GEOTECHNICAL COURSE DATES:

Rock Description Workshop
2nd Sept. 2014, 7th Nov. 2014

In Situ Testing
8th October 2014

GEOTECHNICAL COURSE DATES:

Geotechnical Foundation Design - 6th November 2014

Soil Description Workshop
2nd October 2014
4th Dec' 2014

H&S COURSE DATES:

Avoiding Danger from Underground Services
12th Sept' 2014, 24th Oct' 2014

Safe Supervision of Geotechnical Sites:
3rd - 5th Sept' 2014

WANT TO ADVERTISE IN THE GEOTECHNICA?

1. Select advert size.
(Full, Quarter Page, Directory Entry)
2. Select timescale.
(1, 3, 6 or 12 Months)
3. Format your artwork.
(Adobe PDF, .jpg or .png)
4. Send your artwork to us.
(magazine@geotechnica.co.uk, or contact us on 01295 670990)

Size	Standard Rate	Member's Rate	3 Months	6 Months	12 Months
	£550	£500	POA	POA	POA
	£310	£280	POA	POA	POA
	£160	£145	POA	POA	POA
	£30	£25	POA	POA	POA

Geotechnical Academy™ members will benefit from discounted rates.

2012 Advertising Rates (£) - All

theGeotechnica

EQUIPE GROUP

01295 670990
www.equipegroup.com

ARE YOUR GEOPHYSICAL TECHNIQUES INTRUSIVE?

A look at Arrow Geophysics use of non-intrusive geophysical surveys as part of a cost-effective programme of geotechnical site investigation.

Also included in this month's issue:

- Analytical Testing Requirements for Pipe Selection on Brownfield Sites
- An update on The Geotechnical Academy
- A case study on the use of Bentley Systems' gINT software in Abu Dhabi

Issue No.
32
August 2014

Contents

Welcome

Welcome to the 32nd Edition of **theGeotechnica** - the UK's fastest growing online geotechnically focussed e-magazine.

This month, once again, we have a fantastic line-up of insightful and informative articles that make for a must-read.

The first article of this month's issue comes from David A Bowen, Chemistry Supervisor (Organics) at Terra Tek. This month David discusses analytical testing requirements with regards to UKWIR guidance on the selection of pipes for Brownfield Sites.

Writing our second article of this month's issue is The Geotechnical Academy's Liz Withington. In this article Liz provides an update on the success of The Geotechnical Academy - a joint training venture between Geotechnical Engineering and Equipe Training.

The third article is also our cover article and comes from Tim Archer, Technical Director of Arrow Geophysics Limited, a geophysical consultancy established in 2004 that provides advice on geophysical risk reduction for UK construction projects. In this, the first of a series of articles, Tim argues the case for non-intrusive geophysical surveys as part of a cost-effective programme of geotechnical site investigation.

Our final article comes from geotechnical software specialists Bentley Systems. Using data and material provided by the Abu Dhabi Municipality, this case study from Bentley Systems examines the benefits of instant access to subsurface information and how efficient data management can save both time and money when working on large scale projects.

Also included alongside this month's issue of theGeotechnica is the full Event Review from Geotechnica 2014. The Event Review contains full attendance figures from the event, as well as an overview and summary of the Geotechnical Conference. This Event Review can be found online here in flipbook form and here in PDF form.

As with every new edition of the magazine, the Editorial Team here at **theGeotechnica** will be on the lookout for even more new, original and interesting content from all corners of the sector, and would actively encourage all readers to come forward with any appropriate and relevant content - whether it be a small news item or a detailed case study of works recently completed or being undertaken. If this content is media rich and interactive, then all the better. We are looking to increase the already large readership of the magazine through better social media integration and promotion, as well as improving content month on month.

Finally, for any content that is submitted we will ensure that an advertising space, proportionate to the quality of content provided, is reserved should you wish to place an advert in that single edition of the magazine. We hope you enjoy this month's edition of the magazine and are inspired to contribute your own content for the coming editions of **theGeotechnica**.

Editorial Team,
theGeotechnica

Geotechnical Applications Course

22nd - 26th September 2014

£225 + VAT per day / £1000 + VAT for all 5 days

Monday 22nd September 2014 - Specifying Site Investigations

This one day course will look at the various methods available to carry out intrusive and non intrusive investigation. Whilst the course will concentrate on geotechnical methods some geo-environmental methods will be briefly discussed. The course will look at the aims of SI and categorise the various stages in an investigation.

Trainers: Julian Lovell & Keith Spires, Managing & Operations Directors, Equipe Group

Tuesday 23rd September 2014 - Geotechnical Laboratory Testing Awareness

The course comprises a comprehensive one day overview of the complete process involved in Geotechnical Laboratory Testing from sampling through to interpretation.The course provides guidance on sampling requirements including sample types and sizes and revised regimes to comply with Eurocode 7 and BS 1377. During the day some typical laboratory testing equipment will be used to carry out tests and to give a greater understanding of how the tests are conducted. Practical examples will be carried out to enhance understanding.

Trainer: Pete Reading, Consultant, Equipe Group

Wednesday 24th September 2014 - Soil Description Workshop

From 2007 new European Standards have started replacing the British Standards (Codes) under which investigations in the UK have been carried out. UK working practice will have to change to meet these new requirements but few practitioners are aware of the changes or the timetable. The workshop will comprise a series of lectures on the changes, and lectures on soil description followed by practical sessions describing soil samples.

Trainer: Professor David Norbury, Director, David Norbury Limited

Thursday 25th September 2014 - Geotechnical Field Instrumentation, Monitoring and Reporting

The course comprises a comprehensive one day appreciation of the complete process involved in Instrumentation and Monitoring in the geotechnical environment. The course provides an overview of the current guidance documents and their requirements. The course will consider the design of both individual installations and the installation of suites of instruments in the wider site contex.

Trainer: Dr Andrew Ridley, Managing Director, Geotechnical Observations

Friday 26th September 2014 - Basic Foundation Awareness

This one day course will provide a general overview of foundation design. It will include an assessment of the use and choice of shallow foundations and piles. It will cover the derivation of bearing capacity formula and their use. Exercises will be carried out to calculate the working loads and settlement of simple foundations. The methods used to calculate these will be in accordance with those described in Eurocode.

Trainer: Pete Reading, Consultant, Equipe Group

EQUIPE GROUP

AGS Association of Geotechnical & Geoenvironmental Specialists

For more information, contact Equipe Training:

info@equipegroup.com
www.equipegroup.com
+44 (0)1295 670990
+44 (0)1295 678232

Equipe Group
@EquipeGroup
EquipeGroup

TUTEX
www.tutex.co.uk

Introducing the **MPX** – Multi Platform Coring Unit from Utilicor. Flexible coring equipment that easily mounts on a truck or trailer

Tutex is a provider of innovative safe excavation tools. We specialise in keyhole excavation products such as vacuum excavators, concrete coring units and air excavation hand tools.

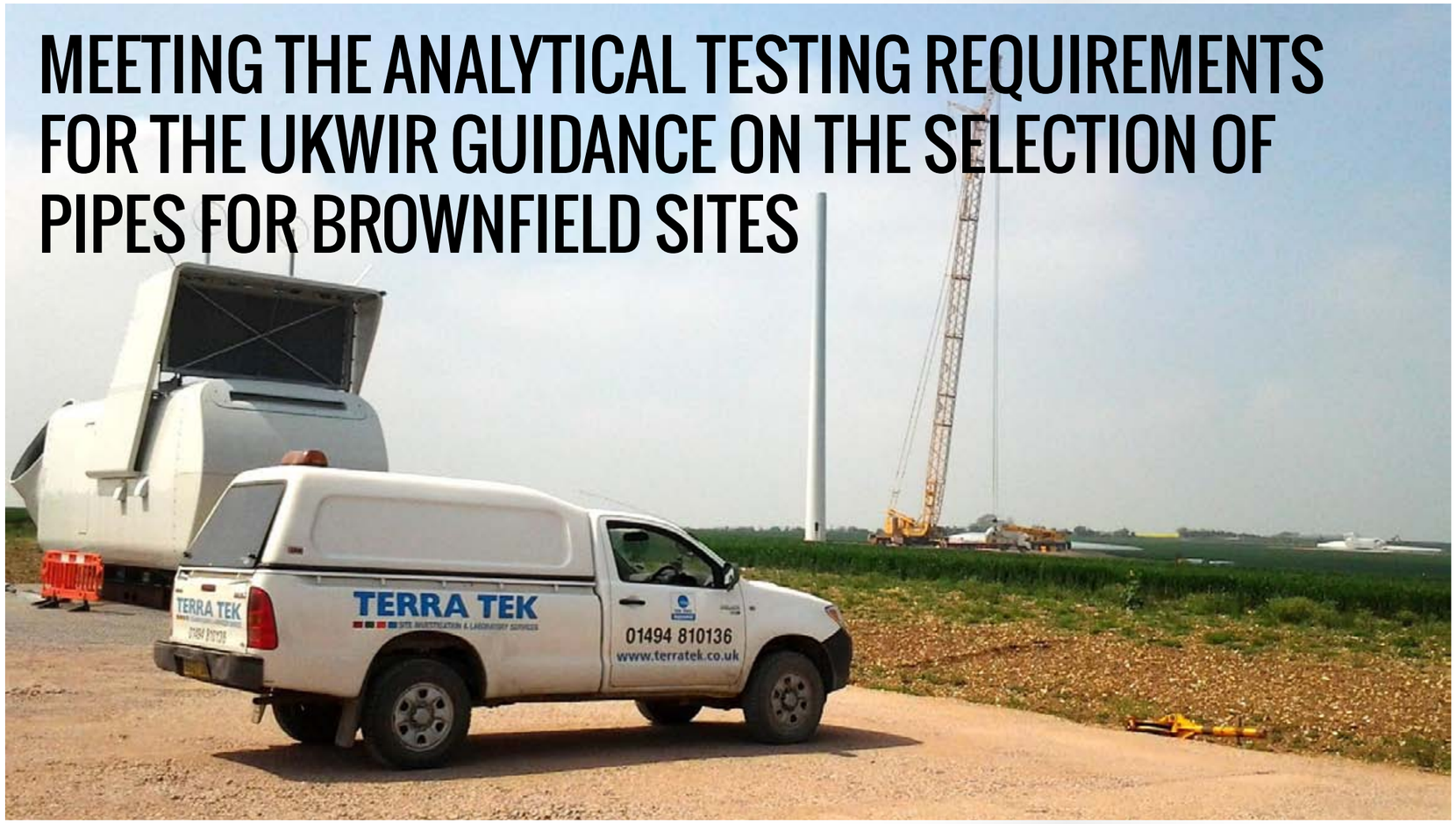
We are the exclusive UK distributor for leading US manufacturers Vector Vacuums, Vac-con, and Air-Spade, as well as offering products from Canadian specialists Utilicor.

We import many tools from North America to the UK and Europe as we believe these products are the best on the market anywhere in the world. We believe that these products are superior to those currently available from within the UK as they are rugged, robust, reliable machines, built to withstand whatever tasks for which they may be required.

Optional Side-Shift allows for precise positioning without repositioning the vehicle or trailer

- Drum Speed: 0 - 280 RPM
- Coring Drum Diameter: up to 24"
- Coring Drum Depth: up to 22"

MEETING THE ANALYTICAL TESTING REQUIREMENTS FOR THE UKWIR GUIDANCE ON THE SELECTION OF PIPES FOR BROWNFIELD SITES



*Writing for **theGeotechnica** this month is David A Bowen, Chemistry Supervisor (Organics) at Terra Tek. This month David discusses analytical testing requirements.*

Why test for environmental contaminants, when laying water supply pipes in Brownfield Sites?

Water authorities are now following the guidance laid out by the United Kingdom Water Industry Research, UKWIR group report entitled "Guidance for the Selection of Water Supply pipes to be used in Brownfield sites", in 2010. This report was published to provide national guidelines for the planning, design, and construction of water supply and / or service pipes in contaminated land / Brownfield sites, to be utilised by water companies, developers, self-lay organisations, and consultants.

Two main concerns relating to the choice of pipe were identified. These were; corrosive chemicals to metallic pipes, and permeation of organic contaminants such as petroleum hydrocarbons and solvents, through plastic pipes, and into the water supply.

"To choose the appropriate pipe for the associated Brownfield site, a site assessment, and a selection procedure for the water supply pipe must be carried out."

To choose the appropriate pipe for the associated Brownfield site, a site assessment, and a selection procedure for the water supply pipe must be carried out. In addition, the chosen pipe for the site has to be of the latest published standard specification on the date that the selection was made.

As part of the site assessment criteria, an analysis suite to target chemicals which can either permeate a plastic pipe or impact the integrity of a metal one, should be undertaken on samples along the proposed route of the pipeline. This suite is broken down into two sections. These are:

UKWIR suite A, which includes VOC's (Volatile Organic Compounds) with TIC's (Tentatively Identified Compounds), BTEX (Benzene, Toluene, Ethyl-Benzene and Xylenes) and MTBE (Methyl-tertiary Butyl Ether), SVOC's (Semi-Volatile Organic Carbons) with TIC's, Phenols, Cresols, Chlorinated solvents, Hydrocarbons >C10-C20 and >C20-C40, Conductivity, Redox potential, and pH.

UKWIR suite B, which includes Ethers, Nitrobenzene, Ketones, Aldehydes, and Amines.

"UKWIR suite A should be considered mandatory for all samples..."

UKWIR suite A should be considered mandatory for all samples, although depending on the findings of the Desk Study and following consultation with the water authority, UKWIR suite B is often required.

The final Site Assessment Report should include all of the information acquired from the Desk Study, Site Walkover, Preliminary Risk Assessment, Intrusive Site Investigation, and Analysis.

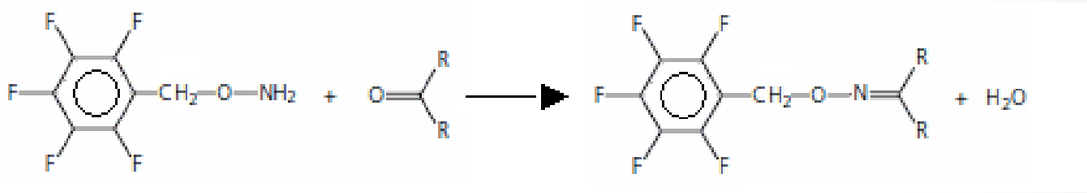
Routine Testing for a UKAS / Mcerts accredited testing laboratory?

Suite A requires routine testing, which can be provided by most UKAS / Mcerts accredited testing laboratories. In suite B however, the testing required for Aldehydes and Ketones in soil is less routine, and could be considered challenging for smaller laboratories which may not have LC-MS instrumentation, often necessary for the analysis of water soluble compounds.

Therefore, the project undertaken in the Organic Chemistry Laboratory at Terra Tek Birmingham was to provide all of the testing requirements in UKWIR suite B using GC-MS and Head-space GC-FID instrumentation.

Method Development

The Ethers, Nitrobenzene, Amines, and the Ketones – Acetophenone and Isophorone, are routinely analysed using an in-house SVOC in soil method by GC-MS. It was the remaining Ketones and Aldehydes however, which posed



the challenge.

Aldehydes and Ketones share the same carbonyl, C=O, functional group, which accounts for their similar properties, and both groups of compounds can be classed as Carbonyls. Therefore, USEPA method # 556 Determination of Carbonyl Compounds in Drinking Water by pentafluorobenzyl-hydroxylamine (PFBHA) derivatization and Capillary Gas Chromatography with Electron Capture Detection, provided the starting point for method development.

This method, although for water, describes the PFBHA derivatization of Carbonyls into their corresponding pentafluorobenzyl oximes.

"The resulting Oximes have a larger molecular mass to the original Carbonyl, are easily extracted in Hexane..."

The resulting Oximes have a larger molecular mass to the original Carbonyl, are easily extracted in Hexane, and can be analysed by Gas Chromatography.

Laboratory trials were performed to assess and modify USEPA method # 556 so that it would be applicable for a soil sample, and analysed by GC/MS rather than GC/ECD as documented.

Extraction

Initial trials investigated the use of HPLC grade water with shaking, to extract the carbonyls from the soil sample. Once extracted, they were derivatized as prescribed. The recovery achieved using this extraction technique was far from satisfactory however; indicating that water alone could not efficiently extract the carbonyl compounds from the soil. Either the extraction procedure had to be more vigorous, or an alternative extracting liquid or mix of liquids would be required.

"The recovery achieved using this extraction technique was far from satisfactory however..."

The extracting solvent would need to be water soluble, and hence, polar. Acetone, often used in the extraction of organic compounds due to its dual solubility in water and organic solvents, would have been the preferred solvent. However, being a carbonyl compound eliminated its use in this particular case. Therefore, it was decided that Methanol, having similar extracting properties to Acetone, except being an Alcohol rather than a Carbonyl, would be investigated.

Having performed the extraction trials, it was found that the optimum recovery was achieved by initially shaking with Methanol, to extract the analytes in their Carbonyl form, followed by the addition of HPLC grade water, and then derivatized into their corresponding pentafluorobenzyl oximes.

Analysis

Analysis was performed by GC/MS rather than GC/ECD, using the prescribed DB5ms, 30m x 0.25mm id x 0.25µm film thickness column. The run time was reduced from 45min to 16min, to increase production, with all of the compounds required, separated and detected.

Asymmetric carbonyl compounds form (E) and (Z) isomers. Therefore, two chromatographic peaks were observed for many of the target analytes, although some of them could not be chromatographically resolved. All peaks for each carbonyl were integrated, and the result to be reported would be the total of both isomers.

Validation

Validation was achieved using a spiked clay, loam and sand sample at 20% and 80% of the working range. The limit of detection was calculated using a clean sand, spiked with a very small amount of analyte, no greater than five times that of the anticipated LOD.

"The remaining volatile Ketones... were analysed by head-space GC..."

The remaining volatile Ketones, not covered by the SVOC or the Carbonyl methods, were analysed by head-space GC, and validated in the same fashion.

"The new methods for Ketones and Aldehydes successfully completed the validation process..."

Conclusion

The new methods for Ketones and Aldehydes successfully completed the validation process, and subsequently, Terra Tek Limited can now routinely analyse for all of the requirements of UKWIR suite A and suite B, and assist in the selection of water supply pipes which are to be used in Brownfield sites. ■

References:

UK Water Industry Research, Guidance for the selection of water supply pipes to be used in Brownfield sites, Report Ref. No. 10/WM/03/21, 2010.

US EPA, Determination of Carbonyl Compounds in Drinking Water by petafluorobenzyl-hydroxylamine (PFBHA) derivatization and Capillary Gas Chromatography with Electron Capture Detection, Method # 556, Rev 1.0, 1998.

THE GEOTECHNICAL ACADEMY

*Writing for **theGeotechnica** this month is The Geotechnical Academy's Liz Withington. In this month's article, Liz provides an update on the success of The Geotechnical Academy - a joint training venture between Geotechnical Engineering and Equipe Training.*

In September 2012 The Geotechnical Academy was launched to provide a training network to further the knowledge and understanding for early career geo-professionals.

So how has The Geotechnical Academy developed over these two years? The concept was to deliver a series of monthly modules. Each module would cover a different geotechnical subject, taking the delegate from concept to completion of a geotechnical investigation.

"The overall structure of each module has remained a constant, the day starting with a lecture followed by practical demonstrations and site visits."

The overall structure of each module has remained a constant, the day starting with a lecture followed by practical demonstrations and site visits. The day is completed with a facilitated open discussion which enables delegates to discuss experiences that they have encountered in their working lives.

As The Geotechnical Academy has progressed there have been opportunities to complete practical activities, learn from guest lecturers and develop through group activities. The delegates have also visited sites in urban locations, environmentally sensitive sites and completed construction projects.

The completed project has particular value as the delegates can compare the construction methods used by Isambard Kingdom Brunel for a viaduct with a newly constructed canal supported on piled foundations and surrounded by a contiguous piled wall and sheet piling. Construction methods are discussed, along with subjects such as geotechnical risk, design of the ground investigation, geo-environmental hazards and ecology. The delegates then visit a derelict canal and apply the newly learnt principals to design a ground investigation and form a ground model.

"The delegates then visit a derelict canal and apply the newly learnt principals..."

The Geotechnical Academy is lucky to have the support of a number of geotechnical companies. Specific modules are hosted at their premises so as to enable the delegates to experience working stores, laboratories and the latest field equipment. Staff are also available for demonstrations and presentations, drilling supervisors explain the workings of rigs and ancillary equipment, Health and Safety managers discuss

industry specific issues and laboratory technicians demonstrate testing. A full day is spent in a geotechnical laboratory where delegates are given the opportunity to carry out a variety of tests. Particular emphasis is placed on selecting the correct class of sample along with considering the quantity of material required for each test to be compliant. Discussion of the laboratory testing parameters initially focuses on sample type and quality including Eurocode 7 and is then extended into how a variable parameter such as plasticity affects the behaviour of a soil type. The delegates from a consultancy background consider this to be a particularly valuable day and are always astounded about the amount of work required for a simple classification test.

"Particular emphasis is placed on selecting the correct class of sample along with considering the quantity of material required for each test to be compliant."

The Geotechnical Academy has recently developed a program of visiting partner companies. Over the next academic year these partners will deliver lectures to complement each module and includes suppliers, piling contractors, chemical and geotechnical laboratories, insitu testing contractors and environmental consultants. Dr. Roger Chandler from Keynetix recently presented a lecture on the importance of "Geotechnical Data Management, AGS, BIM and BS8574". This subject links into a number of modules, but in particular the first module where delegates consider the planning of geotechnical works and the final module where geotechnical risk is identified and managed. One of the delegates commented:

"Rogers's contribution really opens your eyes to the difference between data and information, in particular the importance of high quality data that can be accurately stored and retrieved. Roger really engaged with us and passed on a wealth of knowledge that has already proved integral to both my career progression and confidence on site".

"An aspect of the course that has particularly grown are the group activities..."

An aspect of the course that has particularly grown are the group activities where delegates join together in small groups and are given a task to develop and then present back to the whole group. An example of this is looking at a real site for a proposed new road. The groups consider aspects such as geotechnical risk, ground investigation, instrumentation, data and the ground model. Other group activities include delegates acting as either clients, consultants or ground investigation contractors; during this exercise they explore the desired outcome of the project from their perspective, alongside other considerations such as risk and finance.

Over forty delegates from contractors, consultants

“I highly recommend The Geotechnical Academyasitprovides knowledge on all the multiple facets of the industry... while reinforcing or teaching new skills and providing us with knowledge to not only do our jobs well, but to do them to the highest standard possible...”

and academia have enrolled over the past two academic years. Feedback from these delegates reflected the broad aims of The Geotechnical Academy, where the delegates appreciated the practical demonstrations, site visits, information on health and safety, discussions regarding EC7, structured debates and the opportunities to network. A recent graduate summarized his experience:

“The course is full of content which is very well presented, providing lots of information supported by practical sessions. For anyone new to the geotechnical industry I highly recommend The Geotechnical Academy as it provides knowledge on all the multiple facets of the industry from health and safety to client and contractor interaction, while reinforcing or teaching new skills and providing us with knowledge to not only do our jobs well, but to do them to the highest standard possible by understanding how and why we do things. This course is really quite valuable for anyone looking to make progress in the industry and I would not hesitate to get involved if you are at all interested in learning about the geotechnical engineering world.

The value that The Geotechnical Academy is bringing to the geotechnical industry is contributing to raising the knowledge, experience and expectations of young geo-professionals. With two further groups starting in 2014 and an ever expanding list of companies who wish to become partners its success will continue to contribute to raising standards across the industry.

CPD Approved Courses for Geotechnical Academy Alumni

Specifying Site Investigations
This one day course will look at the various methods available to carry out intrusive and non intrusive investigation. Whilst the course will concentrate on geotechnical methods some geo-environmental methods will be briefly discussed. The course will look at the aims of SI and categorise the various stages in an investigation.

Soil Description Workshop
From 2007 new European Standards have started replacing the British Standards (Codes) under which investigations in the UK have been carried out. UK working practice will have to change to meet these new requirements but few practitioners are aware of the changes or the timetable. The workshop will comprise a series of lectures on the changes, and lectures on soil description followed by practical sessions describing soil samples.

Rock Description Workshop
From 2007 new European Standards have started replacing the British Standards (Codes) under which investigations in the UK have been carried out. UK working practice will have to change to meet these new requirements but few practitioners are aware of the changes or the timetable. The workshop will comprise a series of lectures on the changes, and lectures on rock description followed by practical sessions describing rock and compiling mechanical logs of rock core.

In Situ Testing
The course will cover both the theory and the practice of various In Situ Testing techniques used on typical geotechnical projects. In addition the courses will consider the effect that Eurocodes will have on the UK's current practice. This course provides an overview of in situ tests used in common practice and some of the more specialist tests together with their advantages and limitations.

Instrumentation and Monitoring
The course comprises a comprehensive one day appreciation of the complete process involved in Instrumentation and Monitoring in the geotechnical environment. The course provides an overview of the current guidance documents and their requirements. The course will consider the design of both individual installations and the installation of suites of instruments in the wider site contex.

Basic Foundation Awareness
This one day course will provide a general overview of foundation design. It will include an assessment of the use and choice of shallow foundations and piles. It will cover the derivation of bearing capacity formula and their use. Exercises will be carried out to calculate the working loads and settlement of simple foundations. The methods used to calculate these will be in accordance with those described in Eurocode.

IOSH Working Safely on Geotechnical Sites
This one day course is developed by industry specialists within RPA Safety Services and Equipe Training as a foundation to site safety. Its aim is to impart the core safety skills required of those working on geotechnical sites by building on their existing specialist technical skills. After attending the course, candidates should be able to identify hazards on site, understand basic safety legislation, participate fully and confidently in site safety consultation and manage priority risks to a sufficient standard.

IOSH Avoiding Danger from Underground Services
Partnering with RPA Safety Services once again, Equipe provide another IOSH certified health and safety course. This one day course is aimed at anybody involved in specifying, instructing, managing, supervising or actually breaking ground and really addresses the problems and risks related to underground services, which may be encountered during both planning and execution of geotechnical projects.

IOSH Safe Supervision of Geotechnical Sites
Equipe has partnered with RPA Safety Services, an independent occupational health and safety specialist, to provide a unique IOSH certified course for the Drilling and Geotechnics industry. The three day course is certified by IOSH, is specifically focussed on the geotechnical industry and provides a totally unique and relevant Health and Safety course for managers and supervisors.

THE GEOTECHNICAL ACADEMY

A collaboration between

geotechnical

15% off Equipe Courses for Academy Alumni

Visit our websites for more details:

www.geotechnicalacademy.co.uk

www.equipegroup.com

BE CAREFUL WHERE YOU DIG THAT HOLE!

Writing for theGeotechnica this month is Tim Archer, Technical Director of Arrow Geophysics Limited, a geophysical consultancy established in 2004 that provides advice on geophysical risk reduction for UK construction projects. In this, the first of a series of articles, Tim argues the case for non-intrusive geophysical surveys as part of a cost-effective programme of geotechnical site investigation.

The UK subsurface is a busy place! Centuries of human habitation and decades of industrial and domestic construction activity have left us with an impressive legacy of buried hazards and obstructions, most within the top five metres of the subsurface.

"Planning legislation requires due consideration of environmental matters..."

Planning legislation requires due consideration of environmental matters, including archaeological impact, on green field developments. In urban contexts, brown field development faces additional challenges from underground services, unexploded ordnance, environmental spills and past phases of building work. Natural and manmade cavities, including sinkholes, solution features and abandoned mine workings complete the rather gloomy picture that confronts us as technical specialists striving to work safely and efficiently within the built environment.

So what is the most effective means of locating subsurface risks, and of minimising their impact on a proposed development? Historically there has been little alternative to excavating a smaller or larger sample of ground, depending on the perceived level of risk, in the hope of locating features that may have cost and/or safety significance. Sometimes this programme of excavation is entirely random; at other times it is designed based on "gut feel" or existing site knowledge, which may often

Image courtesy of Arrow Geophysics Ltd.

One thousand cubic metres of ground went down the side of this reservoir in a single afternoon! Geophysical investigation was used to locate other areas of potential ground failure.

"Sometimes this programme of excavation is entirely random; at other times it is designed based on "gut feel"..."

be incomplete, particularly on sites with a complicated development history.

We believe that there is a better way to proceed.

Over the past twenty-five years, there has been an upsurge in the use of NON-INTRUSIVE geophysical techniques that remove the need for guess work when it comes to locating hazards and obstructions within the shallow subsurface. It is our intention in this and subsequent articles for theGeotechnica to introduce the usefulness, and highlight some of the caveats, of these non-intrusive geophysical techniques as part of the overall geotechnical solution that you are able to offer to your clients.

Whilst it may still be necessary to dig down to investigate and/or remove the source of the danger, with the help of a carefully-planned geophysical investigation, you and your client can at least have the assurance that this excavation will be carried out in the right place!

Tim Chapman, Director at Arup, wrote recently that significant delays due to ground problems occur on one out of every five construction projects [1]. Clearly, developing a detailed understanding of the subsurface is vital if developer costs are to be kept to a minimum.

In the same article, Chapman states that typically only 5 to 22 pence per £100 of a project's building cost are spent investigating

Image courtesy of Arrow Geophysics Ltd.

Geophysical investigation is used to satisfy planning conditions imposed by archaeological constraints.

"In the same article, Chapman states that typically only 5 to 22 pence per £100 of a project's building cost are spent investigating ground problems."

ground problems.

So how do we maximise the value of this incredibly slender financial resource?

The answer is two-fold. First, we need to make sure that we do not miss anything important. Second, we need to make sure that any costly and time-consuming excavation work that may be required on site is carried out in the right place.

Fortunately, it has been proven time and again on sites across the UK that geophysical techniques can meet both of these requirements. This is because these geophysical techniques are:

Objective: by sampling an entire site at a regular station spacing, geophysical techniques remove the subjectivity often associated with designing a programme of intrusive sampling, where tough decisions must often be taken for commercial reasons

"...geophysical techniques remove the subjectivity often associated with designing a programme of intrusive sampling..."

on which parts of the site to investigate – and which parts to leave out.

Time and cost efficient: typically, a geophysical survey can sample up to a hectare of ground per day (up to five hectares per day on green field sites) at a measurement density better than one reading per square metre.

"The danger of accidentally exposing live services, unexploded ordnance, and a wide range of environmental contaminants cannot be overstated."

Less time on site translates to less cost for your client, or perhaps higher margins for your site team.

Non-intrusive: most geophysical techniques are completely non-intrusive. As well as reducing time on site, this criterion is extremely important on high-risk sites (eg contaminated land) and sensitive sites (eg church graveyards). The danger of accidentally exposing live services, unexploded ordnance and a wide range of environmental contaminants cannot be overstated. Non-intrusive survey to determine the location of such hazards before construction work commences is an obvious means of reducing risk.

Able to locate a wide range of survey targets: by mounting several geophysical sensors on the same survey platform, a wide range of survey targets can be located for little more than the cost of a single-technique survey.

"So why don't we use geophysical techniques all the time?"

So why don't we use geophysical techniques all the time? And why do we bother with intrusive excavation at all?

The answer is that, like any other means of investigation, geophysical techniques have certain limitations.

As geophysical practitioners, we sometimes speak with clients who have "tried

Several geophysical sensors can be mounted onto a single survey platform to improve time and cost efficiency (image courtesy of Geomatrix Earth Science Ltd).

✓ = primary method ? = secondary method × = poorly suited	Gravity	Magnetic	Seismic refraction	Seismic reflection	Resistivity	Spontaneous potential	Induced polarisation	Electromagnetic	Very low frequency	Ground penetrating radar	Magneto-telluric	Magnetic resonance sounding	Radiometrics
Hydrocarbon exploration	✓	✓	✓	✓	×	×	×	?	×	×	?	×	?
Regional geology	✓	✓	✓	✓	×	×	×	✓	×	×	✓	×	?
Mineral exploration	?	✓	×	×	✓	✓	✓	✓	✓	×	✓	×	✓
Site investigation	?	✓	?	?	✓	×	×	✓	×	✓	×	×	?
Hydrogeology	?	×	?	?	✓	✓	?	✓	?	✓	×	✓	×
Subsurface cavities	?	×	?	×	✓	×	×	✓	?	✓	×	×	×
Contaminant plumes	×	×	×	×	✓	×	×	✓	?	?	×	×	×
Metallic objects	×	✓	×	×	?	×	×	✓	×	✓	×	×	×
Archaeology	?	✓	×	×	✓	×	×	✓	×	✓	×	×	×
Biogeophysics	×	×	×	×	✓	✓	✓	×	×	×	×	×	×
Forensics	×	×	×	×	×	×	×	×	×	✓	×	×	×
Unexploded ordnance	×	✓	×	×	×	×	×	✓	×	?	×	×	×

Geophysical methods and their main applications (table modified from Reynolds [2])

"As geophysical practitioners, we sometimes speak with clients who have "tried geophysics and it didn't work"."

geophysics and it didn't work". Why this apparent lack of success? In the overwhelming majority of cases, the answer is simple: INAPPROPRIATE SURVEY DESIGN.

The geophysical survey in question failed because the person commissioning it, or even worse the person carrying it out, did not understand (or perhaps did not want to consider) the fundamental inability of the proposed survey design to deal with the problem at hand.

Let us take a simple example: a client wants to find a fuel storage tank on a partly-decommissioned filling station in central London. He commissions a ground penetrating radar survey, which fails to locate any evidence of the underground storage tank. The survey fails because the site has a high clay content, and the GPR system is unable to penetrate more than 200 mm into the subsurface.

Or another example: the client commissions a microgravity survey to locate gull holes

"The geophysical survey in question failed because the person commissioning it, or even worse the person carrying it out, did not understand (or perhaps did not want to consider) the fundamental inability of the proposed survey design to deal with the problem at hand."

beneath a proposed residential complex in

mid Kent. No gull holes are reported by the geophysical survey, but within three years ground subsidence is evident beneath two of the newly-

"The survey fails because to save cost the contractor has used a station spacing of 5m, which fails to locate small-scale near-surface features..."

erected housing units. The survey fails because to save cost the contractor has used a station spacing of 5m, which fails to locate small-scale near-surface features that would have been located if a station spacing of 2m had been used instead.

The good news is that, in both of the above cases, a successful outcome could have been obtained if the geophysical survey had been designed appropriately. Getting the survey design right is all important if a geophysical survey is to achieve its stated objectives.

When designing a geophysical survey to locate a particular target in a particular context, it is important to consider the following factors:

Depth of burial: the deeper a target is located, the more difficult it is to detect from surface. This may be because the geophysical signal has to travel further, because there is greater interference from overlying material, or because

"This may be because the geophysical signal has to travel further, because there is greater interference from overlying material..."

the signal contrast from the target is too small to measure accurately.

Nature of the soil: ground that is electrically conductive, poorly consolidated or full of building debris tends to work against effective geophysical survey.

"Target composition and state of preservation: metallic targets are often easier to locate than non-metallic targets."

Target composition and state of preservation: metallic targets are often easier to locate than non-metallic targets. Lead-lined coffins are often easier to locate than earth-cut graves. An unexploded bomb dropped yesterday is often easier to locate than an unexploded bomb dropped 70 years ago.

Practical constraints: these include limited site access, public interference, surface obstructions, vibrations from moving vehicles and a range of other logistical and technical considerations.

Geophysical techniques have many advantages, including full site coverage, time and cost efficiency, non-intrusive operation and sensitivity to a wide range of

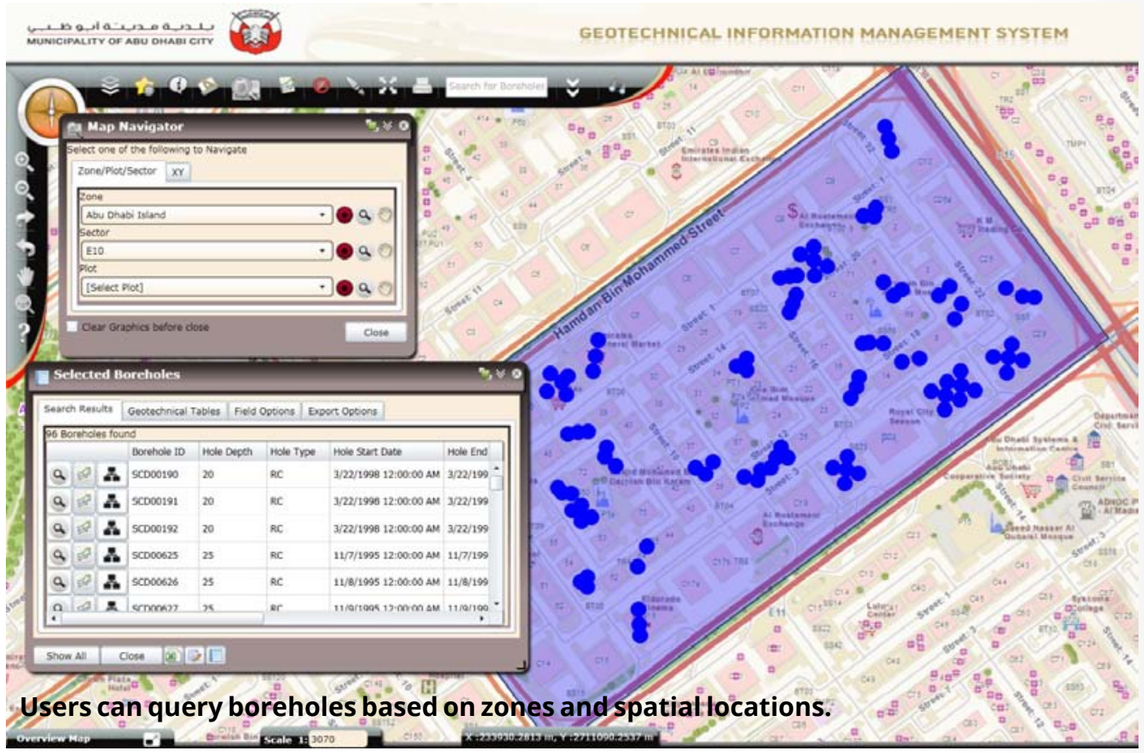
"Geophysical surveys need to be carefully designed if they are to form part of a cost-effective programme of geotechnical site investigation."

survey targets. Geophysical surveys need to be carefully designed if they are to form part of a cost-effective programme of geotechnical site investigation.

In future articles, we will look at some specific applications of geophysical techniques in more detail. We will also discuss what to do when conventional geophysics is NOT the answer, for example when targets are too deep or too subtle to be explored from surface. ■

References:
[1] Chapman, TJP (2008). The Relevance of Developer Costs in Geotechnical Risk Management. Foundations: Proceedings of the Second BGA International Conference on Foundations, ICOF2008.

[2] Reynolds, JM (2011). An Introduction to Applied and Environmental Geophysics – Second Edition. Wiley-Blackwell. 696 pp.



Users can query boreholes based on zones and spatial locations.

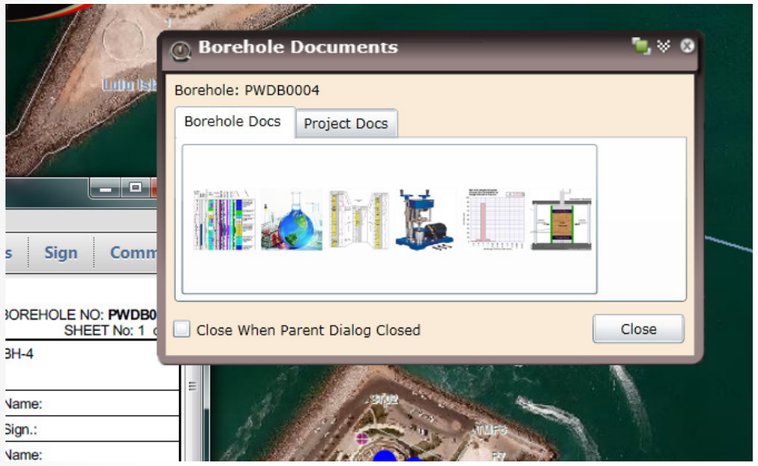
gINT SUPPORTS COMPREHENSIVE GEOTECHNICAL INFORMATION MANAGEMENT SYSTEM FOR THE MUNICIPALITY OF ABU DHABI CITY

*Writing for **theGeotechnica** this month are geotechnical software specialists Bentley Systems. Using data and material provided by the Abu Dhabi Municipality, this case study examines the benefits of instant access to subsurface information and how efficient data management can save both time and money when working on large scale projects.*

Instant Access to Subsurface Information Increases Productivity Twofold

Efficient Data Management

The Municipality of Abu Dhabi City ensures sustainable development and enhances the quality of life for the Emirate of Abu Dhabi, United Arab Emirates. Since its inception in 1962, the Municipality has implemented projects aimed at establishing modern infrastructure for the city. The Municipality routinely commissions and manages projects where large volumes of data from site investigation and design are archived and accessed by internal and external users. Using Bentley's gINT software and web mapping, the Municipality's Spatial Data Division developed the Geotechnical Information Management System (GIMS) as a comprehensive



Users can access legacy borehole data, including scanned report, geotechnical lab reports, and more.

geotechnical database and information system for quick access to all geotechnical data. Providing instant access to subsurface investigation data supports rapid decision-making and appropriate resource allocation, thereby saving time and money.

"Providing instant access to subsurface investigation data supports rapid decision-making..."

Accessing Legacy Data

The Municipality had extensive legacy information from site investigations such as borehole log reports, cross sections, and other data. Much of this information was in paper and image format. The paper filing systems were cumbersome for users to access, documents were often misplaced or deteriorated, and users were frequently unaware of what information was available – all leading to underutilization of existing geotechnical data. Geotechnical information needed to be digitized and effectively archived so that it could be made available internally and externally for future projects. The challenge was to collect data that was scattered throughout the organization in multiple sources and in multiple formats. Users had to perform extensive manual validation to capture and correct errors at the source. In some cases, data redundancies had to be eliminated because data was entered three different times for three different reports (borehole log, cross section, and lab report). There was no automatic way to validate information submitted by consultants and contractors.

Centralize and Standardize

The Municipality's current system also lacked interoperability with other software, such as the existing geographic information system (GIS) and civil design software. The Spatial Data Division determined that the solution was to centralize and validate, where possible, all subsurface acquired information using gINT Professional Plus, Bentley's geotechnical and geoenvironmental data management and reporting software that supports Microsoft SQL Server. With gINT software, engineers and geoprofessionals can gather, man- age, present, and report on subsurface data more efficiently and with greater accuracy. gINT allowed the Municipality to dynamically share this information internally and externally through desktop and web-based GIS.

"gINT allowed the Municipality to dynamically share this information internally and externally..."

This new system imposed a standard method of project data submission where site investigation was a key component. The objectives were to validate data and capture errors at the source to reduce the risk of inaccurate subsurface information entering future infrastructure projects such as bridges, drainage systems, road networks, transportation systems, and comprehensive development programs. The system also automated the submission process wherever possible.

Implementation Challenges

The GIMS implementation project required capturing 20,033 hardcopy logs and reports into gINT. The

The Geotechnical Information Management System (GIMS) provides easy access to data for all boreholes around Abu Dhabi.

reports were scanned, and the actual borehole records to be used within gINT were extracted. Both legacy scans and actual detail records were linked into gINT.

The project team created semi-automatic, robust submission standards for controlling geotechnical data

"Data entry was divided into two phases, with the first phase migrating 4,516 boreholes..."

uniformity and quality. Data entry was divided into two phases, with the first phase migrating 4,516 boreholes saved in Excel format and distributed over 130 files. gINT was customized to automatically import the Excel data while simultaneously checking for errors. The second phase involved data entry for 15,517 bore- holes in image and paper format. Data entry was validated in order to detect typographic errors. The process of scanning boreholes, retrieving geotechnical data, and entering data into the custom database required much attention to detail. gINT made this task much easier by automatically checking for consistency and accuracy using gINT Rules (gINT's VBA-like programming language).

Project Outcomes and Benefits

The GIMS for Abu Dhabi City supports a consolidated geotechnical database in accordance with internationally accepted standards of the Association of Geotechnical and Geoenvironmental Specialists (AGS). GIMS was integrated with the Municipality's GIS web portal by creating a custom geotechnical web map application for gINT. The GIS integration allows access to the existing geotechnical data at any time, from anywhere, via the Internet or the Municipality's intranet. The robust geotechnical data submission standards ensure the uniformity and quality of data that is submitted. By providing geotechnical data templates in gINT, Microsoft Access, and AGS 3.1 format, GIMS also enables the exchange of geotechnical data between stakeholders.

Twofold Productivity Increase

gINT's streamlined data management processes improve the Spatial Data Division's daily productivity

"By having a data submittal standard, site investigation data can now be instantaneously available..."

twofold. By having a data submittal standard, site investigation data can now be instantaneously available to the GIMS database upon submission by geotechnical consultants. By providing instant access to subsurface investigation data, Abu Dhabi Municipality is able to make better decisions regarding subsurface investigations, improve resource allocation, and avoid redundant drilling and testing. In doing so, the Municipality saves considerable time and money. The quick and easy access to high-quality geotechnical data for Abu Dhabi Municipality and its consultants and contractors also enhances the infrastructure planning process by providing a better understanding of the subsurface. Using GIMS, reported underground voids and cavity locations can be quickly and easily determined to enable better infrastructure planning and design. ■

Directory

borehole surveying software

GEOMEM
24 John Huband Drive, Birkhill, Angus, DD2 5RY
United Kingdom
Tel: 01382 329 011 **Fax:** 01382 230 256
Email: tech@geomem.com

consultants

GROUND TECHNOLOGY
Ground Technology Services, Maple Road, Kings Lynn, Norfolk, PE34 3AF
Tel: 01553 817657 **Fax:** 01553 817658
Email: mail@groundtechnology.co.uk

drilling contractors

APEX DRILLING SERVICES
Sturmi Way, Bridgend, CF33 6BZ
Tel: 01656 749149
Email: thomas.martin@apex-drilling.com

BOREHOLE SOLUTION SITE INVESTIGATION
13 Great North Road, Buckden, St Neots, Cambridgeshire, PE19 5XJ
Tel: 01480 812457 **Mob:** 07969 715655
Email: boreholesolutions@gmail.com

CONCEPT
Unit 8 Warple Mews, Warple Way, London W3 0RF
Tel: 020 8811 2880 **Fax:** 020 8811 2881
Email: si@conceptconsultants.co.uk

DYNAMIC SAMPLING UK
Unit 8 Victory Park Way, Victory Road
Derby, DE24 8ZF
Tel: 01332 771104 **Mob:** 07836 365533
Email: info@dynamicsampling.co.uk

GEOTECHNICAL ENGINEERING
Centurion House, Olympus Business Park, Quedgeley, Gloucester, GL2 4NF
Tel: 01452 527743 **Fax:** 01452 729314
Email: geotech@geoeng.co.uk

RGI GEOTECHNICAL INVESTIGATION
Unit 37, Longfield Road, Sydenham Industrial Estate, Leamington Spa, Warwickshire, CV31 1XB
Tel/Fax: 01926 886329 **Mob:** 07748871546
Email: rgi10@aol.com

TERRA FIRMA GROUND INVESTIGATION
Rowan Tree Farm, Blackwell Hall Lane, Ley Hill, Buckinghamshire, HP5 1UN
Tel: 01494 791110 **Fax:** 01494 791108
Email: enquiries@terrafirmagi.co.uk

drilling equipment

DRILLWELL
Unit 3, Rotherham Close, Killamarsh, Sheffield, S21 2JU
Tel: 0114 248 7833 **Fax:** 0114 2487997
Email: sales@drillwell.co.uk

field instrumentation

CONCEPT
Unit 8 Warple Mews, Warple Way, London W3 0RF
Tel: 020 8811 2880 **Fax:** 020 8811 2881
Email: si@conceptconsultants.co.uk

GEOTECHNICAL OBSERVATIONS
The Peter Vaughan Building, 9 Avro Way, Brooklands, Weybridge, Surrey KT13 0YF
Tel: 01932 352040 **Fax:** 01932 356375
Email: info@geo-observations.com

geophysics

EUROPEAN GEOPHYSICAL SERVICES
22 Sansaw Business Park, Hadnall, Shrewsbury, Shropshire SY4 4AS
Tel: 01939 210 710 **Fax:** 01939 210 532
Email: eurogeophys@europeangeophysical.com

TERRADAT
Unit 1, Link Trade Park, Penarth Road, Cardiff, CF11 8TQ
Tel: 08707 303050 **Fax:** 08707 303051
Email: web@terradat.co.uk

geotechnical software

KEYNETX LTD
Systems Park, Moons Park, Burnt Meadow Road,
Redditch, Worcestershire, B98 9PA
Tel: 01527 68888 **Fax:** 01527 62880
Email: sales@keynetix.com

geotechnical specialists

GEOTECHNICAL ENGINEERING
Centurion House, Olympus Business Park, Quedgeley, Gloucester, GL2 4NF
Tel: 01452 527743 **Fax:** 01452 729314
Email: geotech@geoeng.co.uk

GEOTECHNICAL OBSERVATIONS
The Peter Vaughan Building, 9 Avro Way, Brooklands, Weybridge, Surrey KT13 0YF
Tel: 01932 352040 **Fax:** 01932 356375
Email: info@geo-observations.com

SOILS LIMITED
Newton House, Tadworth
Surrey, KT20 5SR
Tel: 01737 814221 **Fax:** 01737 812557
Email: southwest@soilslimited.co.uk

health and safety

EB SAFETY
Tel: 01926 642465 **Mob:** 07881858271
Email: ebetts@ebsafety.co.uk

laboratory services

ALCONTROL LABORATORIES
Units 7 & 8 Hawarden Business Park, Manor Road, Hawarden, Deeside, Flintshire CH5 3US
Tel: 01244 528 700 **Fax:** 01244 528 701
Email: hawarden.sales@alcontrol.com

CHEMTEST
Depot Road, Newmarket, CB8 0AL
Tel: 01638 606 070 **Fax:** 01638 606 071
Email: peter.noone@chemtest.co.uk

CONCEPT
Unit 8 Warple Mews, Warple Way, London W3 0RF
Tel: 020 8811 2880 **Fax:** 020 8811 2881
Email: si@conceptconsultants.co.uk

GEOLABS
Bucknalls Lane, Garston, Watford, Hertfordshire, WD25 9XX
Tel: 01923 892 190 **Fax:** 01923 892 191
Email: admin@geolabs.co.uk

K4 SOILS LABORATORY
Unit 8, Olds Close, Watford, Hertfordshire, WD18 9RU
Tel: 01923 711288 **Fax:** 01923 711311
Email: office@k4soils.com

site investigation

CONCEPT
Unit 8 Warple Mews, Warple Way, London W3 0RF
Tel: 020 8811 2880 **Fax:** 020 8811 2881
Email: si@conceptconsultants.co.uk

training and education

EQUIPE GROUP
The Paddocks, Home Farm Offices,
The Upton Estate, Banbury, Oxford, OX15 6HU
Tel: 01295 670990 **Fax:** 01295 678232
Email: info@equipegroup.com

Rotary Drillers

We have vacancies available for experienced Lead Rotary Drillers, both in the UK and Worldwide.

- Excellent Rates of Pay
- Conventional, Wireline and Geothermal
- positions all available
- Onshore and Offshore
- Minimum 5 Years experience
- and NVQ Level 2 is preferable

All interested applicants, please forward your CV to:
keith.spires@equipegroup.com

theGeotechnica

Driving our industry forward...

Equipe Group
The Paddocks, Home Farm Drive
The Upton Estate
Banbury, OX15 6HU