



**TECHNOLOGY AND RESEARCH GROUP**

**NINETEENTH ANNUAL REPORT  
2021**

## **Introduction by the TRG Chairman**

*CL:AIRE had another busy year in 2021, providing industry with a range of new or updated outputs. These included free industry guidance on sustainable management practices, a sustainability assessment tool, technical reports on Category 4 screening levels for three contaminants, risk assessment good practice for coal mine gas emissions, free webinars on the Gas Protection Verification Accreditation Scheme, Category 4 screening levels, coal mine gas emissions risk assessment, and low cost eLearning modules on brownfield site investigation, soil and groundwater risk assessment and sustainable remediation appraisal.*

*The TRG has played a key peer review role in all of these outputs.*

*There have also been some changes to the TRG this year. We said farewell to Brian Bone who retired from the TRG after 16 years' service. After a much shorter period with us, Brian McVeigh also stepped down due to a change in role. Many thanks to both Brian's for their contributions to CL:AIRE.*

*Four new Early Career Professionals (ECPs) joined the TRG during 2021 - Oliver Gernon, Arup; Emily Reynolds, Mott MacDonald; Daniel Simons, Soilfix; and Leigh Ward, Atkins. Thanks to Amy Juden, EPG Ltd who completed her two year ECP role at the end of 2021.*

*I know that the CL:AIRE Board and Management Team greatly appreciate the time and effort taken by the TRG members in ensuring the quality of CL:AIRE products. In fact they consider the TRG fundamental to maintaining and enhancing CL:AIRE's reputation and supporting the development of the organisation.*

*I would also like to express my personal thanks to the TRG members and their employers for their contributions.*

*This document is in two parts - the first gives background to the important role of the TRG within CL:AIRE, whilst the second details its activities during 2021.*

*The Annual Report is written for CL:AIRE's Members and the wider industry and aims to demonstrate the value of the TRG to CL:AIRE's activities and CL:AIRE's reputation across the world.*

Seamus Lefroy-Brooks  
April 2022

# **BACKGROUND TO CL:AIRE AND THE TRG**

## **INTRODUCTION**

CL:AIRE is an environmental organisation, established in 1999, to improve standards and efficiency in the brownfield regeneration industry. CL:AIRE's status as an independent organisation allows it to appraise and disseminate knowledge on innovation and good practice. Thus increasing confidence across the industry, which is driving forward effective regeneration of brownfield land. This is recognised both in the UK and worldwide with CL:AIRE's profile continuing to grow.

CL:AIRE consists of a team of professionals who carry out its daily activities, supported by a Board of Trustees, an advisory group – the Technology and Research Group (TRG) and a number of task groups. The TRG plays a key role in CL:AIRE's work, supporting CL:AIRE on issues associated with technology development and sustainable land reuse, peer review of technical publications and resources, and offering strategic review and steering functions for all CL:AIRE's activities. The TRG also offers several positions for early career professionals, which enables fact-track awareness to emerging industry issues and access to experienced practitioners for mentoring support.

CL:AIRE is a registered charity and an environmental body registered with ENTRUST. It is also an incorporated company, limited by guarantee and registered in England and Wales.

Appendix 1 describes the wide range of activities that CL:AIRE undertook in 2021.

## **THE TRG PROCESSES**

The work of the TRG is facilitated through regular meetings, email correspondence and telephone calls. The CL:AIRE team focuses the input of the TRG to ensure the expertise of the group has the greatest impact. The TRG comprises high calibre renowned professionals who are expert in policy, legislation and regulatory guidance as well as the practicalities of managing and regenerating brownfield sites. The TRG expertise adds real value by ensuring CL:AIRE activities are consistent with UK policy, legal requirements and best practices and are of sound scientific and technical quality. The independent review provided by the TRG ensures transparency and accountability of CL:AIRE activities.

## **TRG MEMBERS IN 2021**

Chair: Seamus Lefroy-Brooks – LBH GEO  
Deputy Chair: Kim Baines – International Atomic Energy Agency  
Bob Barnes – Environment Agency  
Brian Bone – Bone Environmental Consultant (until November 2021)  
Simon Burr – CampbellReith  
Ruth Chippendale – Shell  
Max Coleman – Caltech  
Steve Edgar – Vertase FLI  
Liz Gray – Atkins  
Mark Hodson – University of York  
Brian McVeigh – Northern Ireland Environment Agency (until July 2021)  
Richard Moss – Independent consultant  
Sarah Poulton – Natural Resources Wales  
Mike Rivett – GroundH2O plus Ltd  
Steven Thornton – University of Sheffield  
Gary Wealthall – Geosyntec Consultants Ltd  
Karen Young – Jacobs

## **Early Career Professional TRG Members**

Oliver Gernon – Arup  
Amy Juden – EPG Ltd  
Emily Reynolds – Mott MacDonald  
Daniel Simons – Soilfix  
Leigh Ward – Atkins

Short biographies of the current TRG members are given in Appendix 2.

# THE 2021 ANNUAL REPORT

## 1. TRG ACTIVITIES

### 1.1 TRG Meetings

During 2021, three TRG meetings were held by teleconference.

### 1.2 Project Applications Reviewed

The current status of CL:AIRE Technology Demonstration Projects (TDP) and Research Projects (RP) is provided in Appendix 3. No new demonstration or research project applications were reviewed in 2021.

### 1.3 CL:AIRE Resources Reviewed

#### 1.3.1 *Bulletins*

No new bulletins were reviewed in 2021.

#### 1.3.2 *Technical Reports and Tools*

TRG members reviewed four technical reports prepared for industry in 2021 and an online tool. One was SuRF-UK's "Sustainable Management Practices for Management of Land Contamination" which was published in September 2021. The second was "Good Practice for Risk Assessment for Coal Mine Gas Emissions" which was published in October 2021. The third was an output from Phase 2 of the Category 4 Screening Level (C4SL) project (see Appendix 1 for more details) on 1,2-dichloroethane and will be published in 2022. The fourth was updated guidance on monitored natural attenuation and will be published in 2022.

Three C4SL reports that were reviewed in 2020 were published in 2021. These addressed the contaminants - tetrachloroethene, trichloroethene and vinyl chloride.

An online tool was developed and published in February 2021 It was SuRF-UK's "Tier 1 Sustainability Assessment Tool".

#### 1.3.3 *Online training*

TRG members completed the review of one new Options Appraisal eLearning package in 2021 which is scheduled for release in 2022. Two updated eLearning packages "Introduction to Soil and Groundwater Risk Assessment" and "Sustainable Remediation Appraisal" that were reviewed in 2020 were released in 2021.

The current list of all CL:AIRE Resources is provided in Appendix 4.

### 1.4 Other Activities

In addition to the above activities the TRG members were asked to comment on, or contribute to, many of CL:AIRE's initiatives (listed in Appendix 1). Further contributions included the following:

- Reviewed Definition of Waste: Development Industry Code of Practice procedural documents relating to declarations and material management plans
- Assessed materials management on mega sites
- Reviewed sustainable materials management training
- Assessed the regulatory practice around the redevelopment of landfills
- Discussed wider sustainability issues in industry
- Reviewed content ideas for new per- and polyfluoroalkyl substances (PFAS) publications
- Commented on document accessibility
- Discussed ways and means of improving industry standards
- Reviewed new training module content

## **2. A LOOK AHEAD TO 2022**

Building on the achievements of 2021, a new wave of CL:AIRE outputs is predicted for the forthcoming year. The TRG will be reviewing Concawe bulletins, guidance reports, industry reports, webinars, eLearning modules and outputs from the industry initiatives CL:AIRE is involved in, as well as contributing strategic review, support and steering functions for all CL:AIRE's activities.

## CL:AIRE's Activities 2021

### 1. Industry Initiatives

#### **The National Brownfield Forum & National Quality Mark Scheme**

The National Brownfield Forum was set up in July 2011, originally established by Department for Communities and Local Government (DCLG<sup>1</sup>) and Department for Environment, Food and Rural Affairs (Defra). The aim of the Forum is to promote the sustainable use of land. It brings together private and public sector organisations to take an open and forward-looking strategic overview of current and future land use issues. The Forum considers UK-wide issues and references overseas experience where appropriate. Representation of organisations on the Forum is kept under review, and seeks to represent a broad spectrum of interests.

CL:AIRE acts as the secretariat for the Forum on a voluntary basis with all notes from the meeting being made publicly available from CL:AIRE's website at [www.claire.co.uk/brownfieldforum](http://www.claire.co.uk/brownfieldforum).

The National Quality Mark Scheme (NQMS) for land affected by contamination is a scheme that has been developed by the National Brownfield Forum to provide visible identification of documents that have been checked for quality by a Suitably Qualified and experienced Person (SQP). It provides increased confidence and improved quality of submissions made under regulatory regimes, particularly planning applications, related to previously used land.

The NQMS was launched in January 2017 and CL:AIRE acts as the administrator. More information can be found via [www.claire.co.uk/nqms](http://www.claire.co.uk/nqms).

#### **The Definition of Waste: Development Industry Code of Practice (DoWCoP)**

The DoWCoP is an initiative to improve the sustainable and cost effective development of land through the reuse of materials generated at a site. The DoWCoP provides a clear, consistent and streamlined process which enables the legitimate reuse of excavated materials on-site or their movement between sites with a significantly reduced regulatory burden. In many instances the DoWCoP can provide an alternative to Environmental Permits or Waste Exemptions when seeking to reuse excavated materials.

CL:AIRE administers the DoWCoP declaration process and Qualified Person Register, and provides the Qualified Person training course.

#### **Register of Materials (RoM)**

CL:AIRE keeps a register of materials and services which may fall within the DoWCoP. It aims to link material holders with service providers or organisations requiring materials in order to make the process of finding project partners an easier and quicker process.

The dedicated website for this initiative is: [www.claire.co.uk/projects-and-initiatives/dow-cop](http://www.claire.co.uk/projects-and-initiatives/dow-cop)

#### **Asbestos in Soil**

The Asbestos in Soil and Construction & Demolition Materials – Joint Industry Working Group (Asbestos in Soil JIWG for short) was established in November 2011 after the Environmental Industries Commission (EIC) and CL:AIRE formally joined forces and then invited a wide range of both private and public sector organisations that are all looking to work together to meet the challenges posed by asbestos in soil. In 2016 CL:AIRE published the Asbestos in Soil JIWG guidance titled “Control of Asbestos Regulations 2012: Interpretation for Managing and Working with Asbestos in Soil and Construction & Demolition materials: Industry Guidance (shortened name CAR-SOIL™)”.

A key part of this project is to meet and engage with the regulators and this includes, primarily Health and Safety Executive, Environment Agency (waste, permitting and contaminated land), Department for Transport (DfT), Defra (REACH<sup>2</sup> and contaminated land) and DLUHC.

The dedicated website for this project is: [www.claire.co.uk/asbestos](http://www.claire.co.uk/asbestos)

<sup>1</sup> now Department for Levelling Up, Housing and Communities (DLUHC)

<sup>2</sup> UK registration, evaluation, authorisation and restriction of chemicals (REACH)

## **SuRF-UK & SuRF International**

SuRF-UK is the United Kingdom's Sustainable Remediation Forum – an initiative set up to progress the UK understanding of sustainable remediation. CL:AIRE is the secretariat for SuRF-UK.

In 2021, CL:AIRE published an updated SuRF-UK report titled “Sustainable Management Practices for Management of Land Contamination” and an updated Tier 1 qualitative sustainability assessment tool.

All SuRF-UK publications can be found on its dedicated web page: [www.claire.co.uk/surfuk](http://www.claire.co.uk/surfuk)

CL:AIRE also continues to perform the secretariat function for the international Sustainable Remediation Forums (SuRF International) group meetings. The chairs of SuRF International and associated partners meet three times a year to share progress and learning amongst the different networks and develop opportunities for collaboration ([www.claire.co.uk/surfinternational](http://www.claire.co.uk/surfinternational)).

## **Gas Protection Verification Accreditation Scheme**

In 2021, CL:AIRE, with the support of an industry working group, launched the Gas Protection Verification Accreditation Scheme (GPVS). The scheme seeks to raise standards in membrane inspection, verification and reporting and provide all stakeholders involved in land contamination management with enough confidence that risks associated with ground gases have been adequately managed ([www.claire.co.uk/gpvs](http://www.claire.co.uk/gpvs)).

## **2. UK Projects & Publications**

### **Water and Land Library (WALL)**

The objective of WALL is to make freely available a comprehensive listing of links to water and land references, both past and present, produced by respected industry publishers including the Environment Agency, Association of Geotechnical and Geoenvironmental Specialists (AGS), Building Research Establishment (BRE), Construction Industry Research and Information Association (CIRIA), National House-Building Council (NHBC), CL:AIRE and others.

In 2021, WALL continued to grow in terms of usage and number of references listed.

Industry professionals can access WALL by going to [www.claire.co.uk/wall](http://www.claire.co.uk/wall). CL:AIRE actively seeks to grow WALL by asking relevant organisations and professionals visiting the site to fill in a feedback form to identify further documents to be included.

### **Category 4 Screening Level (C4SL) Project**

Soil and Groundwater Technology Association (SAGTA) is leading a collaborative industry initiative to develop twenty C4SLs for a range of contaminants which have been selected following a consultative process choosing the contaminants which would be most useful to industry. The project is being delivered by a consortium of partners and CL:AIRE is acting as Project Manager supported by Simon Firth (Firth Consultants Ltd) and Naomi Earl (Freelance Consultant).

The first three contaminant reports on tetrachloroethene, trichloroethene and vinyl chloride were published in 2021. These can be downloaded from the dedicated project website: [www.claire.co.uk/c4sl](http://www.claire.co.uk/c4sl)

### **Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration**

In 2020, CL:AIRE published guidance on applying statistics to land contamination decision-making. In 2021, the author of the guidance, statistician Nigel Marriott, delivered online training courses on the application of the guidance.

### **Monitored Natural Attenuation (MNA) Guidance**

CL:AIRE is working with a small group of industry experts to update the 2000 MNA guidance document for publication in 2022.

### **Natural Source Zone Depletion (NSZD) Guidance**

CL:AIRE is working with Geosyntec to write new technical guidance on NSZD, which will sit alongside the MNA Guidance. The new guidance will be published in 2022.

### **Legacy Wastes in the Coastal Zone: Environmental Risks and Management Futures**

Starting in January 2020, the legacy wastes project is a four-year research project funded by the Natural Environment Research Council (NERC) (<https://research.ncl.ac.uk/legacywastes/>). It brings together expertise in waste management, freshwater and seawater geochemistry, geomorphology, hydrology, ecology and environmental policy to provide a multi-scale assessment of the risks posed by municipal and mineral-rich legacy wastes in the coastal zone and provide a framework for their effective future management.

The project has also been approved by the CL:AIRE TRG as CL:AIRE Research Project RP27.

### **ICEC - MCM**

CL:AIRE is supporting The Interdisciplinary Circular Economy Centre for Mineral-based Construction Materials (ICEC-MCM), led by University College London. The ICEC-MCM launched in early 2021 and aims to develop systems and technologies for more efficient use and recovery of mineral resources.

## **3. European Projects**

### **Enhanced and Innovative In Situ Biotechnologies for Contaminated Land Remediation (EiCLaR) – [www.eiclar.org](http://www.eiclar.org)**

CL:AIRE is part of a EU and China consortium called EiCLaR composed of thirteen EU and five Chinese partners. Led by the University of Lyon, the four-year project started in early 2021 and will develop scientific and technical innovations for *in situ* bioremediation technologies. CL:AIRE is involved in delivering the knowledge transfer activities.

### **ReCon Soil – [www.claire.co.uk/projects-and-initiatives/recon-soil](http://www.claire.co.uk/projects-and-initiatives/recon-soil)**

The ReCon Soil project, supported by the European Regional Development Fund via the Interreg France (Channel) England programme, started in April 2021 and will run until June 2023. The project is studying the potential reuse of surplus materials from the construction industry.

### **Concawe Case Studies and Analysis of Sustainable Remediation Techniques and Technologies**

CL:AIRE and r3 environmental technology are delivering a Concawe Project which will compile case studies of sustainable remediation techniques and technologies, with a specific focus on European examples.

## **4. Training**

In 2021, CL:AIRE continued to provide a mixture of classroom-based and online training on the following topics:

- Definition of Waste Code of Practice (DoWCoP)
- Asbestos in Soil and Construction & Demolition Materials CAR-SOIL™
- Statistics for Comparing Soil Contamination Data to a Critical Concentration

Due to the pandemic, the range of subject titles was reduced and those courses that had a practical element did not run.

CL:AIRE has eLearning modules for remediation technologies, options appraisal, risk assessment, sustainable remediation, asbestos awareness for land professionals and site investigation for brownfield sites. It is also developing further modules in new areas, which will be launched in 2022.

## **5. Membership Development**

CL:AIRE's membership was stable at over 120 organisations in 2021, most listed on the CL:AIRE website.



## TRG MEMBER BIOGRAPHIES (AT START OF 2022)

### **Seamus Lefroy-Brooks (Chair), LBH GEO**

Seamus is multi-chartered as a Civil Engineer, Geologist and Environmentalist and is a UK Registered Ground Engineering Adviser under the RoGEP scheme. He has worked as a consultant for over 40 years and is a past chair of both the AGS and the Land Forum/National Brownfield Forum. He was also a founding committee member of SoBRA.

He assisted Defra with the Part 2A statutory revisions and was one of the twelve experts appointed to the government's National Expert Panel for Land Contamination.

He is now chair of the National Brownfield Forum's Professional Standards Committee leading the initiative to deliver the National Quality Mark Scheme for the management of land affected by contamination.

Seamus has been significantly involved in the management of asbestos in soils risk. He is a member of the JIWG and served on WG2 of the HSE CFM, being named recently for assisting HSE with the update to HSG248.

He has also sat on various CIRIA and BSI steering groups and is notably one of the authors of the present BS4845 relating to landfill gas. He is an active member of both the IES land community and the EIC contaminated land working group.

Seamus is a QP, SQP and a SiLC. Through his firm, LBH GEO, he works as a consultant to government, land owners, developers and regulators alike and endeavours to bring an experienced and practical eye to the solution of all manner of ground-related problems.

### **Dr Kim Baines, International Atomic Energy Agency (Deputy chair)**

Kim is an Environmental Remediation Specialist leading international projects at the IAEA currently focused on the characterisation and stewardship of radioactive land contamination. The scope of sites is broad ranging from uranium mining and milling sites, to early nuclear research sites through to nuclear accident sites. Prior to her current position, Kim worked for the Nuclear Decommissioning Authority (NDA) as Strategic Authority for Land Quality Management and Land Use. Kim was responsible for developing the NDA's approach to the Site End State and which has included providing technical support to the Winfrith and Dounreay sites. Prior to her position with the NDA, Kim worked for 16 years in the nuclear and redevelopment industries on the remediation of contaminated land.

Kim was the sponsor for NDA R&D within the field of Land Quality. Kim successfully chaired the Nuclear Industry Land Quality Group for 5 years seeing membership increase to include all but one of the UK nuclear site licence operators. Kim has facilitated the working relationship between the regulators and industry within the nuclear sector. This has enabled the successful development and implementation of regulator guidance for the management of decommissioning wastes and land contamination (Guidance on Requirements for Release of Nuclear Sites from Radioactive Substance Regulation "GRR").

Kim has also worked extensively on non-nuclear brownfield sites ranging from petrol stations, to gas works to coal mining sites. Kim's specialism for several years was human health and controlled water risk assessment and the development of remedial strategies.

### **Bob Barnes, Environment Agency**

Bob has worked for the Environment Agency for nearly 30 years. For 8 years he worked as the groundwater and contaminated land technical specialist for the Agency's Hampshire and the Isle of Wight operational area. Following this he joined the then National Groundwater and Contaminated Land Centre, now part of the Environment and Business Directorate of the Agency where he resides as a Principal Scientist.

Over the past 20+ years, in addition to waste research, he has undertaken research and developed technical guidance on all aspects of managing land contamination and supported operational colleagues' site investigations in the field.

### **Simon Burr, CampbellReith**

Simon has been working in the environmental consultancy field since 1993, with specialisation in contaminated land risk assessment, investigation and remediation at a senior project management level. He has been responsible for a large number of regeneration projects and manages a number of client portfolios. He is a registered Specialist in Land Condition (SiLC) and as a member of SoBRA was one of their representatives at the government consultation concerning the revisions to contaminated land statutory guidance. He was also a member of SoBRA's sub-committee which developed the accreditation scheme for contaminated land risk assessors.

As Partner for CampbellReith's London Land Quality department, Simon manages the development of their human health, groundwater and ground gas risk assessment capabilities. As well as responsibility for managing and delivering the environmental work of CampbellReith he has developed the waste soils assessment services and manages the production of Materials Management Plans across the practice to enable appropriate reuse of waste soils across their projects. He has also undertaken technical assessments and ground gas assessments for CampbellReith's landfill projects to enable their development.

### **Ruth Chippendale, Shell**

Ruth is Principal Program Manager within the Shell Downstream soil and groundwater team. In this role she is accountable for managing soil and groundwater risks for Shell Downstream in the UK, primarily across a nationwide portfolio of retail petrol stations.

Ruth is a contaminated land professional with over 25 years experience. She has a geology and hydrogeology background and is a Chartered Geologist, Chartered Environmentalist and Full Member of IEMA. Before joining Shell, Ruth's early career was spent within environmental consultancy where she participated in, and led, teams delivering site investigation, risk assessment and remediation services. The first phase of her Shell career was spent in Shell Global Solutions in the UK, undertaking technical assurance and regulatory advocacy work for sites across Europe and beyond, and later taking on a combined team leadership and technical role. More recently she broadened her experience to cover a wider environmental remit in upstream oil and gas outside the UK, working in operations in Gabon, Australia and Qatar, before returning to live and work in the UK in 2020.

### **Professor Max Coleman, Caltech and Emeritus Professor of Sedimentology, University of Reading**

Max's current work focuses on searching for life outside the Earth but he has more than 20 years' experience of research in contaminated land and water. His main personal research interests are in the interaction of microbial populations with sedimentary systems and environmental geochemistry and he is continuing work on contamination problems, especially natural attenuation approaches. His career as a research scientist has been split equally between employment in government, industrial and academic sectors.

As well as pure research, Max has applied multidisciplinary, fundamental scientific research to elicit solutions to practical problems in petroleum exploration and production, environmental pollution, radioactive waste storage and forensic science. He has written more than 140 publications mainly in stable isotope chemistry and its applications to geochemistry, hydrochemistry and microbial processes.

### **Steve Edgar, Vertase FLI**

The Managing Director of Vertase FLI, Steve guides the business and the team through the more challenging remediation sites the UK has to offer. He initially cut his teeth as a geologist for a consultancy working on a variety of remediation projects in the nineties during the founding years of the remediation industry. He has spent most of his career in remediation contracting, designing and implementing in situ and ex situ remediation projects on sites ranging in size and complexity from petrol forecourts to tar and chemical processing plants, landfills.

As well as his technical background he also has significant experience of the regulatory, finance, planning and other drivers behind brownfield redevelopment. He has tackled some of the trickiest sites remediation wise, in the UK and for some of the most demanding clients. Professionally he has a passion for good science coupled with practicality which stands him and Vertase FLI in good stead within the industry.

**Liz Gray, Atkins**

Liz is an advocate for bringing excavated materials into the spotlight during the planning phase of a project to maximise reuse and sustainability benefits. She has worked with industry over the last 16 years to improve resource efficiency in construction including the application of the DoWCoP to large infrastructure and multi-phase projects. She co-authored the inaugural IEMA guidance on the assessment of materials and waste in Environmental Impact Assessment and leads on materials and waste assessments in EIA for road, rail, housing and NSIP schemes, including those submitted for Development Consent Orders and Transport Works Act Orders.

Liz is a Qualified Person under DoWCoP and delivers DoWCoP training courses as a trainer for CL:AIRE. With a background in land contamination, Liz's experience encompasses waste and resource management, due diligence, environmental management and management systems, compliance/assurance auditing and reporting and training development and delivery.

**Professor Mark Hodson, University of York**

Mark is a professor of environmental geochemistry and mineralogy at the University of York. His current research interests cover three interrelated strands: water-rock interactions, remediation of contaminated land and earthworm ecology. His remediation work has focused on the use of soil amendments to immobilise inorganic contaminants in situ and assisted phytoremediation. He has also carried out work on the chemistry of acid mine drainage, contaminant bioavailability and the response of soil organisms to contamination.

Mark was a member of the Earth Systems and Environmental Sciences REF2014 and REF2021 subpanels, acting as subpanel chair for REF2021. He currently acts as a panel Chair for Natural Environment Research Council grant schemes.

**Edward Lewis, Northern Ireland Environment Agency**

Edward has a BA and MA in Earth Sciences from St Hugh's College, Oxford University and a Ph.D and DIC in Environmental Engineering from Imperial College, London.

Edward has 9 years experience as a consultant Contaminant Hydrogeologist working for Atkins Ltd in Birmingham. His main experience during this time was in the fields of land contamination and landfill risk assessment. He also worked on a number of flood defence schemes. He is experienced in the use of most of the risk assessment software packages and technical requirements associated with groundwater/environmental risk assessment in the UK.

Since 2012 Edward has been at the Northern Ireland Environment Agency as a Senior Scientific Officer in the Land and Groundwater Team (LGWT). The principal work streams in the LGWT relate to land contamination addressed through the planning regime. He also provides hydrogeological and land contamination advice to colleagues across a range of teams with regard to groundwater resourcing, mining, cemeteries, end of waste applications and landfill risk assessments. He has been involved in a number of projects for the NIEA including the assessment of risks associated with the absence of Part III of the Waste and Contaminated Land (NI) Order 1997 in the province of Northern Ireland and the ongoing Mobuoy Road remediation project.

**Richard Moss, independent consultant**

Richard is the recently retired Director Environmental Affairs, Assets & Operations EMEA and APAC at AkzoNobel. Richard is a process engineer with over 35 years of experience working in research, consulting and the chemical industry. His experience covers HSE, legacy & environmental liability issue management, environmental risk assessment, environmental & HSE Due Diligence and business risk management including business continuity, crisis management and product liability risk evaluation.

For over 30 years Richard worked within ICI and AkzoNobel with responsibilities covering topics such as management of environmental liabilities, site closures, acquisition and divestment due diligence. He has gained broad experience in contaminated land assessment and liability management; covering an extensive range of sites and contaminants. Richard has spent a significant time working on difficult DNAPL sites, including probably the largest assessment of vapour intrusion in the UK. For AkzoNobel Richard worked on contaminated sites in over 40 countries; here he was responsible for delivering robust assessment of the business risk and where needed sustainable, innovative and cost effective solutions.

**Sarah Poulton, Natural Resources Wales**

Sarah is an Environmental Hydrogeologist with 9 years' experience in the field of Remediation Engineering, working on a variety of contaminated land and groundwater projects across the UK. Sarah has recently started a new role as a Lead Specialist Advisor in Hydrogeology for Natural Resources Wales; in her role, she provides an expert technical lead on Hydrogeology and helps manage the preparation of internal policy, programmes and guidance. She leads on, and project manages, specific and complex hydrogeological issues and projects. Previously, she was a Principal Remediation Consultant and Project Manager, with a strong technical focus primarily in Controlled Water Risk Assessment.

Sarah is a Chartered Environmentalist (CEnv) through the Institution of Environmental Sciences, and a full member of RemSoc where she also helped develop and now leads the Early Careers Practitioners subgroup; a platform that she uses to deliver remediation and brownfield land focussed information aimed specifically at those within the 5-10 years of their career. She was invited by the IES to join a Working Group focussed on Land Condition, with the principle purpose of developing evidence-led policy on land management. Through this, she helped in the production of the document " Sustainable, healthy and resilient: Practice-based approaches to land and soil management".

**Dr Michael Rivett, GroundH<sub>2</sub>O plus Ltd**

Michael is a contaminant hydrogeologist with over 35 years of groundwater experience gained mostly in the academic – university sector. He is founding director of GroundH<sub>2</sub>O plus Ltd based in Birmingham founded in 2016. His research-oriented background allows the company to specialise in research-informed hydrogeological assessment and technical review of groundwater contamination issues of concern to a variety of sectors, including contaminated land, nuclear, energy-development, water-industry and developing world sectors.

Michael has a significant track record of published research and projects working with industry on organic contaminants, L/DNAPLs, radiological contamination, shale gas exploitation, groundwater – surface-water interactions, urban contaminated land, highway de-icing salt impacts, and groundwater sustainability, especially in the developing world context gained through his recent 2016-21 part-time Research Fellowship position with the University of Strathclyde on their Malawi project.

Michael has previously served as Chair of the British Chapter of the International Association of Hydrogeologists and Chair of the Hydrogeological Group of the Geological Society. He has edited or authored several publications with CL:AIRE including the 'LNAPL handbook' and their recent Technical Bulletin on Natural Source Zone Depletion. He has served on the TRG since 2008.

**Professor Steve Thornton, University of Sheffield**

Steve is Professor of Environmental Engineering Science within the Groundwater Protection and Restoration Group at the University of Sheffield. He has over 25 years experience in contaminant hydrogeology, with particular interest in the application of natural attenuation for pollution management, monitoring techniques and performance assessment of natural attenuation at field scale and in situ / engineered bioremediation.

Steve's current research involves field, laboratory and modelling studies on the natural attenuation and treatment of organic contaminants, petroleum hydrocarbons and ether oxygenates in groundwater, development of electrokinetic methods for enhanced bioremediation, development of reactive barrier design concepts for waste disposal sites and measures to support sustainable agriculture. He led the EU Marie Skłodowska-Curie Innovative Training Network, INSPIRATION, on the theme of managing soil and groundwater impacts from agriculture, and before that led the EU Marie Curie Initial Training network, ADVOCATE, on sustainable in situ remediation.

Steve is an Associate Editor of the international journal Ground Water and a Visiting Professor in the College of Water Sciences at Beijing Normal University in China and AGH University of Science and Technology in Poland.

**Professor Gary Wealthall, Geosyntec Consultants Ltd.**

Gary is the Managing Director of Geosyntec's consulting operations that support businesses in the UK, Ireland and Continental Europe. He is a Senior Principal with more than 30 years of experience in contaminant hydrogeology research and practice. He is also an Adjunct Professor at the University of Toronto and was previously a Principal Research Scientist with the British Geological Survey and Research Fellow at the University of Sheffield.

Gary specialises in the development and application of high-resolution site characterisation methodologies for the selection, design and implementation of advanced remediation technologies. He serves as a Subject Matter Expert for industry clients in Europe, North America, South America and South Africa. He also has significant experience as a technical training instructor on leading-edge professional development courses on five continents, including co-presenter of the prestigious Princeton Remediation Courses.

Gary is an Editorial board member of QJEGH and has published numerous research papers and best-practice guidance documents on the behaviour of dense and light non-aqueous phase liquids (DNAPLs and LNAPLs) in intergranular and fractured bedrock aquifers and aquitards. He is co-author of a number of best-practice documents, e.g. a Guide for NAPL Migration in Sediments (ASTM, 2019), Integrated DNAPL Site Characterization and Tools Selection (ITRC, 2015), a Generic Work Plan to Assess Dense Non-Aqueous Phase Liquid Mobility in the Subsurface at Manufactured Gas Plant Sites (EPRI, 2015), and An Illustrated Handbook of LNAPL Transport and Fate in the Subsurface (CL:AIRE, 2014).

**Karen Young, Jacobs UK Ltd**

Karen is a Senior Associate Director and Head of Discipline for the Jacobs UK and Europe land quality team. She has over 20 years of experience in contaminated land assessment, firstly as a regulator with Salford City Council and then Warrington Borough Council before becoming an environmental consultant with Jacobs. She has experience in contaminated land assessment, environmental impact assessment and materials management plans and has worked on a wide range of projects including the Avenue Coking Works remediation, numerous Environment Agency flood defence schemes and major infrastructure projects including Wylfa Newydd, Heathrow Expansion and HS2.

Karen has experience of applying the DoWCoP to major infrastructure schemes, in particular HS2 on behalf of ALIGN JV, and as part of this project has worked closely with CL:AIRE and the Environment Agency to develop a framework approach to applying materials management plans to large-scale, long-running projects.

## EARLY CAREER PROFESSIONAL TRG MEMBER BIOGRAPHIES (AT START OF 2022)

### **Emily Reynolds, Mott MacDonald**

Emily is a Graduate Environmental Consultant, recently obtaining a Masters in Applied Environmental Geology at Cardiff University. As a new graduate, Emily's work involves contaminated land risk assessments, supporting geotechnical and geo-environmental desk studies, and environmental permitting. This primarily focuses on generic quantitative risk assessment reporting, compiling bespoke flood risk activity permits and production of drainage consent packs. Emily is also an Early Careers Committee Member of the Geological Society's Contaminated Land Group.

### **Oliver Gernon, Arup**

Oliver is a Geo-Environmental Consultant at Arup with over five years' experience in ground engineering and contaminated land consultancy. He is accredited by SoBRA as a Registered Risk Assessor in Controlled Waters and Human Health and is experienced in risk management, remediation, and brownfield redevelopment.

Oliver has a keen interest in the application of digital tools to geo-environmental schemes and is further developing his knowledge of geospatial modelling and visualisation by focusing on 3D geological and contaminant modelling. Oliver's experience has included designing and managing site investigations, remediation schemes, piling into contaminated land, environmental permitting, construction quality assurance and verification of materials re-used under CL:AIRE's DoWCoP.

### **Jess Shaw, Arcadis**

Jess is a Senior Environmental Consultant at Arcadis with 6.5 years' experience, 5 of which in the brownfield and contaminated land industry. Prior to her time at Arcadis, Jess worked for a small consultancy gaining experience in waste legislation and permitting. At Arcadis, Jess has developed a wide range of experience in environmental monitoring, ground investigations, site conceptualisation and risk assessment, however more recently, has been specialising in brownfield decommissioning, demolition and remediation of public and private sector sites.

Day to day, Jess works on both small- and large-scale demolition and decommissioning projects, providing technical advice, managing surveys, planning works and overseeing a site team delivering activities. Jess is passionate about digitalisation and finding new innovative ways of monitoring and sampling to improve sustainability and provide Clients with high quality technical solutions. She has recently been appointed as a radiation protection supervisor, in charge of a handheld XRF which she used on a recent demolition project to aid the recovery of significant quantities of platinum group metals.

Jess was shortlisted in 2021 as the Best Young Brownfield Professional in the Brownfield Briefing Awards and is also a member of the young professional group and innovation working group with the NICOLE network.

### **Dan Simons, Soilfix**

Dan is an Assistant Project Manager at Soilfix and a Chartered Environmental Surveyor with the RICS. He has over 9 years experience in planning and environmental consultancy, contaminated land / site investigation and EIA, initially working as an environmental scientist, before moving into Project Management.

In his current role with Soilfix, he is responsible for managing the operational and technical delivery of remediation projects including the preparation of factual and interpretative reports such as Remediation Method Statements and Material Management Plans. Dan has specialist skills in topographical surveying, 3D digital terrain modelling and volumetric analysis.

### **Leigh Ward, Atkins**

Leigh is a Senior Environmental Consultant and Chartered Scientist at Atkins in the Contaminated Land and Hydrogeology practice. She has over 8 years of experience in contaminated land assessment and remediation with specialism in former gasworks sites and gasholder demolition and infilling works.

Leigh brings brownfield sites back into beneficial use through de-constraining, characterisation, remediation and demolition as an environmental consultant, project manager, and previously as client

through secondment. She engages project stakeholders and has presented to CLOs at a regional level about the gasholder demolition and sludge treatment process on behalf of the client. More recently, Leigh has led the design and management of remediation and expanded her project experience into multi-disciplinary infrastructure projects for site assessment and earthworks design, including authoring Material Management Plans.

## Status of CL:AIRE Technology Demonstration Projects

| Code    | Project Title and Project Operator  | Status                         |
|---------|---|--------------------------------|
| TDP 1:  | Remediation Trial Using Low Temperature Thermal Desorption to Treat Hydrocarbon Contaminated Soil - British Aerospace Systems   | Completed + Report Available   |
| TDP 2:  | Remediation of Basford Gasworks Using Soil Washing – National Grid Property/VHE   | Completed + Report Available   |
| TDP 3:  | Design, Installation and Performance Assessment of a Zero Valent Iron Permeable Reactive Barrier in Monkstown, Northern Ireland- Nortel Networks/Golder Associates/Queen's University Belfast/Keller Ground Engineering Ltd | Completed + Report Available   |
| TDP 4:  | Slurry-Phase Bioreactor Trial - Parsons Brinckerhoff/National Grid Property   | Completed + Report Available   |
| TDP 5:  | A Reducing and Alkalinity Producing System (RAPS) for Passive Treatment of Acidic, Aluminium Rich Leachates from Mine Spoils - University of Newcastle/Durham County Council  | Completed + Report Available   |
| TDP 6:  | Bioremediation Trial at The Avenue - DEC NV/Jacobs/East Midlands Development Agency/Homes and Communities Agency  | Completed + Report Available   |
| TDP 8:  | Field Demonstration of Accelerated Carbonation Technology (ACT) at The Avenue – Jacobs/East Midlands Development Agency/Homes and Communities Agency  | Completed + Bulletin Available |
| TDP 9:  | Use of an Air Sparge Treatment Curtain to Remediate Groundwater at a Former Gas Works – WorleyParsons Komex/National Grid Property  | Completed + Report Available   |
| TDP 10: | Thermal Remediation Trial at The Avenue - MEL Limited/Jacobs/East Midlands Development Agency/Homes and Communities Agency  | Completed + Bulletin Available |
| TDP 11: | Soil Washing Remediation Trial at The Avenue - DEC NV/Jacobs/East Midlands Development Agency/Homes and Communities Agency  | Completed + Bulletin Available |
| TDP 12: | Bioremediation of the Coke Works and Former Colliery at Askern, Doncaster - Ecologia Environmental Solutions Ltd/Carillion Civil Engineering/Yorkshire Forward  | Completed + Report Available   |
| TDP 13: | A Permeable Reactive Barrier for Remediation of Extremely Polluted Groundwater Associated with a Highly Pyritic Abandoned Colliery Spoil Heap - University of Newcastle upon Tyne and Northumberland County Council         | Completed + Report Available   |
| TDP 16: | Remediation of Chlorinated Hydrocarbon Contaminated Soils using <i>Ex Situ</i> Soil Vapour Extraction – RemedX and ABB  | Completed + Report Available   |



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|---------|--|-----------------------------------|
| TDP 17: | <i>In Situ</i> Bioremediation of Cyanide, PAHs and Heterocyclic Compounds using Engineered SEquenced REactive BARrier (SEREBAR) Techniques - Queen's University Belfast/National Grid Property/Parsons Brinckerhoff  | Completed + Report Available      |
| TDP 18: | Source Area <i>in situ</i> BioREmediation (SABRE) – Akzo Nobel/Archon Environmental/British Geological Survey/Celanese Acetate/Chevron/DuPont/ESI/ General Electric/Environment Agency/GeoSyntec/ Golder Associates/Honeywell/Scientifics/Strategic Environmental Research and Development Program (SERDP)/Shell Global Solutions/Terra Systems/University of Edinburgh/University of Sheffield/US Environmental Protection Agency | Completed + 6 Bulletins Available |
| TDP 20: | Design, Installation and Performance Assessment of a Permeable Reactive Barrier (PRB) to Treat Carbon Disulphide Contaminated Groundwater at a Former Chemicals Site in Manchester - CEL International Ltd, ESI, Akzo Nobel  | Completed + Report Available      |
| TDP 21: | Remediation of Agricultural Diffuse NITRAte Polluted Waters through the Implementation of a Permeable Reactive BARrier (NITRABAR) – University of Oxford/Queen's University Belfast/Environment Agency/Ecomesh Ltd (N. Ireland)/PGRW (Poland)/Zenengo (Belgium)/APCO Ltd (Malta)/CL:AIRE   | Completed + Report Available      |
| TDP 22: | Improved Ground Gas Risk Prediction by Continuous In-borehole Gas Monitoring (IRP-IGM) - Salamander; Urban Vision; The University of Manchester  | Completed + Bulletin Available    |
| TDP 23: | <i>Ex Situ</i> Treatment of Coal Tar Impacted Soil Using Low Temperature Thermal Desorption at the Former Gasworks, East Dock Street, Dundee - National Grid Property Holdings Ltd; White Young Green; Bilfinger Berger; I & H Brown   | Completed                         |
| TDP 24: | Application of Thermally Enhanced Soil Vapour Extraction (TESVE) to remediate the unsaturated zone at the Western Storage Area (WSA), Harwell - UK AEA; Provectus Group; Nuclear Decommissioning Authority   | Completed + Report Available      |
| TDP 25: | Decision Support Tool for Innovative <i>In Situ</i> Multi-Contaminant Groundwater Remediation - WorleyParsons Komex, National Grid Property, Environment Agency, Bradford City Council and Imperial College  | Completed + Bulletin Available    |
| TDP 26: | <i>In Situ</i> Soil and Groundwater Decontamination using Electric Resistive Heating Technology (Six-Phase Heating®) - Terra Vac (UK) Ltd; Taylor Wimpey Ltd   | Completed + Bulletin Available    |
| TDP 28: | <i>In Situ</i> Heating using Radiofrequency (RF) Coupled with Soil Vapour Extraction/High Vacuum Dual Phase Extraction for the Remediation of Contaminated Soil in the Unsaturated Zone - Ecologia Environmental Solutions Ltd; Total UK Ltd   | Completed + Bulletin Available    |
| TDP 29: | Low-cost Rapid On-Site Quantification of Oil-based Contamination (ROSQUO) - National Grid, Cranfield University and WSP Remediation  | Completed                         |
| TDP 30: | Remediation Field Trials for the Chromium-Contaminated Area at Shawfield, Glasgow - Clyde Gateway Urban Regeneration Company and URS Corporation Ltd   | Completed + Bulletin Available    |

|         |   |                                |
|---------|---|--------------------------------|
| TDP 31: | Demonstration of the Arvia® Process of Adsorption Coupled with Electrochemical Regeneration for the On-site Destruction of Organic Contaminants in Groundwater - Arvia Technology Ltd and VertaseFLI. | Completed + Bulletin Available |
| TDP 32: | <i>In Situ</i> Chemical Oxidation of Carbon Disulphide Using Activated Persulphate – Arcadis, FMC Environmental Solutions   | Completed                      |

## Status of CL:AIRE Research Projects

| Project Code | Project Title and Principal Project Operator   | Status                         |
|--------------|--|--------------------------------|
| RP 2:        | Hydro-biological Controls on Transport and Remediation of Organic Pollutants for Contaminated Land - Professor Howard Wheater, Imperial College of Science, Technology and Medicine; Professor Jeremy Mason, Kings College, London; and National Grid Property | Completed                      |
| RP 3:        | Processes Controlling the Natural Attenuation of Fuel Hydrocarbons and MTBE in Chalk - Dr Steve Thornton, University of Sheffield  | Completed + Report Available   |
| RP 4:        | The Development of a Statistical Model to Optimise Investigation to Characterise Contaminated Land - Professor Mike Ramsey, University of Sussex   | Completed + Report Available   |
| RP 5:        | The Use of Bonemeal Phosphates to Stabilise Metal Contamination - Dr Eva Valsami-Jones, The Natural History Museum   | Completed + Bulletin Available |
| RP 6:        | Phytoextraction of Metals: Investigation of Hyperaccumulation and Field Testing - Professor Steve McGrath - Rothamsted Research  | Completed + Report Available   |
| RP 9:        | The Development of an Indicator Methodology to Determine the Plant Availability of Potentially Toxic Elements - Tony Hutchings, Forest Research/Martina Juvara – Arup  | Completed + Bulletin Available |
| RP 10:       | Comparative Assessment of Approaches for Predicting the Fate and Transport of Dissolved Phase Hydrocarbons in Chalk Aquifers - Natalyn Ala, Atkins Environment   | Completed + Bulletin Available |
| RP 12:       | Development of an <i>In Situ</i> Aquifer Assessment Tool with Risk Management Calculator for Natural Attenuation - Professor Steve Banwart, University of Sheffield  | Completed                      |
| RP 13:       | <i>In situ</i> Source Treatment for Enhanced Bioremediation Processes (IN-STEP) - Professor Bob Kalin, Queen's University Belfast  | Completed + Report Available   |
| RP 14:       | Use of Longitudinal STREAMTUBE-Based Monitoring Approaches to Determine Contaminant Fate Within the SABRE Intra-Source/Plume Test Cell.- Dr Mike Rivett, University of Birmingham  | Completed + Bulletin Available |
| RP 15:       | Ferric Iron Remediation and Stabilisation (FIRS): electrokinetic remediation of heavy metal-contaminated back garden sites - Dr Andrew Cundy, University of Sussex, Dr Laurence Hopkinson, University of Brighton  | Completed + Bulletin Available |
| RP 16:       | Performance Assessment of Stabilised/Solidified Waste Forms (PASSiFy) – Dr Colin Hills, University of Greenwich  | Completed + Report Available   |
| RP 17:       | The Use of Recycled Construction/Demolition and Industrial Waste as a Substrate in a Novel Manganese Removal Passive Treatment System - Dr Selina Bamforth, University of Newcastle upon Tyne and Dr Karen Johnson, University of Durham                       | Completed                      |

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|--------|--|--|
| RP 18: | Optimising Biopile Processes for Weathered Hydrocarbons within a Risk Management Framework - Professor Simon Pollard, Cranfield University   | Completed + Bulletin Available             |
| RP 19: | Process Envelopes for Cement-based Stabilisation/Solidification (ProCeSS) - Dr Julia Stegemann, University College London  | Completed                                  |
| RP 20: | Increased Acceptability of On-Site Measurement by Estimation and Reduction of Uncertainty – Severn Trent Laboratory, University of Sussex, National Grid Property Holdings, Corus UK,  | Completed                                  |
| RP 21: | The Use of Biologically Enhanced Charcoal for In Situ Remediation of Contaminated Land – Aspire Defence Ltd, Forest Research, University of Surrey, University of Sheffield  | Completed                                  |
| RP 22: | Contaminant – the use of Supercritical Carbon Dioxide (SC-CO <sub>2</sub> ) for the In Situ Sampling and Analysis of Contaminants - PJH Partnership Limited, University of Birmingham, Pera Innovation, Lankelma   | Completed                                  |
| RP 23: | Regeneration of Brownfield Using Sustainable Technologies (ROBUST) – Dr Karen Johnson and Dr Clare Bamba, Durham University  | Completed + Bulletin Available             |
| RP 24: | Soil Mix Remediation Technology (SMiRT) – Robert McGall, Eco Foundations and Dr Abir Al-Tabbaa, University of Cambridge  | Completed                                  |
| RP 25: | Cleaning Land for Wealth (CL4W) - University of Warwick, Newcastle University, the University of Birmingham, Cranfield University and the University of Edinburgh  | Completed                                  |
| RP 26: | Resource Recovery and Remediation of Alkaline Wastes (R3AW) – University of Hull, University of Leeds, Newcastle University, University of Sheffield, Cardiff University   | Completed + Bulletin Available             |
| RP 27: | Legacy wastes in the coastal zone: Environmental risks and management futures - Newcastle University, University of Hull, University of Exeter, University of Leeds, University of Plymouth, Liverpool John Moores University, University of Glasgow and the UK Centre for Ecology and Hydrology | Project in Progress (started January 2020) |

## CL:AIRE RESOURCES

### **Technology Demonstration Project (TDP) Reports and Bulletins**

- TDP1 - *Remediation trial using low temperature thermal desorption to treat hydrocarbon-contaminated soil (2004)*  
 TDP2 - *Remediation of Basford Gasworks using soil washing (2003)*  
 TDP3 - *Design, installation and performance assessment of a zero valent iron permeable reactive barrier in Monkstown, Northern Ireland (2001)*  
 TDP4 - *Slurry-phase bioreactor trial (2004)*  
 TDP5 - *A Reducing and Alkalinity Producing System (RAPS) for passive treatment of acidic, aluminium rich mine waters (2005)*  
 TDP6 - *Biopile field demonstration at the Avenue Coking Works (2004)*  
 TDP9 - *Design, installation and performance assessment of an air sparge curtain system (2004)*  
 TDP12 - *Bioremediation of the Coke Works and Former Colliery at Askern, Doncaster (2005)*  
 TDP13 - *A permeable reactive barrier for remediation of extremely polluted groundwater associated with a highly pyritic abandoned colliery spoil heap (2006)*  
 TDP16 - *Ex situ soil vapour extraction to remediate chlorinated hydrocarbons (2007)*  
 TDP17 - *A biological sequential reactive barrier (SEREBAR): design, installation and performance at a former manufactured gas plant site in south west England (2008)*  
 TDP20 - *Design and installation of a permeable reactive barrier to treat carbon disulphide contaminated groundwater (2009)*  
 TDP24 - *Application of thermally enhanced soil vapour extraction (TESVE) to remediate the unsaturated zone at the Western Storage Area, Harwell (2010)*  
 TDP26 - *In situ soil and groundwater decontamination using electric resistive heating technology (2008)*  
 TDP28 - *In situ radio frequency heating (ISRFH) of hydrocarbon contaminated chalk at a former service station in Kent (2011)*  
 TDP30 - *In situ 'deliverability' trials using calcium polysulphide to treat chromium contamination at Shawfield, Glasgow (2013)*  
 TDP31 - *Demonstration of the Arvia™ process of adsorption coupled with electrochemical regeneration for the on-site, ex situ, decomposition of organic contaminants in groundwater (2013)*

### **Research Project (RP) Reports**

- RP3 - *Processes controlling the natural attenuation of fuel hydrocarbons and MTBE in the UK Chalk aquifer (2006)*  
 RP4 - *Cost-effective investigation of contaminated land (2007)*  
 RP6 - *Phytoextraction of Metals: Investigation of hyperaccumulation and field testing (2005)*

### **Other CL:AIRE Bulletins**

#### **Technical Bulletins (TB)**

- TB1 - *Introduction to an integrated approach to the investigation of fractured rock aquifers contaminated with non-aqueous phase liquids (2002)*  
 TB2 - *Multilevel sampling systems (2002)*  
 TB3 - *Principles and practice for the collection of representative groundwater samples (2008)*  
 TB4 - *Parameterisation of aquifer hydraulic properties: A contaminant hydrogeology perspective (2009)*  
 TB5 - *The use of geophysical investigation techniques in the assessment of contaminated land and groundwater (2007)*  
 TB7 - *Improving the reliability of contaminated land assessment using statistical methods: Part 1 (2004)*  
 TB9 - *Stabilisation/Solidification Treatment and Remediation: Part 1: Summary of the State of Practice Reports I-IV STARNET (2004)*  
 TB11 - *A practical guide to investigating DNAPL releases in the subsurface (2004)*  
 TB12 - *Statistical assessment of contaminated land: Some implications of the 'Mean Value Test' (2006)*  
 TB13 - *Understanding soil washing (2007)*  
 TB14 - *Treatment of chromium contamination and chromium ore processing residue (2007)*  
 TB15 - *Accounting for the groundwater-surface water interface in contaminated land assessments (2011)*  
 TB16 - *Complete continuous monitoring in underfloor voids (2017)*  
 TB17 - *Ground gas monitoring and 'worst-case' conditions (2018)*  
 TB18 - *Continuous ground-gas monitoring and the lines of evidence approach to risk assessment (2019)*  
 TB19 - *Managing risks and liabilities associated with per- and polyfluoroalkyl substances (PFASs) (2019)*  
 TB20 - *An Introduction to Natural Source Zone Depletion at LNAPL Sites (2019)*  
 TB21 - *The GroundWater Spatiotemporal Data Analysis Tool (GWSDAT) for Groundwater Quality Analyses (2019)*

### **Case Study Bulletins (CSB)**

CSB1 - *Site characterisation in support of monitored natural attenuation of fuel hydrocarbons and MTBE in a chalk aquifer in Southern England (2002)*

CSB2 - *A constructed wetland to treat acid mine drainage from colliery spoils at Quaking Houses, County Durham (2002)*

CSB3 - *Portadown biological reactive barrier (2005)*

CSB4 - *Mine water treatment at Wheal Jane Tin Mine, Cornwall (2004)*

CSB5 - *Remediation trial at The Avenue using stabilisation/solidification and accelerated carbonation technology (2006)*

CSB6 - *Remediation trial at The Avenue using thermal treatment (2006)*

CSB7 - *Remediation trial at The Avenue using soil washing (2008)*

CSB8 - *Public affairs and communications on contaminated land projects (2007)*

CSB9 - *Remediation of a former landfill in Coventry: A practical application of the Definition of Waste: Development Industry Code of Practice in a cluster project (2011)*

CSB10 - *The development of risk based generic assessment criteria (GAC) for assessment of chronic human health risks from exposure to soil contaminants (2011)*

CSB11 - *Remediation of four sites in Northwest England: A successfully completed multi-site, multi-consultant cluster project (2013)*

CSB12 - *SEREBAR: A review of 11 years of operation (2018)*

### **Research Bulletins (RB)**

RB1 - *Enhanced in situ bioremediation technique for manganese removal from mine waters (2003)*

RB2 - *FIRS Ferric Iron Remediation and Stabilisation: a novel electrokinetic technique for soil remediation and engineering (2003)*

RB3 - *Project SIREN: Research Projects (2006)*

RB4 - *Project SIREN – Future Research Needs (2006)*

RB5 - *Remediation of heavy metal pollution via bone meal amendments to soil: Field and laboratory trials (2007)*

RB6 - *Results of a laboratory microcosm study to determine the potential for bioremediation of chlorinated solvent DNAPL source areas (2006)*

RB7 - *Field Portable X-ray Fluorescence (FPXRF): A rapid and low cost alternative for measuring metals and metalloids in soils (2008)*

RB8 - *Modelling approaches for assessing risks associated with petroleum hydrocarbon spills in the UK Chalk aquifer (2009)*

RB9 - *Electrokinetic Ferric Iron Remediation and Stabilisation (FIRS) of hexavalent chromium contaminated soils: An ex situ field scale demonstration (2009)*

RB10 - *Bioremediation of heavy hydrocarbons – reducing uncertainty in meeting risk-based targets: laboratory to field scale (2010)*

RB11 - *Streamtube project overview: longitudinal transect assessment of the SABRE site DNAPL source zone (2010)*

RB12 - *Modelling food-chain transfer of contaminants in soil to terrestrial ecological receptors (2010)*

RB13 - *The utility of continuous monitoring in detection and prediction of "worst case" ground-gas concentration (2011)*

RB14 - *Generic human-health assessment criteria for arsenic at former coking works sites (2011)*

RB15 - *Generic human-health assessment criteria for benzo[a]pyrene at former coking works sites (2011)*

RB16 - *Generic human-health assessment criteria for benzene at former coking works sites (2011)*

RB17 - *A pragmatic approach to ground gas risk assessment (2012)*

RB18 - *Prioritisation of abandoned non-coal mine impacts on the environment (2014)*

RB19 - *Regeneration of Brownfield Land Using Sustainable Technologies (ROBUST) (2016)*

RB20 - *Investigating the potential for biostimulation to remediate uranium-contaminated groundwater (2015)*

RB21 - *Resource Recovery and Remediation of Alkaline Wastes (R3AW) (2019)*

### **Site Bulletins (SB)**

SB1 - *MNA Bulletin (2005)*

SB2 - *SIREN (MNA) overview and description of projects (2005)*

SB3 - *Coal Mine Sites for Targeted Remediation Research:- The CoSTaR Initiative (2006)*

### **Guidance Bulletins (GB)**

GB1 - *Stabilisation/Solidification for the treatment of contaminated soil (2005)*

GB2 - *Managing Japanese Knotweed on Development Sites: Code of Practice (2008)*

GB3 - *The Definition of Waste: Development Industry Code of Practice (2011)*

GB4 - *Transport and Fate of LNAPL in the Subsurface (2015)*

## **DoWCoP Bulletins (DoWCoP)**

DoWCoP1 - *Implementing the waste hierarchy at the Thames Tideway Chambers Wharf site (2019)*

## **Treatability Bulletins (TrB)**

TrB1 - *Soil washing (2011)*

TrB2 - *Permeable reactive barriers (2011)*

TrB3 - *Chemical oxidation (2013)*

## **INSPIRATION Bulletins (IB)**

IB1 - *Use of a novel integrated passive flux sampler to monitor the spreading of solutes in groundwater (2020)*

IB2 - *Development of sensors for monitoring nitrate in groundwater (2019)*

IB3 - *The proportional contribution of nitrate sources in surface water in a mesoscale river catchment with a land-use gradient (2019)*

IB4 - *Micropollutants as tracers for anthropogenic impacts on groundwater quality and recharge sources on a local scale – the case study of Fehraltorf, Switzerland (2019)*

IB5 - *Geological consistency in self-optimising groundwater models using nested particle filters (2019)*

IB6 - *Analysing N sources and transformation processes in groundwater under agricultural areas (chalk aquifer, Belgium) (2019)*

IB7 - *Experimental quantification and kinetics of nitrate reduction potential by reduced species in soil samples obtained from sandy aquifers (2019)*

IB8 - *Bio-restoration of metal-contaminated soil using biochar to enhance the productivity of marginal land (2019)*

IB9 - *Developing biosensors to measure the bioavailability of heavy metals in soil remediation (2019)*

IB10 - *Investigating the effects of biochar and brown coal waste on productivity of maize (2019)*

IB11 - *A decision support tool to select media to mitigate nutrients in farm drainage water (2019)*

IB12 - *Indicators for the selection of filter media options for phosphorus recycling to agricultural soils (2019)*

IB13 - *Isotope techniques for the analysis of  $\delta^{18}\text{O}$  of inorganic phosphate within aquatic ecosystems (2019)*

IB14 - *Integrated use of meta-analytical data to identify management trade-offs on crop growth, soil quality and environmental quality in agriculture (2019)*

IB15 - *Identification of priority areas to target pesticide pollution mitigation measures (2019)*

## **ADVOCATE Bulletins (AB)**

AB1 - *Remediation of TCE contaminated groundwater using permeable reactive barriers (2014)*

AB2 - *Selecting reactive materials for permeable barriers to remediate groundwater contaminated with heavy metals and BTEX: batch and column experiments (2014)*

AB3 - *Enhancing bioremediation of groundwater by microbial interaction with a solid state electrode: proof-of-concept (2014)*

AB4 - *River flows and riparian vegetation dynamics (2014)*

AB5 - *Balancing the Pillars of Technology Sustainability in Soil and Groundwater Remediation*

AB6 - *Nitrogen biotransformation in horizontal subsurfaceflow constructed wetlands treating contaminated groundwater (2015)*

AB7 - *Vadose zone characterisation at industrial contaminated sites (2015)*

AB8 - *The plume fringe: a zone of increased potential for biodegradation in contaminant plumes (2015)*

AB9 - *Delineating groundwater-surface water interaction (2015)*

AB10 - *Dual C-Cl isotope analysis to distinguish processes affecting chlorinated ethenes at field scale (2015)*

AB11 - *Water quality management on a catchment scale (2016)*

## **NanoRem Bulletins (NanoRem)**

NanoRem1 - *Nanotechnology for Contaminated Land Remediation – Possibilities and Future Trends Resulting from the NanoRem Project (2016)*

NanoRem2 - *Appropriate Use of Nanoremediation in Contaminated Land Management (2017)*

NanoRem3 - *Generalised Guideline for Application of Nanoremediation (2017)*

NanoRem4 - *A Guide to Nanoparticles for the Remediation of Contaminated Sites (2016)*

NanoRem5 - *Development and Application of Analytical Methods for Monitoring Nanoparticles in Remediation (2017)*

NanoRem6 - *Forecasting Nanoparticle Transport in Support of In Situ Groundwater Remediation (2017)*

NanoRem7 - *NanoRem Pilot Site – Spolchemie I, Czech Republic: Nanoscale zero-valent iron remediation of chlorinated hydrocarbons (2017)*

NanoRem8 - *NanoRem Pilot Site – Spolchemie II, Czech Republic: Remediation of BTEX compounds using Nano-Goethite (2017)*

NanoRem9 - *NanoRem Pilot Site – Solvay, Switzerland: Nanoscale zero-valent iron remediation of chlorinated solvents (2017)*

NanoRem10 - *NanoRem Pilot Site – Balassagyarmat, Hungary: In Situ Groundwater Remediation Using Carbo-Iron<sup>®</sup> Nanoparticles (2017)*

NanoRem11 - *NanoRem Pilot Site – Neot Hovav, Israel: Transport of Iron Nanoparticles in Fractured Chalk* (2017)  
NanoRem12 - *NanoRem Pilot Site – Nitrastur, Spain: Remediation of Arsenic in Groundwater Using Nanoscale Zero-valent Iron* (2017)

### **SABRE Bulletins (SAB)**

SAB1 - *Project SABRE (Source Area BioRemediation) – an Overview* (2010)  
SAB2 - *Site investigation techniques for DNAPL source and plume zone characterisation* (2010)  
SAB3 - *Results of laboratory column studies to determine the potential for bioremediation of chlorinated solvent DNAPL source areas* (2010)  
SAB4 - *Insights and modelling tools for designing and improving chlorinated solvent bioremediation applications* (2010)  
SAB5 - *Overview of the SABRE field tests* (2010)  
SAB6 - *Source Area DNAPL Bioremediation: performance monitoring and assessment* (2012)

### **SUBR:IM Bulletins (SUB)**

SUB1 - *The role of the development industry in brownfield regeneration* (2006)  
SUB2 - *Uncovering the true impacts of remediation* (2007)  
SUB3 - *Climate change, pollutant linkage and brownfield regeneration* (2007)  
SUB4 - *Measuring sustainability: What's in a number?* (2007)  
SUB5 - *Avoiding future brownfield sites through design for deconstruction and the reuse of building components* (2007)  
SUB6 - *Communicating risk on contaminated sites: How best to engage with local residents* (2007)  
SUB7 - *Acid Tar Lagoons* (2008)  
SUB8 - *Community Engagement, Urban Regeneration, and Sustainability* (2008)  
SUB9 - *Quality in Land Remediation: Indicators and Protocols for Brownfield Land* (2008)  
SUB10 - *The Use of Compost in the Regeneration of Brownfield Land* (2008)  
SUB11 - *Integrated remediation, reclamation and greenspace creation on brownfield land* (2009)  
SUB12 - *SUBR:IM (Sustainable Urban Brownfield Regeneration: Integrated Management) - An overview* (2009)

### **UK Sustainable Remediation Forum (SuRF-UK) Resources**

SuRF-UK: *A Review of Published Sustainability Indicator Sets: How applicable are they to contaminated land remediation indicator-set development?* (2009)  
SuRF-UK: *A Framework for Assessing the Sustainability of Soil and Groundwater Remediation* (2010)  
SuRF-UK: *Annex 1 - The SuRF-UK Indicator Set for Sustainable Remediation Assessment* (2011)  
SuRF1 bulletin: *Sustainability Assessment: Shell Terminal Facility, Madeira* (2013)  
SuRF2 bulletin: *Upper Heyford - Remediation Options Appraisal* (2013)  
SuRF3 bulletin: *Helpston Contaminated Land Project* (2013)  
SuRF4 bulletin: *Phase 3 outputs* (2014)  
SuRF-UK: *Sustainable Management Practices for Management of Land Contamination* (2014)  
SuRF-UK, NICOLE: *A Review of the Legal and Regulatory Basis for Sustainable Remediation in the European Union and the United Kingdom* (2015)  
SuRF-UK: *Certification of Sustainable Remediation Assessment* (2019)  
SuRF-UK: *Terms of Reference* (2019)  
SuRF-UK: *Supplementary Report 1 (SR1) of the SuRF-UK Framework: A General Approach to Sustainability Assessment for Use in Achieving Sustainable Remediation* (2020)  
SuRF-UK: *Supplementary Report (SR2) of the SuRF-UK Framework: Selection of Indicators/Criteria for Use in Sustainability Assessment for Achieving Sustainable Remediation* (2020)  
*Sustainable Management Practices for Management of Land Contamination* (2021)  
SuRF-UK *Tier 1 Sustainability Assessment tool version 2* (2021)

### **Other Publications**

*UK Trade & Investment/EISU & CL:AIRE Trade Guide* (2006)  
*CIEH & CL:AIRE Guidance on Comparing Soil Contamination Data with a Critical Concentration* (2008)  
*The Definition of Waste: Development Industry Code of Practice* (2008)  
*AGS, EIC & CL:AIRE Soil Generic Assessment Criteria for Human Health Risk Assessment* (2010)  
*Defra's "Contaminated Land Remediation Report"* (2011)  
*The Definition of Waste: Development Industry Code of Practice* (2011)  
*Defra's "A Risk/Benefit Approach to the Application of Iron Nanoparticles for the Remediation of Contaminated Sites in the Environment"* (2012)  
*Cluster Guide* (2012)  
*Gasworks Profiles* (2014)  
*An Illustrated Handbook of LNAPL Transport and Fate in the Subsurface* (2014)  
*Defra's "An Examination of Contaminated Land Sector Activity in England and Wales"* (2015)



*Soil and Groundwater Remediation Technologies for Former Gasworks and Gasholder Sites (2015)*  
*Control of Asbestos Regulations 2012 - Interpretation for Managing and Working with Asbestos in Soil and Construction and Demolition Materials: Industry guidance (2016)*  
*Petroleum Hydrocarbons in Groundwater: Guidance on assessing petroleum hydrocarbons using existing hydrogeological risk assessment methodologies (2017)*  
*CL:AIRE 20<sup>th</sup> Anniversary Conference Special Publication (2020)*  
*Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration (2020)*  
*Category 4 Screening Levels: Vinyl Chloride (2021)*  
*Category 4 Screening Levels: Tetrachloroethene (PCE) (2021)*  
*Category 4 Screening Levels: Trichloroethene (TCE) (2021)*  
*Good practice for risk assessment for coal mine gas emissions (2021)*

## **Online Training**

### **Podcasts & Webinars**

*The SuRF-UK framework for sustainable remediation (2011)*  
*Continuous monitoring of ground-gas (2011)*  
*CL:AIRE DNAPL site characterisation webinar (2011)*  
*CL:AIRE DNAPL site remediation webinar (2011)*  
*Using quality compost webinar: Soil manufacture and improvement in brownfield regeneration (WRAP, 2011)*  
*Using quality compost webinar: Achieving successful biomass production on brownfield land (WRAP, 2011)*  
*CL:AIRE LNAPL Illustrated Handbook videos (2016)*  
*Screening Vapour Intrusion Risks at Petroleum Underground Storage Tank Sites webinar (2017)*  
*Verification of Gas Protection Measures webinar (2019)*  
*SuRF-UK Animation – Sustainable Remediation Explained (2019)*  
*CL:AIRE 20<sup>th</sup> Anniversary Conference Presentation videos (2019)*  
*Introduction to the Definition of Waste: Development Industry Code of Practice (2020)*  
*Gas Protection Verification Accreditation Scheme (2021)*  
*Category 4 Screening Levels Phase 2 (2021)*  
*Good Practice for Risk Assessment for Coal Mine Gas Emissions (2021)*

### **eLearning Modules**

*Remediation Technologies and Options Appraisal (2012)*  
*Asbestos in Soil Awareness (2018)*  
*Introduction to Brownfield Site Investigation (2021)*  
*Introduction to Soil and Groundwater Risk Assessment (2021)*  
*Sustainable Remediation Appraisal (2021)*

**All of the Publications and Online Training are available from the CL:AIRE website.**