TECHNOLOGY AND RESEARCH GROUP

EIGHTEENTH ANNUAL REPORT
2020

Introduction by the TRG Chairman

2020 was a unique year and putting the pandemic to one side I'll just focus on the activities of CL:AIRE's Technology and Research Group (TRG).

CL:AIRE ended 2020 in a strong position and once again the TRG was kept busy by reviewing all of its 2020 outputs (bulletins, reports, training courses, eLearning modules) and answering a number of technical queries. Since the TRG provides independent strategic peer review and technical steering functions in support of CL:AIRE's activities, a high workload indicates the continued success of CL:AIRE. Further, the TRG is fundamental to maintaining and enhancing CL:AIRE's reputation and supporting the development of the organisation.

There have been some changes to the TRG this year: We've said farewell to Mike Summersgill and Jonathan Smith who retired from the TRG after 16 and 12 years' service respectively. Thanks to both Mike and Jonathan for their contribution to CL:AIRE's purpose. We've also welcomed four new members to the TRG - Brian McVeigh joined from NIEA as a short-term replacement for Theresa Kearney and Ruth Chippendale - Shell, Liz Gray - Atkins and Karen Young - Jacobs all joined to strengthen the group.

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 and supporting future developments. 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 our activities during 2020.

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
March 2021

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 on innovation in remediation, increasing confidence across the entire industry and driving forward the effective regeneration of brownfield land. This is recognised both in the UK and worldwide with CL:AIRE's profile continuing to grow.

CL:AIRE has had another very full and successful year with a wide range of activities, described in Appendix 1.

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 working groups. The TRG plays a key role in CL:AIRE's work, supporting CL:AIRE on issues associated with technology development, providing guidance on issues relating to sustainable land reuse and offering strategic review and steering functions for all CL:AIRE's activities.

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.

THE TRG PROCESSES

The TRG ensures the real added value to CL:AIRE. This is due in large part to the TRG processes – which ensure consistency with UK policy and legislation, an appropriate scientific and technical quality of work, and transparency; and the TRG members – who are high calibre renowned experts in their field. The TRG processes work through a number of communication routes including meetings and email exchanges.

TRG MEMBERS IN 2020

Chairman: Seamus Lefroy-Brooks – LBH GEO
Theresa Kearney (until July 2020) & Brian McVeigh (from July 2020) – Northern Ireland Environment Agency
Kim Baines – International Atomic Energy Agency
Bob Barnes – Environment Agency
Brian Bone – Bone Environmental Consultant
Simon Burr – CampbellReith
Ruth Chippendale – Shell (from November 2020)
Max Coleman – Caltech
Steve Edgar – Vertase FLI
Liz Gray – Atkins (from December 2020)
Mark Hodson – University of York
Richard Moss – Nouryon
Mike Rivett – GroundH2O plus Ltd
Jonathan Smith – Shell Global Solutions (until November 2020)
Mike Summersgill – SEnSe Associates (until September 2020)
Steven Thornton – University of Sheffield
Gary Wealthall – Geosyntec Consultants Ltd
Karen Young – Jacobs (from December 2020)

Early Career Professional TRG Members

Roseanna Bloxham – RSK
Abigail Brooks – Vertase FLI
Sarah Hey – Hydrock
Amy Juden – Arup

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

THE 2020 ANNUAL REPORT

1. TRG ACTIVITIES

1.1 TRG Meetings

During 2020, three full TRG meetings were held by teleconference. An additional two TRG subgroup meetings were held which focused on the Definition of Waste: Development Industry Code of Practice initiative and included invited guests from the Environment Agency and Natural Resources Wales.

1.2 Project Applications Reviewed

The TRG reviewed one research project application in 2020. Project #181 – *Legacy wastes in the coastal zone: Environmental risks and management futures* was submitted by Dr Adam Jarvis, Newcastle University. It was approved as CL:AIRE Research Project #27. A brief project summary is given in Appendix 1.

The current status of CL:AIRE Technology Demonstration Projects (TDP) and Research Projects (RP) is provided in Appendix 3.

1.3 CL:AIRE Resources Reviewed

1.3.1 Bulletins

TRG members completed the review of the final bulletin from the INSPIRATION training network on sustainable agriculture, which was published in July 2020.

Bulletin No.	Bulletin Title/Topic
INSPIRATION Bulletin IB1	Use of a novel integrated passive flux sampler to monitor the spreading of solutes in groundwater

1.3.2 Reports

TRG members reviewed four industry reports in 2020. One was "Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration" which was published in September 2020. The three other reports were outputs from Phase 2 of the Category 4 Screening Level (C4SL) project (see Appendix 1 for more details). These reports address specific contaminants – tetrachloroethene, trichloroethene and vinyl chloride and will be published in 2021.

Two SuRF-UK reports that were reviewed at the end of 2019 were published in 2020: Supplementary Report 1 (SR1) of the SuRF-UK Framework: A General Approach to Sustainability Assessment for Use in Achieving Sustainable Remediation; and Supplementary Report (SR2) of the SuRF-UK Framework: Selection of Indicators/Criteria for Use in Sustainability Assessment for Achieving Sustainable Remediation.

1.3.3 Online training

TRG members completed the review of two updated eLearning packages in 2020 which are scheduled for release in 2021 (shown in italics below):

Training type	Title/Topic
eLearning	*Introduction to Soil and Groundwater Risk Assessment*
eLearning	*Sustainable Remediation Appraisal*

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

- Reviewed potential amendments to the Definition of Waste: Development Industry Code of Practice
- Assessed the regulatory practice around the redevelopment of landfills
- Reviewed the proposed verification of gas protection accreditation scheme
- Discussed ways and means of improving industry standards
- Reviewed new training module content

2. A LOOK AHEAD TO 2021

Building on the achievements of 2020, a new wave of CL:AIRE outputs is predicted for the forthcoming year. The TRG will be reviewing a number of new bulletins, 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 within its sustainable land reuse remit.

3. HOW TO GET INVOLVED

CL:AIRE encourages participation and engagement in many different activities under the sustainable land management theme. Whether it is undertaking or supporting research, developing and managing industry initiatives, creating and distributing publications, developing and hosting training, eLearning, webinars and events, then CL:AIRE is interested in talking to you.

The first step is to get in contact with one of the CL:AIRE team via the Help Desk https://www.claire.co.uk/help-desk:

Appendix 1

CL:AIRE's Activities 2020

1. Industry Initiatives

The National Brownfield Forum & National Quality Mark Scheme
The National Brownfield Forum was set up in July 2011, originally established by DCLG (now MHCLG) and 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.

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 (www.claire.co.uk/nqms). CL:AIRE acts as the administrator for the scheme.

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. 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.

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 HSE, EA (waste, permitting and contaminated land), Department for Transport (DfT), Defra (REACH and contaminated land) and MHCLG.

The dedicated website for this project is: www.claire.co.uk/asbestos

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.

All SuRF-UK publications can be found on its dedicated web page www.claire.co.uk/surfuk

In 2020, CL:AIRE published two new SuRF-UK reports:

- Supplementary Report 1 of the SuRF-UK Framework: A General Approach to Sustainability Assessment for Use in Achieving Sustainable Remediation
- Supplementary Report 2 of the SuRF-UK Framework: Selection of Indicators/Criteria for Use in Sustainability Assessment for Achieving Sustainable Remediation

CL:AIRE also continues to perform the secretariat function for the International SuRF group meetings. The chairs of the international Sustainable Remediation Forums (SURF) 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).

Gas Protection Verification Accreditation Scheme
CL:AIRE, with the support of an industry working group, has developed a gas protection verification accreditation scheme. 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. The scheme will be launched in early 2021.

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, AGS, BRE, CIRIA, NHBC, CL:AIRE and others.

In 2020, WALL continued to grow in terms of usage and number of references listed.

CL:AIRE invites industry professionals to visit WALL by going to www.claire.co.uk/wall and filling in a feedback form to identify further documents that they feel should be added to WALL.

Category 4 Screening Level Project
SAGTA is leading a collaborative industry initiative to develop 20 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 were reviewed by the TRG in 2020, ready for publication in 2021.

The dedicated project website is: 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.

The new guidance was written by statistician Nigel Marriott, supported by a steering group comprising representatives from Environment Agency, Nuclear Decommissioning Authority (NDA), RSK, Soil and Groundwater Technology Association (SAGTA), Society of Brownfield Risk Assessment (SoBRA), and Yorkshire and Lincolnshire Pollution Advisory Group (YALPAG).

The guidance updates a 2008 document of a similar name that was published by CL:AIRE and the Chartered Institute of Environmental Health, supported by SAGTA. As the new guidance adopts an entirely different approach to the previous guidance, it completely supersedes it and the 2008 document has now been withdrawn.

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 2021.

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 team includes researchers from 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.

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

ICEC - MCM
CL:AIRE supported a successful proposal submitted to UK Research and Innovation (UKRI) called The Interdisciplinary Circular Economy Centre for Mineral-based Construction Materials, led by University College London. Starting in early 2021, the project aims to develop systems and technologies for more efficient use and recovery of mineral resources.

3. European Projects

INSPIRATION
The EU-funded Marie Skłodowska-Curie innovative training network on the theme of sustainable agriculture finished in 2020 (www.inspirationitn.eu) with the publication of the final INSPIRATION bulletin (available at https://www.claire.co.uk/information-centre/cl-aire-publications). The network was led by the Groundwater Protection and Restoration Group at the University of Sheffield, in collaboration with partners from 8 European countries.

Enhanced and Innovative In Situ Biotechnologies for Contaminated Land Remediation (EiCLaR)
In 2020, CL:AIRE was part of a successful consortium bid for funding for project EiCLaR. The four-year project will start in early 2021 and is a EU/China consortium composed of 13 EU and 5 Chinese partners. The project, led by the University of Lyon, will develop scientific and technical innovations for in situ bioremediation technologies. CL:AIRE is involved in delivering the knowledge transfer activities.

ReCon Soil
In 2020, CL:AIRE was part of a successful bid for funding from the European Development Fund. Starting in early 2021, the ReCon Soil project will study the potential reuse of surplus materials from the construction industry. It is a cross-Channel research project and will run until June 2023.

The partner organisations involved in the project are University of Plymouth, Eden Project Learning and University of East Anglia from the UK and in France, Bureau de Recherches Géologiques et Minières, Normandie (BRGM), Comité d'Action Technique et Economique, Bretagne (CATÉ) and Université Le Havre Normandie.

4. Training

CL:AIRE continued to provide a mixture of classroom-based (Gas Protection Verification) and online training (Definition of Waste: Development Industry Code of Practice; Statistics for Land Contamination), the latter for the majority of 2020.

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 2021.

5. Events

Although most events were postponed or moved to a virtual setting in 2020 CL:AIRE did hold one informal Members' Social Event in March 2020 in Bristol.

6. Membership Development

CL:AIRE’s membership was stable at over 120 organisations in 2020, listed on the CL:AIRE website.

Appendix 2

TRG MEMBER BIOGRAPHIES (AT END OF 2020)

Seamus Lefroy-Brooks (Chair), LBH WEMBLEY
Through his firm, LBH WEMBLEY, Seamus 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. He 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 in the geotechnical & geoenvironmental sector for over 35 years with the same firm since graduation.

Seamus is a registered SiLC, a Qualified Person under the DoW CoP scheme and was one of the twelve experts appointed to the government's National Expert Panel for contaminated land. Seamus is the chairman of the National Brownfield Forum's Professional Standards Committee leading the initiative to deliver a National Quality Mark Scheme for land contamination reports.

Seamus has been significantly involved in the recent initiatives in relation to asbestos in soils. He is a member of the Joint Industry Working Group (JIWG) on Asbestos in Soils and served on the Working Group (WG2) of the Health & Safety Executive (HSE) Committee for Fibre Measurement (CFM), tasked with formulating revised HSE guidance.

Dr Kim Baines, International Atomic Energy Agency
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 position with the IAEA, Kim worked for 16 years in the nuclear and redevelopment industries on the remediation of contaminated land. Prior to her current position, Kim worked for the Nuclear Decommissioning Authority 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.

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 over 25 years. For eight 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 fourteen 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.

Professor Brian Bone, Bone Environmental Consultant
Brian is a geologist with 19 years public service experience as regulator and scientist with Warwickshire County Council and the Environment Agency for England and Wales. He developed his expertise, led two teams in operation and research, and carried out research dealing with a wide range of technical issues including landfill gas management, contaminated land assessment and remediation, and special (hazardous) waste. Brian's current work as an independent consultant includes the sustainable remediation of contaminated soil and groundwater, the recovery of waste for

construction and emissions from construction products. He is Secretary to CEN/TC154/WG 13 (Aggregates - Dangerous Substances), Technical expert on CEN/TC351/WG1 (Release of dangerous substances to soil, groundwater and surface water), Technical expert on UK Mirror Committee to CEN/TC351 (Construction products – assessment of release of dangerous substances) and, until 2018, a member of Sustainable Remediation Forum UK (SuRF-UK) Steering Group. Brian is Visiting Professor at the Centre for Research in the Built and Natural Environment at Coventry University.

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 he 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, he 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 100 publications mainly in stable isotope chemistry and its applications to geochemistry, hydrochemistry and microbial processes.

Steve Edgar, Vertase FLI
A Director of Vertase FLI, Steve guides the remediation 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. 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. She 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. He currently acts as a panel Chair for the Natural Environment Research Council standard grant scheme and is deputy chair of the Earth Systems and Environmental Sciences subpanel for REF2021.

Richard Moss, Nouryon
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.

Over the past 29 years Richard has 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.

Dr Michael Rivett, GroundH_2O 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_2O 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. He 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. He 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. His 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. He 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 schemes including Wylfa Newydd, Heathrow Expansion and HS2.

Karen has experience of applying the DoWCoP to major infrastructure schemes and has worked 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 END OF 2020)

Roseanna Bloxham, RSK
Roseanna is a senior geoenvironmental engineer at RSK with over six years' industry experience with particular knowledge of designing and managing intrusive site investigations, contaminated land risk assessments and development of preliminary shallow and deep foundation recommendations. Roseanna trains our new graduates in the fundamentals of site work and data collection by mentoring them in the field and leading training presentations. She is currently responsible for managing projects, supervising and reporting on all aspects of geoenvironmental investigations.

Roseanna has worked on numerous petroleum retail sites as part of a large, UK-wide site investigation contract. Her responsibilities have included developing work plans and costing scopes; coordinating and delivering investigations in accordance with Shell's requirements; supervising site works, including utility clearance surveys; overseeing various drilling operations using shell-and-auger, window-sampling and rotary drilling methods; supervising soil verification following the removal of petroleum dispensary infrastructure; and sampling groundwater and vapour.

Abigail Brooks, Vertase FLI
Abigail is a Project Environmental Engineer whose current focus is Landfill Remediation. She has worked in the Contaminated Land industry since 2015, initially as an Environmental Consultant dealing with oil spills across the UK, before progressing to Environmental Engineering at VertaseFLI. Abi's work entails handling onsite geotechnical and geo-environmental aspects of projects and ensuring compliance with bespoke permits. She has a leading role in the technical management of complex and challenging remediation schemes. Abi is also an Early Careers Committee member of the Geological Society's Contaminated Land Group.

Sarah Hey, Hydrock
Sarah is a Senior Geo-environmental Consultant at Hydrock Consultants Ltd, she obtained a Masters in Geology at the University of Leicester before becoming a consultant for the construction industry. She has over 5 years' experience undertaking ground investigations and producing factual and interpretative reports, including Remediation Method Statements. She spent the early stages of her career in the Midlands working on a variety of contaminated land projects before moving up to the North West in Manchester. Sarah is a Chartered Geologist.

Amy Juden, Arup
Amy is a Senior Consultant at Arup and a Chartered Geologist and Contaminated Land Consultant with seven years' experience in the brownfield redevelopment industry.

Amy has specialist skills in site conceptualisation, geoenvironmental ground investigation, and contaminated land risk assessments, including for ground gases and asbestos. Amy's ground contamination experience includes providing investigations and assessments for redevelopment of brownfield land with a variety of previous site uses, including: landfills, land raise, petroleum depots, former quarry, manufacturing works, rail land and a power station. The first two years of her career were at a small geoenvironmental consultancy in the southeast where, as a graduate geologist and project engineer she gained valuable practical experience in managing ground investigation site work and supervising remediation, including under part 2A. During six years at Arup in London Amy developed her technical and project management skills and applied these to larger scale mixed-use development projects, eventually co-ordinating multidisciplinary Arup teams in delivering engineering consultancy services for high-profile developments.

Amy was awarded the Best Young Brownfield Professional at the September 2019 Brownfield Briefing Awards. Amy is also Treasurer of the Geological Society Contaminated Land Group and an active member of the SoBRA working group for asbestos in soils, currently developing asbestos in soils human health risk assessment industry guidance.

Appendix 3

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 *Ex Situ* Soil Vapour Extraction – RemedX and ABB	Completed + Report Available
TDP 17:	*In Situ* 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 *in situ* 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)/Zenenzo (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:	*Ex Situ* 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 *In Situ* Multi-Contaminant Groundwater Remediation - WorleyParsons Komex, National Grid Property, Environment Agency, Bradford City Council and Imperial College	Completed + Bulletin Available
TDP 26:	*In Situ* Soil and Groundwater Decontamination using Electric Resistive Heating Technology (Six-Phase Heating®) - Terra Vac (UK) Ltd; Taylor Wimpey Ltd	Completed + Bulletin Available
TDP 28:	*In Situ* 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:	*In Situ* 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 *In Situ* Aquifer Assessment Tool with Risk Management Calculator for Natural Attenuation - Professor Steve Banwart, University of Sheffield	Completed
RP 13:	*In situ* 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

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:	Contaminal – the use of Supercritical Carbon Dioxide (SC-CO_2) for the In Situ Sampling and Analysis 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 Bambra, 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)

Appendix 4

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 δ18O 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® 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) Publications

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)*

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 20th Anniversary Conference Special Publication (2020)
Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration (2020)

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 20th Anniversary Conference Presentation videos (2019)
Introduction to the Definition of Waste: Development Industry Code of Practice (2020)

eLearning Modules

Remediation Technologies and Options Appraisal (2012)
Introduction to Soil and Groundwater Risk Assessment (2013)
Sustainable Remediation Appraisal (2013)
Asbestos in Soil Awareness (2018)
Introduction to Brownfield Site Investigation (2018)

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