housing demand, increasing numbers of sites containing mining legacy features are now being considered for development.

A coal mining risk assessment should be produced for coal field developments, drawing on available historical and site-based sources including (but not limited to) abandonment plans, geological plans, historical borehole logs and mining reports. This assessment should clarify the risk posed to a future development from mining legacy, namely mine entries, recorded or probable mine workings, coal mining hazards, opencast workings, mine gas or geological discontinuities (faults and fissures). If required, a suitable scheme of site investigation should be proposed and a remediation strategy designed, utilising the investigation findings.

Any works to intersect or disturb Coal Authority property, including coal seams, workings and mine entries, requires prior approval of the Coal Authority. These works should be undertaken in a manner which addresses the risks of intersecting mining features, including the monitoring of mine gases and the use of appropriate flushing mediums. Investigations should aim to make an accurate assessment of on site features by ensuring that any boreholes or excavations are appropriately distributed and extend to an adequate depth.

The challenges posed by developing on the coalfield can be both complex and costly, requiring thorough consideration from geologists and engineers. However, through the undertaking of a detailed desk study (which considers the risks both during and after site works) and through engineering and layout solutions, many coalfield sites which may otherwise be disregarded could now be considered suitable for development.

NOTES

The journey to tackle asbestos from soil: the killer which could still surround us

Joanne Kwan
CIRIA

Once thought to be safe, durable, fire proof and cost effective material, asbestos was widely used for many decades throughout the UK. Figures release in July by HSE indicated that the number of deaths caused by mesothelioma, the main disease due to asbestos exposure will continue to be around 2500 deaths per year for the rest of this decade.

Poor disposal practices, demolition and other anthropogenic processes have resulted in asbestos often being present in the ground particularly on brownfield sites. The Control of Asbestos Regulations 2012 states that all 'duty holders' in construction projects have the responsibility to reduce the risk associated with asbestos 'as far as is reasonable practicable'. Other asbestos related regulations include, the Construction Design and Management Regulations 2007 and the Health and Safety at Work Act 1974. These also extend to asbestos found during ground investigation and other similar activities.

Guidance on asbestos from soil lags behind those for buildings. The Association of Geotechnical and Geoenvironmental Specialists (AGS)'s *Site investigation asbestos risk assessment* was published in 2013. Then in 2014 CIRIA produced report C733 *Asbestos in soil and made ground: a guide to understanding and managing risk* published which is the first comprehensive guidance for the past 20 years. This was followed by SOBRA's protocols for monitoring for earthwork activities in 2015 and JIWG's *Control of Asbestos Regulations 2012: Interpretation for Managing and Working with Asbestos in Soil and Construction & Demolition materials: Industry Guidance* (CARSOIL) in 2016. The latter attempts to interpret of how CAR2012 applies to contaminated soil. JIWG also revised the two decision support tools in March 2017 which were first launched less than a year ago.

In regards to helping those who are 'on the front line' i.e. the site and ground workers, nothing was available until February 2017 when CIRIA's C765 *Asbestos in soil and made ground good practice site guide* was published. This will be supported by the first asbestos from soil APP to be launched in early 2018.

However are these new guidance and tools really able to raise standard of our practice? This paper will discuss the UK construction industry's journey in getting better for the management of asbestos from soil risk, what are still lacking and how different stakeholders could further improve their practice in the future.

NOTES

POSTER ABSTRACTS

(in alphabetical order)

The Impact of Asbestos on Construction Projects: A Risk-Based Management Solution in Practice

Grainger, S.[1], Baker, K.[1], Hay, S.[1], Garland, L.[1], Welburn, P.[1] and Milburn, C.[2]

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[2] Environment Agency, Lateral, 8 City Walk, Leeds, West Yorkshire, LS11 9AT

Asbestos containing materials and free fibres present in the ground continue to present a significant challenge to construction and infrastructure projects in the UK, due to concerns that fibre emissions can result in unacceptable risk to human health. Further, changes in the standard laboratory analysis methodology used to screen soils for the presence of asbestos fibres is resulting in an increased frequency of detections of asbestos fibres in soils requiring assessment prior to earthworks schemes commencing. In the absence of clear regulatory guidance in the UK relating to the investigation or quantification of risks associated with asbestos in soils, precautionary risk mitigation measures are being employed throughout the lifetime of earthworks projects, increasing programme timescales and significantly impacting upon overall cost. Additionally, long-term risk management decisions which in many cases are not sustainable, such as excavation and disposal to landfill, are being adopted routinely. However, a new approach to developing a technically more robust and sustainable management strategy for sites affected by asbestos in the ground has been developed, and will be described alongside its effective use at a site in England.

The Environment Agency commissioned a managed realignment scheme within the Greatham Creek Estuary, as part of the region's flood defence strategy. The selected site is a former brinefield, located on reclaimed marsh land. On completion of the scheme, the site was planned to form a new nature reserve able to receive flood water, with footpaths present on the boundary of the site accessible by the general public. At the western edge of the site is a large spoil mound. Preliminary investigations carried out on the spoil mound identified the presence of asbestos fibres, at concentrations greater than 0.1% in a number of samples, raising concern that the spoil mound was a potential emission source for asbestos fibres in air both now and in the future. Potential remediation options comprised complete removal of the spoil mound and disposal to landfill, at a cost of more than €50million, or a full engineered capping solution, costing €2.9million to implement.

To develop a more sustainable solution, the new approach to assessing risks from asbestos fibres in soils was applied, comprising 4 phases:

1. Detailed review of existing site data.
2. Quantitative Risk Assessment (QRA) – derivation of risk-based screening levels.
3. Air sampling programme.
4. Risk Evaluation – interpretation of findings of the air sampling programme.

Within the QRA, the predicted incidence of asbestos-related disease was modelled assuming a measured concentration of asbestos fibres in air, resulting in the development of acceptable concentrations of asbestos fibres in air based on exposure by future land users. The QRA highlighted that existing air sampling data had not achieved a sufficiently low limit of quantification to evaluate the risks to human health. As a result, a new air sampling

programme was designed, setting clear data quality objectives to enable the risk evaluation to be completed, and agreed with the Local Authority prior to undertaking the works.

In the final study phase, the results of the air monitoring programme were evaluated against the risk-based screening criteria. The conclusion of the study was that the potential risks to future land users were acceptable, with no requirement to remove the spoil mound or provide an engineered cap. Access to the spoil mound by the general public has been restricted through installation of a fence, to further minimise potential for exposure to the asbestos. This has resulted in a more sustainable outcome for the scheme, considerable time efficiencies and a cost efficiency of €2.78million.

Electrokinetic-enhanced removal of toluene from physically heterogeneous granular porous media

Gill, R.T.[1,2], Thornton, S.F.[1], Harbottle, M.J.[3] and Smith, J.W.N. [1,2]

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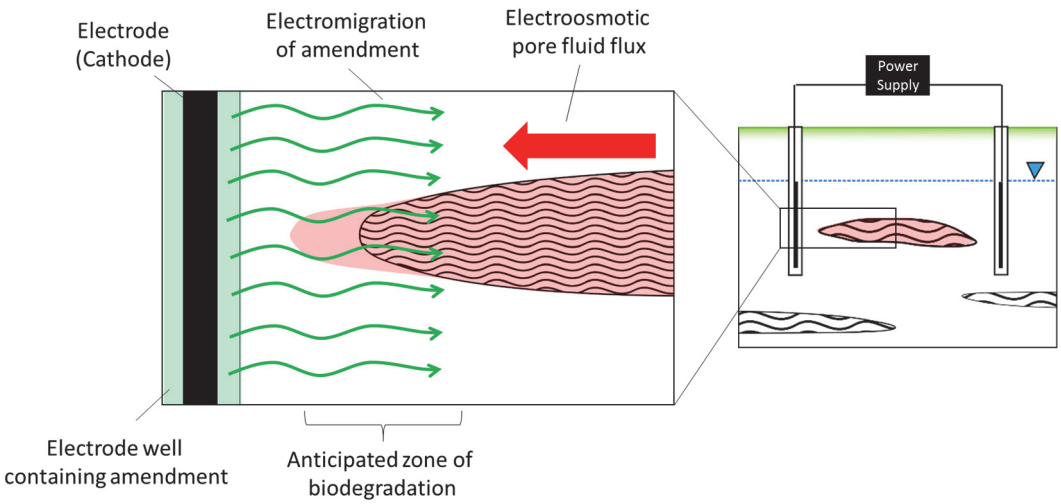
2. Shell Global Solutions, Kessler Park, 2288 GS Rijswijk, The Netherlands
3. Cardiff University, School of Engineering, Queen's Buildings, The Parade, Cardiff CF24 3AA, UK



Current remediation technologies can be ineffective due to mass transfer limitations. A typical scenario where these limitations control remediation efficacy is a physically heterogeneous aquifer where hydraulic conductivity (K) varies spatially. Under these conditions remediation is limited by solute migration across K boundaries. This research investigates the application of electrokinetics (EK) to enhance the biodegradation of toluene sequestered within a low-hydraulic conductivity (K) zone of a physically heterogeneous water-saturated granular porous media.

The hypothesis tested was that EK transport processes, which operate independently of K-controlled advection, can deliver a limiting amendment, nitrate, across a high-/low-K boundary to stimulate bioremediation. Two types of experiment were evaluated: (1) bench-scale that represented the active EK system and heterogeneous sediment configuration; and (2) microcosms that represented biodegradation in the bench-scale tests under ideal conditions. In both experiments a single species inoculum capable of degrading toluene under denitrifying conditions was distributed within the sediment matrix. A conceptual model of the bench-scale tests identified three principal toluene removal mechanisms: electroosmotic pore fluid flux, diffusion and biodegradation. A rapid decrease in toluene concentration during the application of EK is attributed to electroosmotic removal. Comparison of diffusion and biodegradation (microcosm) removal rates confirmed that electroosmosis was the most effective removal mechanism under the conditions evaluated. A sensitivity analysis was conducted to determine the experimental conditions under which biodegradation would be the dominant removal mechanism. It identified that within the experiment, the voltage gradient would need to drop below 25 V/m to reduce the electroosmotic pore fluid flux to a point where toluene would not be mobilised. Furthermore,

the analysis identified the most influential sediment properties, namely electroosmotic permeability and fraction of organic carbon that will determine the toluene migration rate under EK.

Overall, this work has important field-scale implications, by re-evaluating the best mechanisms for coupling EK and bioremediation. The movement of toluene from low-K zones by electroosmosis (and subsequent mixing with nitrate in adjacent high-K sediments) may enhance biodegradation more effectively than electromigration of ionic electron acceptors into low-K zones containing oxidisable organic contaminants.

EPS' Fuel Feasibility Decision Matrix

Sam Setchell[1], Tom Androsiuk[1], Will Evans[1] and Marcus Bell[1]
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www.epstrategies.co.uk

Through extensive work with clients in the Petrol Filling Station (PFS) industry the need for better communication of the environmental risks associated with developing and or refurbishing PFS infrastructure was identified, particularly in light of the Environment Agency's Position Statements previously presented in GP3 and now revamped as GP2017 and the perceived lack of consistency in approach between different EA regional offices. Through discussion with key stakeholders a high level guide was developed that takes a 'whole forecourt management' approach and considers the Geo-Environmental setting to create a clear 'Environmental Sensitivity Scenario' ranking.

Our objective was to provide a high level decision making tool which could steer our clients and their project teams on Environmental Risk at early feasibility stage, so that potential cost, program and space requirements could be taken into account with greater assurity of regulator agreement. The matrix was developed with valuable input from both industry and key Environment Agency personnel.

The result is the 'EPS Fuel Storage Matrix' (Figure 1) which provides a clear Environmental Sensitivity Scenario (EnvSS) ranking of 1-4 (including 3a and 3b). This ranking is broadly based on publically available information that includes consideration of the following:

- Aquifer Designation and continuity
- Ground water regime
- Basal and surface water flow
- Geology and geological context
- Proximity of key receptors – eg. Housing, Schools and other infrastructure

Environmental Sensitivity Scenario		Examples of Site Specific Characteristics beyond vulnerability mapping (examples of mitigating factors)	Typical Fuel Storage Installation			
			Tanks	Lines	Drainage	EMS
1		• Not within SPZ1 • Site specific ground conditions do not support Vulnerability Status of aquifer designation • Limited saturated thickness (typically less than 1.0m) • Baseflow contribution to local surface water features found to be limited	Standard Double Skin Tank Installation with interstitial monitoring	Plastic Lines	Non-Specific (unless potential for differential settlement)	Standard
2		• Secondary aquifer with seasonally high groundwater above tank base, but limited environmental sensitivity (e.g. on basis of site specific ground conditions, resource potential, proximity / connectivity to surface water)	Concrete Encasement around double skin tanks with interstitial monitoring	Plastic Lines	Plastic Pipes	Standard
		• Principal aquifer / high environmental sensitivity, but seasonally high groundwater below proposed tank base				Enhanced Context Specific EMS
3	a	• Secondary Aquifer with groundwater above tank base	Double Skin Tanks with interstitial monitoring, within robust Membrane Lined Cell with monitor wells.	Plastic Lines	Plastic Pipes	Standard
	b	• Principal Aquifer with groundwater above tank base **but** environmental sensitivity limited by site specific conditions (e.g. groundwater not associated with regional resource, close proximity to surface water leading to increased vulnerability to catastrophic failure) • Refurbishment / upgrade of existing where above ground not appropriate (e.g. no space for above ground tanks, blue book safe distances not being achievable, traffic safety concerns, excessive pipe runs, proximity of housing)		Double Skin Plastic		Enhanced Context Specific EMS
4		• Principal Aquifer with laterally continuous groundwater above tank base or in SPZ1	Above Ground Tanks	Double Skin Plastic	Plastic Pipes	Enhanced Context Specific EMS

Figure 1: The EPS Fuel Storage Matrix , Published on www.epstrategies.co.uk

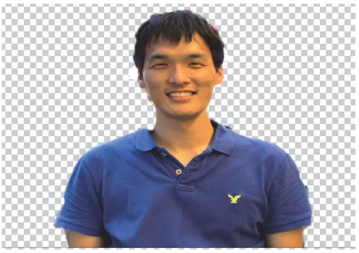
The technical input into these rankings can range from desk study type analysis through to significant site investigation and monitoring. The EPS-Fuel Storage Matrix then compares

the EnvSS to relevant typical fuel storage installation requirements likely to be required. This makes reference to the tanks (above or below ground and construction requirements), fuel lines, drainage systems and environmental monitoring systems, as it essential that both early and subsequent decision making doesn't just take account of one aspect of a Petrol Filling Station, but considers Whole Forecourt Management.

It is important to note that final site specific decisions will always be refined and agreed through an appropriately detailed Fuel Storage Feasibility Assessment which can consider the site specific environmental context, take account of the wider stakeholder interests and recommend a way forward in line with the Position Statements of GP2017.

The EPS Fuel Storage Matrix is already being used by both stakeholders within the PFS industry and the EA as the helpful high-level tool it was intended to be. A major supermarket have recently used this tool to plan the next 5 year plan of infrastructure improvements. Feedback from clients has highlighted the befit in being able to compare the various costs of construction and ongoing management dependent on the sites environmental ranking. Colleges have highlighted the benefit of the matrix as a communication tool when trying to justify the upfront cost of proper desk studies and site investigations.

Integrated hydrogeophysical modelling for contaminated land risk assessment



Michael Tso *(Lancaster University, m.tso@lancaster.ac.uk), Oliver Kuras (British Geological Survey) and Andrew Binley (Lancaster University)*

Geophysical methods, such as electrical resistivity imaging, have been used as a characterisation tool to underpin groundwater and contaminated land risk assessment for decades. However, the geophysical responses rarely play any role in the actual risk assessment. We attribute the above to (i) the uncertainty of relating hydrological and geophysical responses; (ii) the images themselves may not provide any data directly useful for the risk assessment and (iii) contaminant estimates from uncoupled geophysical inversion may not be hydrologically realistic. To address these issues, we present a modelling and data assimilation framework that integrates groundwater and geophysical modelling to estimate contaminant mass discharge (CMD) probabilistically. The framework includes proposing a series of leaks rates, running them through realisations of the subsurface using a coupled hydrogeophysical code under some assumed petrophysical relationships, and then compute the likelihood of each scenario to be generated from the observed time-lapse geophysical response. The collection of likelihoods, in turn, will allow computation of a posterior probability distribution of CMD. The goal of this framework is to show that by including proposed fate and transport models to the interpretation of geophysical monitoring data, the utility of the geophysical data to provide information about the monitored process can be enhanced.

The model integration, achieved by PFLOTRAN-E4D (Johnson et al. 2017), can ensure the hydrological processes inferred from the geophysical responses are hydrologically reasonable. Unlike previous geophysical work that focuses on delineating the architecture of plume, we focus on estimating the CMD. The use of CMD is useful because (i) it is an integrated measure that is readily usable for compliance or monitoring remediation (ii) since it is a spatial integral, there is no need to handle the effect of smoothing of geophysical or concentration distribution images. Our framework does not require any geophysical inversion, which can be computationally prohibitive for probabilistic estimation problems. In this presentation, we will present the initial results from this novel framework, and discuss future work and considerations to implement it to large-scale problems.

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Lower Library:
Exit via main reception onto Piccadilly, or via staff entrance onto the courtyard.
Lecture Theatre
Exit at front of theatre (by screen) onto Courtyard or via side door out to Piccadilly entrance or via the doors that link to the Lower Library and to the staff entrance.
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All accidents should be reported to Reception and First Aid assistance will be provided if necessary.

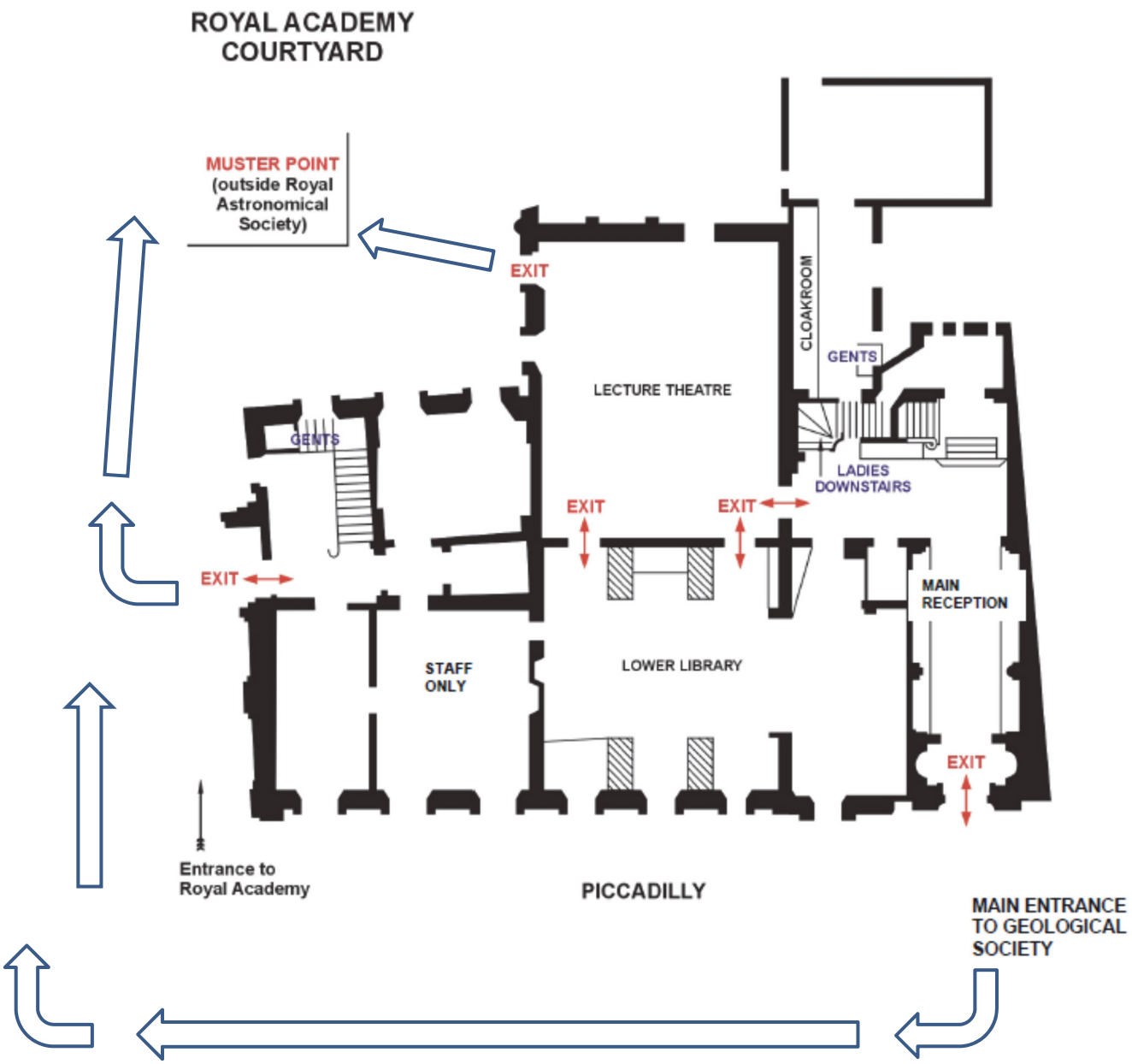
Facilities

The ladies toilets are situated in the basement at the bottom of the staircase outside the Lecture Theatre.

The Gents toilets are situated on the ground floor in the corridor leading to the Arthur Holmes Room.

The cloakroom is located along the corridor to the Arthur Holmes Room.

Ground Floor Plan of the Geological Society, Burlington House, Piccadilly



Geological Society 2017 Conferences

Date	Title	Location
6-7 November	Janet Watson 2017 Meeting: The Future of Contaminated Land Risk Assessment: stakeholder perspectives	Burlington House
08 November	GSL Nottingham Career and Industry Day	British Geological Survey, Keyworth
15-17 November	PG: Handling Fault Seals, Baffles, Barriers and Conduits	Burlington House
22 November	GSL Edinburgh Career and Industry Day	Our Dynamic Earth, Edinburgh
23 November	Bryan Lovell 2017 Meeting: Mining for the Future	Burlington House
27-28 November	PG: Cross-border Exploration between UK and Norway	Burlington House

https://www.geolsoc.org.uk/Events/Society