environmentanalyst

Brownfield Briefing Awards Winners Guide

Winter 2019

Beautiful Brownfield Photographic Competition 2019

Remediation of a sludge lagoon, photograph courtesy of Celtic

environmentanalyst

BROWNFIELD DEVELOPMENT FESTIVAL 2020

Summit & Brownfield Awards

8 October, London

This new event will begin with a three-stream summit, followed by our Brownfield Awards (formerly the Brownfield Briefing Awards). The multi-topic nature of the summit and its co-location with the awards make this the perfect event for the whole team.

De Vere Grand Connaught Rooms,
61-65 Great Queen St,
Holborn, London, WC2B 5BZ

Day: Summit

During the day, delegates will have the opportunity to select and move between each of the summit topic streams - Planning & Regeneration, Remediation and Waste Management - choosing the focus of most relevance to them.

Evening: Brownfield Awards

The Festival will finish with our annual Brownfield Awards, now in their 16th year. The Awards Gala Dinner will once again give the industry an opportunity to come together and showcase their expertise in front of hundreds of clients and peers. To be notified when entries open make sure to check our website.

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2019 WINNERS

From the editor

Gasworks figure large in this year's *Brownfield Briefing* Awards featuring in five winning entries and two which were highly commended. But the awards were for different reasons.

With the Walton on Thames Part 2A investigation (p4) it was the thoroughness of the risk assessment and exemplary community involvement, including a plain English summary for residents which stood out. For **National Grid's** general gasworks entry (p11), it was the diversity of community engagements which was a winning feature, ranging from photo competitions, murals, capturing stories and memorial events. For **Wood E&IS** and **NG's** risk assessment of a small and hard to access northern gasworks site (p 20), it was innovative use of Cost Benefit Analysis including social value and environmental sustainability which was highlighted. At the Fulham gasworks (p37) it was the multidisciplinary working in a highly complex site involving relocation of services which impressed the judges. The teamwork saved 4200m^3 of waste going to landfill and reduced financial and time impacts. For the Project of the Year at Meridian Water (p 43) remediation innovation played its part, with only the second use of the NET system for NAPL remediation in the UK along with an innovative bioremediation solution. Community benefits were also important in this project ranging from new parks and housing to low carbon heat and construction apprenticeships for local people.

An international award was introduced this year and **Arcadis** and **EVOCRA's** successful treatment of PFAS, an emerging contaminant of worldwide concern (p26) is timely. It contained some world firsts including using a TOP assay for validation and compliance assessment. The highly commended Onogonda Lake clean-up (p31) brought a rare dredging entry to the awards including innovative site-specific biodegradation and capping design.

The increasing sophistication of instruments providing ever more accurate data for decisions moves on apace. **WSP** used advanced MIP investigations at **AstraZeneca's** constrained site in Macclesfield (p14) which saved 4000m^3 of soil being excavated. And the highly commended remediation of explosive burial pits from **AECOM** and **Ramora** (p7) saw electromagnetic induction, magnetometry and electrical resistance tomography to remediate 13.8t of explosives. **McAuliffe** (p25) used a digitally generated grid with highly efficient GPS enabled excavators at Hooton (p25).

The integration of remediation-based regeneration projects with local communities becomes ever tighter, witnessed at the **Goodyear** development (p26).

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WINNER

Also Highly Commended In Best Public Sector/Not for Profit Led Project (see page 32)

Former Walton on Thames Gasworks - Part 2A investigation

ORGANISATIONS

BuroHappold Engineering and Elmbridge Borough Council

The success of this Part 2A investigation by **BuroHappold** and **Elmbridge Borough Council (EBC)** demonstrates the value of a programme of work that was planned and conducted in accordance with best practice.

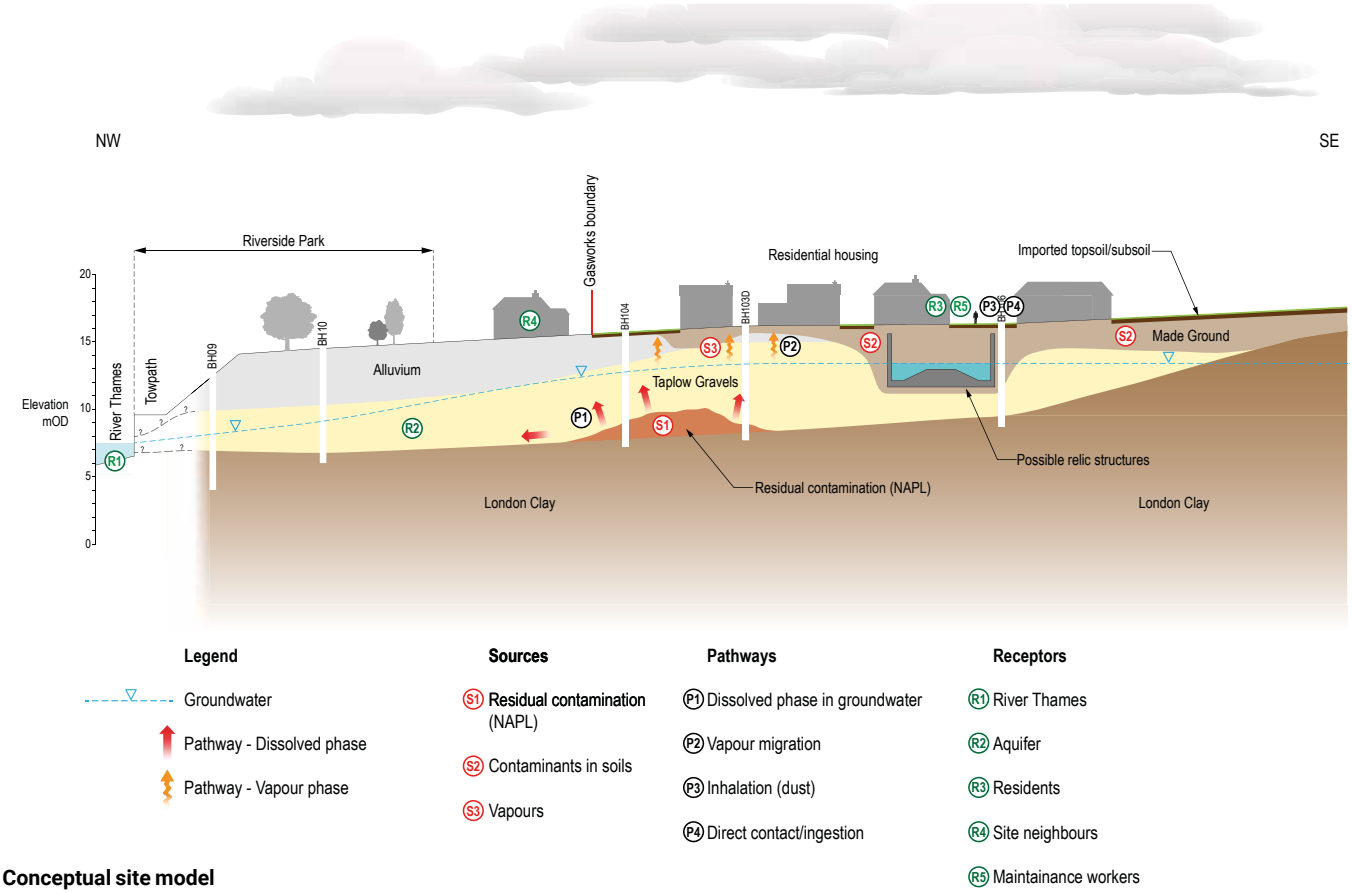
During the desk study, investigation design, resident engagement, exploratory works, risk assessment, remediation, and reporting phases, the plans: were framed by best practice guidance and procedures; focused on the conceptual site model as it became progressively more defined; were rigorously implemented, providing reliable data for risk assessments; and recognised and reflected uncertainties by incorporating flexibility and responsiveness to emerging data.

Background

Land occupied by Walton on Thames Gasworks from the 1860s was redeveloped and is now occupied by private and community housing, a day centre and disused children's day nursery. This 1980s redevelopment was informed by investigation and remedial action (removal of near surface contamination and infrastructure and importing capping/soils). The investigation was limited and there was little reliable evidence of remediation undertaken, construction materials or current land condition.

Under their Part 2A responsibilities, EBC carried out a comprehensive desk study of this priority site. Their report identified several potentially significant contaminant linkages and uncertainties about ground conditions, residual contamination and redevelopment. EBC, with no external grants or funding invited tenders for site investigation to assess these linkages. BuroHappold's proposal was successful, reflecting its: focus on the conceptual site model; recognition of the critical importance of interaction with the public; and value for money.

The investigation, designed to interrogate contaminant linkages and uncertainties, took place over Autumn 2017/Spring 2018. Contamination of soils, groundwater and gas/vapour were identified. Robust risk assessments demonstrated that, though most contaminant linkages presented a low risk, some risks were greater than low.



Conceptual site model

However, detailed assessment and consideration of factors in accordance with the Statutory Guidance led BuroHappold to conclude that: a significant possibility of significant harm (SPOSH) did not exist; the site should not be determined as contaminated land; and no retrospective remediation was required to ensure safe occupation or its current use.

The report was scrutinised and agreed by the local authority, the **Environment Agency**, and **Public Health England**. The report presented to residents described how no remedial action was required for them to continue the safe enjoyment of their homes and neighbourhood. The project was completed on time and to budget.

Although not meeting SPOSH, in one garden gasworks wastes were encountered at a shallow depth, presenting particularly difficult circumstances for one family. Voluntary remedial action was planned, arranged and overseen by BuroHappold to resolve these risks at no cost to the family or local authority.

Exemplary best practice

Best practice was exemplified by the sustained focus on the conceptual site model and a phased and reactive approach during the desk study and intrusive elements of the investigation. The initial desk study carried out by EBC was thorough and comprehensive, resulting in the identification of potentially significant contaminant linkages requiring further definition. The site investigation targeted the potentially significant contaminant linkages but also incorporated sufficient flexibility to react to observations on site and to emerging data from supplementary sampling and chemical analyses. For example, initial interpretation and modelling of soil and groundwater data indicated gasworks residues at depth could present a vapour risk to people in that locality.

Groundwater was re-sampled and tested for relevant determinands and a specialist contractor (**Enitial**) employed to sample vapours from the existing wells via SiloCan canisters with testing by **Jones Environmental**. A vapour DQRA assessed the potential risks to residents in this area. Because of the critical nature of this aspect, an independent specialist (Firth Consulting) carried out a peer review of the modelling and assessment. The results of that review proved helpful to the confidence of all parties. Uncertainties regarding water supply pipework identified in the initial desk study were resolved by; appropriate chemical analyses of soils at relevant horizons, detailed interrogation of Building Regulations Department records (EBC) and finally excavation and examination by **Affinity Water**.

JUDGES' QUOTE:

The judges said: "A very well-presented submission detailing a robust Part 2A investigation and assessment on a very sensitive residential site. Good reference to standards and guidance with exemplary community involvement, including a plain-English summary for residents."

Cost effectiveness

The initial BuroHappold proposals were not the lowest cost solution proposed to EBC, but at tender stage were judged to provide the Council with best value for money. This cost effectiveness was facilitated by the focus on the conceptual site model.

A relatively limited number of boreholes, appropriately located, provided adequate definition of the geology, groundwater and soil vapour regimes. The necessary definition of shallow soils was obtained by low impact hand-dug pits to 600mm with multiple samples at each location, targeted analysis to define soil chemistry by area and depth, reflecting the conceptual site model.

Nested soil vapour wells were installed alongside groundwater wells to minimise installation cost and potential future disruption for soil vapour assessment. Chemical analysis of soils, groundwater and vapours was phased, with uncertainties from initial data clarified by specific tests on particular samples to fill gaps and ensure adequacy of data for risk assessment, and off-site wells installed by the EA in 1999 identified in the desk study were located and accessed by BuroHappold but were blocked. They were refurbished and, following recovery, groundwater samples were taken and tested avoiding additional off-site intrusive work, saving time and money.

Compliance

Because this was a Part 2A investigation and assessment, a thorough understanding of and compliance with the statutory guidance, relevant British Standards, and other good practice guidance was imperative, and was planned and adopted throughout. The fact that the eventual decisions taken by the local authority would have legal force, had to meet legal tests and would have

Shallow hand dug pits

major consequences for all stakeholders (especially residents) meant it was imperative that the work informed those decisions.

Thus, in planning, design and implementation, the investigation was framed by understanding that the conceptual site model and subsequent risk assessments would inform those decisions on the category of land. Similarly, to provide confidence in the data obtained to the relevant parties all of the fieldwork and data assessment had demonstrably accord with the relevant standards.

Engagement

As a Part 2A investigation, engagement with the public was of paramount importance. If this engagement failed, then no matter how well the investigation was executed and how diligently the risks assessed, the residents would not trust decisions made or the people who made them.

At the project initiation meeting all staff involved were briefed on the project, especially on the importance of public interaction. A briefing note along comparable lines was then prepared and presented to the site investigation contractor's (**GEL**) personnel. In partnership with the local authority, the team attended public drop in meetings before and after completing the work. Throughout the team were in close contact with residents, responding to requests, organising access etc. all of which went well – a large element of which being due to the conduct and "human" behaviour of site staff.

Progress reports were produced daily that were uploaded by EBC onto a dedicated web page. Direct enquiries from the public were responded to, particularly early on, where considerable concerns were expressed. By dealing with such enquiries in an appropriate and sympathetic manner, the team built trust with residents, which proved invaluable in obtaining access for intrusive works, and gaining acceptance of results and conclusions.

This acceptance was facilitated by a Summary Report, published for and delivered to all residents. The report comprised 10 pages with a single Executive Summary page. The data and how it had been obtained were described in the context of Part 2A. The text was written in straightforward jargon-free English, and was illustrated by photographs, drawings, and graphics, all designed to boost understanding and trust.

Environmental, economic, and social benefits

This project began with the local authority fulfilling its duties under Part 2A and identifying a site where there was a potential for significant harm to people and the environment as a result of historic contamination and insufficient evidence of remediation at redevelopment. Notwithstanding the authoritative nature of the desk study report, its publication inevitably gave rise to substantial negative reactions by residents.

For the majority of residents, one of the main benefits of the project conclusions was the removal of uncertainty and the confirmatory statement from EBC that there was to be no Determination of Contaminated Land. Plans for sale, purchase, or building extensions had all been put on hold by the initial notification and of course, there were significant long-term financial implications around value and equity. The successful conclusion of the work returned the value of these assets, removed the uncertainty and associated levels of stress that affecting the health and wellbeing of some residents.

In one garden, localised gasworks waste (tars) was discovered at shallow depth. The family were extremely concerned about risks to their health, but also about the potential financial impacts involved in any clean-up and the effect on property value and potential for sale. Determination under Part 2A was judged disproportionate but action by the homeowner could have put individuals at risk, incurred considerable cost, and potentially caused the inappropriate or illegal disposal of hazardous waste.

BuroHappold approached **Keltbray** and agreed that appropriate remedial action could be undertaken voluntarily. EBC was kept fully informed of this initiative, but this remediation did not form part of the contract. Further investigation confirmed the nature and extent of the source (possibly dumped and hidden by the builder) and the planned remediation was carried out by Keltbray and BuroHappold (at no cost to residents) in accordance with a Method Statement and compliant with all relevant regulations. A Verification Report was prepared, submitted to and accepted by EBC. In addition to the obvious financial benefits, the social, health, and environmental benefits of this action were substantial, not only to the individuals directly concerned, but also to the wider community.

A robust, sustainable, and defensible solution

The solutions to the issues arising on this site were provided by an appropriately planned, designed, rigorously implemented and phased programme of investigation and risk assessment. The data were reliable due to adherence to good standard practice. The risk assessments were undertaken in accordance with current best practice guidance. The critical vapour assessment was validated by specialist third party review. The final report, describing the investigation and risk assessments was subject to scrutiny and review by the local authority, Public Health England and the Environment Agency. This all resulted in conclusions that were robust and defensible and entirely consistent with the requirements of the Statutory Guidance.

HIGHLY COMMENDED

Characterisation and Remediation of Legacy Explosive Burial Pits

ORGANISATIONS

AECOM & RAMORA UK

In 2017-2018, a massive quantity of buried explosive waste (more than 13 tonnes) required remediation to facilitate the beneficial reuse of a former explosives factory in England. Most of the "conventional" sites the applicants focus on involve managing a "one-in-a-million" additional death or cancer risk, but explosives and fireworks burial sites pose substantially greater risks. The immediate and catastrophic risk of death is real and ever present. Attentiveness to worker and wider community health and safety protocols at these sites is especially heightened. Mistakes cannot be tolerated.

The site started operations in the 1940s. Initial production focused on fireworks for displays and home use, but by the mid-1950s production concentrated on unique defence needs. Products included mini-flares, five-inch reconnaissance flares, smoke grenades, large marine smoke markers, hand held rockets, shipborne rocket defence systems, and other pyrotechnic components.

Exposure of the concrete cap on a burial pit

As late as the 1980s, burial pits were being created to dispose of explosive waste material and stores generated on-site, with very few written records of pit content and location. The lack of records and the site's expansion over time, led to site development over these pits. At the end of 2015, the site ceased explosives production and subsequently underwent demolition and decommissioning to prepare the site for sale and redevelopment for commercial/industrial purposes.

AECOM had been providing environmental support for the site owner since the site was purchased in the mid-2000s. This support was primarily related to the management of legacy issues arising from the historical use of hydrocarbons and chlorinated solvents. In 2017, the company was requested to provide further assistance with the decommissioning of the site. This assistance related to geophysical surveys to understand the location and dimensions of potential buried pits, support with the decommissioning plan and the execution of a technical advisor role using explosives expertise from AECOM's Australian operations.

Using the information generated from AECOM's geophysical surveys - which included the use of electromagnetic Induction, magnetometry, ground penetrating radar, and electrical resistivity tomography - Ramora carried out the excavation and successful remediation of the legacy explosive burial pits.

Remediation was a key requirement for the site's sale, which was due to be completed by the summer of 2018. The project represented a true international collaboration between the client, specialist consultants and the specialist remediation team to locate the explosives and remediate them in a safe and efficient manner.

In all, the team located and remediated 13.8 tonnes net explosive quantity of legacy buried explosives that posed a potential risk to site and adjacent land users. The works were completed safely and to the satisfaction of both the regulators and the site purchaser.

The complexity of the geophysical survey given site constraints that led to the identification of all nine burial pits is attributed to the range of techniques applied, the experience of the AECOM team and the development of an excellent working relationship with Ramora to facilitate ground-truthing of the geophysical responses observed.

In turn, the expertise and experience provided by Ramora allowed the safe and successful remediation of the legacy explosive burial pits, which involved the excavation of any explosive material and destruction of it through incineration in a purpose-built series of burn areas on-site. In the areas of higher risk, the mitigation works involved using more than 100 forty-foot empty shipping containers, stacked two high and buttressed with soil-filled containers to mitigate an explosive event.

The planning, investigation and on-site remediation techniques employed provided a robust sustainable solution and facilitated the successful sale of the site to allow future site development.

WINNER

Rapid identification of coal tar in bituminous road binder

ORGANISATION

QROS Limited

In the UK, utilities dig approximately 2.5 million holes in roads and pavements every year. WM3 guidance states that any soil or other material excavated is waste and should be assessed and classified for waste management purposes. Any excavated material identified as hazardous must be disposed of at a licenced hazardous waste receiver and the hazardous waste landfill tax paid. New laws in April 2018 bring significant fines and a possible criminal prosecution if waste is incorrectly classified or disposed.

Material excavated during utilities works and road repairs consists of road surface material that contains aggregate and a binder and soil from the subsurface. Before 1980, the majority of the binder was derived from coal tar, an absolute hazardous material under WM3 rules. Petroleum bitumen, the residue from crude oil distillation, has been routinely used to make road binder since 1980 and is classified as non hazardous under WM3. Bitumen is essentially 100% petroleum hydrocarbon.

The soil subsurface may be contaminated with coal tar residue if coal tar derived road binder was used when the original road surface was put down. The majority of roads in the UK contain variable patches of coal tar and bitumen. The coal tar may be in lower layers, but repairs and re-use of excavated material can mix everything up.

WM3 has specific rules for bituminous waste containing coal tar. The waste is considered hazardous if it contains more than 0.1% coal tar or any coal tar present contains benzo a pyrene above 0.005%. Bitumen is considered non-hazardous, so waste can be 100% bitumen and still be non-hazardous.

PAK spray and lab analysis

Chemical analysis is needed to identify if coal tar is present. One regularly used option is PAK spray, a quick roadside test that reacts with polyaromatic hydrocarbons (PAHs) in the binder to give a visual colour change to indicate if coal tar is present. Coal tar and bitumen contain the same PAH compounds. Coal tar usually contains more of a certain type of PAH than bitumen, giving a darker colour.

The PAK user guide recommends its use on material that is above 15°C and dry. In the UK, for much of the year, this is not that common, causing the PAK spray to give false negative results, especially when mixtures of coal tar and bitumen are present. PAK spray also gives false positive results because some bitumen binders contain naturally high PAH concentrations. The colour change is also subjective, with people interpreting the colour change differently. PAK spray is therefore not sufficiently reliable to ensure compliance with waste management legislation.

JUDGES' QUOTE:

The judges said: "A rapid, yet robust technique for assessing coal tar content in road materials with potential widespread application in assisting contractors to select the correct disposal option".

Another option is conventional laboratory analysis. The most frequently used analysis is GC-MS for the 16 target PAHs. The "double plot" ratio of these PAHs can indicate if a sample is just coal tar or just bitumen, but cannot reliably measure the proportions of coal tar in bitumen when mixed together. WM3 states that "Assessments based on PAHs alone are not consistent with the legislation and cannot be used to classify a waste as non-hazardous".

Just using GC-MS for the 16 PAHs is therefore inappropriate for coal tar identification. The more comprehensive conventional laboratory analysis required to get data consistent with the legislation is more expensive because multiple analytical methods are required and it typically takes weeks to deliver results. Common practice involves a single GC-MS 16 PAH analysis to quantify benzo a pyrene (BaP) classifying arisings containing above 50 mg/kg BaP as hazardous. WM3 guidance states that the 50 mg/kg BaP limit (0.005%) refers to the binder content in the waste and not the total waste, unless the coal tar content is known where the 50 mg/kg limit applies to the coal tar alone.

PAH results alone cannot give the proportion of coal tar in the binder, so the total binder value is used. This can lead to incorrect hazard classification for bitumen/coal tar mixtures. Results may also include the aggregate content in the final result, diluting the BaP value. Being unfamiliar with how the values have been generated can cause misunderstanding with the data interpretation. This can lead to inadvertent misclassification, fines, and potential prosecution. Results from this analysis may not comply with WM3 guidance unless correctly interpreted. Regulators and various utilities industry associations recommend chemical testing that determines coal tar content to be accredited to UKAS standards.

An analysis method is accredited for a specific task. A method that is UKAS or MCERTS accredited for the determination of the 16 PAHs in a silty soil, clay, loam or made ground is not accredited for the determination of the 16 PAHs in a bituminous mixture. The data are only accredited for the determination of coal tar in bituminous waste if the interpretation is included in the accreditation scope.

In the UK there are no laboratories that are specifically accredited for the analysis and determination of coal tar content in a bituminous matrix. The simple PAH analysis by GC-MS cannot be accredited for coal tar analysis because the data generated cannot reliably identify if coal tar is present in bituminous mixtures. This means the majority of utilities contractors aren't getting accredited results for coal tar determination in bituminous waste, but may be under the impression they are.

QED HC-1 hydrocarbon analyser

Where the liability lies

Local Authorities and the **Highways Agency** are responsible for UK roads, so are jointly liable with the utility and contractor for any arisings incorrectly classified and disposed of. To minimise this liability, contracts with contractors now make the contractor take full responsibility for identifying if coal tar is present. The potential liability of incorrect disposal, the delay in obtaining results and the uncertainty of analysis pose significant problems for utilities contractors. If they wait several weeks for lab results from analysis that meets the legislative requirements, the arisings must be left by the excavation until a correct hazard assessment is made.

The contractor, however, can get financial penalties if the utility is not connected or traffic congestion occurs because the works are not finished quickly. The alternative is to assume all the arisings are hazardous and pay the increased costs of shipping to a licenced hazardous waste receiver using a licenced hazardous waste carrier.

Hazardous waste disposal sites are often far from where the excavations are carried out, increasing HGV vehicle travel time. With new low emission zones in city centres, typical "muck away" HGVs will need to pay additional entry and exit fees. By assuming everything is hazardous, the work is finished on time, but the cost of sending arisings from 2.5 million excavations as hazardous could be as much as £1 billion per annum in management, transportation and landfill tax fees.

QED HC-1 hydrocarbon analyser

The QED HC-1 is a UK-designed and manufactured instrument specifically designed to analyse for a wide range of petroleum and coal tar derived hydrocarbons. The QED can be set up in the back of a van, on an office desk or in a laboratory. It does not need expensive sample extraction systems or use environmentally damaging solvents such as dichloromethane, typically used in conventional laboratories. It is easy to use, requiring only basic skills and has a comprehensive QC system to ensure valid data are generated.

The QED can, within a few minutes of taking a sample of road surface or subsurface, detect and identify if coal tar, bitumen or bitumen/coal tar mixtures containing as little as 1% coal tar are present. For mixtures, the result will indicate the approximate percentage of coal tar in the bitumen. If coal tar is detected, the approximate percentage of benzo pyrene in the coal tar is given with a detection limit below 0.005%. The sample cost is at least 10 times lower than conventional laboratory analysis that meets the legislative requirements.

Sample extraction and analysis are simple. A sample pot is filled a quarter full with small pieces of road surface sample. Extraction solvent is added until the layer of binder is covered. Nothing is weighed or measured, so no special equipment is needed. The sample is shaken for about 30 seconds and then a dip-stick is put into the solvent and immediately transferred to the QED analysis cuvette and analysed. The QED analysis takes approximately five seconds. If the cuvette contains too much or too little sample, the QED QC system detects this and provides a dialogue box that tells the operator what to do to obtain a valid result.

The analysis is unaffected by temperature or sample moisture and only measures the extractable binder component so is unaffected by variability in percentage aggregate within the binder. If the identification is just bitumen-based road binder, the arisings containing binder are non hazardous. If the result is just coal tar, the arisings will be hazardous. Binder content is typically 3%-6% in a road surface so even relatively low coal tar content in the bitumen may breach the 0.1% limit. Where a mixture is present, if the BaP content of the coal tar present is above 0.005%, according to WM3, the material is hazardous.

QED analysers provide reproducible results regardless of the operator, location or instrument used. This gives confidence to the contractor and regulator that data generated are reliable and fit for purpose. Results generated are easy to interpret and less open to misunderstanding.

As no accredited methods are available, it is possible to use the QED under the BATNEEC principle, Best Available Technique (technology) Not

Entailing Excessive Cost, embodied in the Environmental Protection Act 1990. If the proposed technique is sufficiently reproducible, has an appropriate QC process to give confidence the data is valid and allows the user to comply with current environmental regulations, it can be used and the data will be accepted by the regulator. The QED can be used in a conventional laboratory setting and obtain UKAS accreditation as a single analysis method for the specific task of coal tar identification in road binder. Waste contractors, landfill operators and utilities labs in the UK currently operate QEDs and rely on the data that the EA also accepts.

When the QED is used by utility contractors, they are confident any arisings are correctly classified for WM3, minimising their liability. Where unplanned works are required, samples can be analysed on-site during the excavation process. For planned works, cores are analysed at the contractor's depot or sent to a lab that uses the QED. Sample turnaround is fast even if sent to a lab. The low per-sample cost allows contractors to analyse individual bands of binder within a road surface without exceeding the usual low analytical budget.

Using a QED reduces costs for contractors and speeds up repairs

Using a QED significantly reduces the costs for utility contractors, speeds up road repairs, reduces the overall environmental impact of utility works and allows full compliance with current environmental regulations.

WINNER

Celebrating a century of gasholders

ORGANISATION

National Grid

Last year, **National Grid (NG)** dismantled its 100th gasholder, marking the half-way point of its nationwide gasholder dismantling programme. Gasholders are one of the most identifiable structures of the UK's industrial past, and have been an ever-present feature of the urban skyline for generations of people. Unsurprisingly, the dismantling of gasholders invokes a range of reactions and emotions among local people, former gasworks employees, and industry enthusiasts. Its programme has provided an opportunity to celebrate this industrial heritage and involve the public in events that engage them and encourage participation. The programme has delivered some special initiatives over the last year.

The winning poster

Innovation and best practice

Frequently, the level and type of interaction between our projects and the local community is led by the community. This typically includes familiar approaches such as donating artefacts to local museums and libraries, and organising educational visits to local schools.

This year, NG has taken a more innovative approach with the aim of creating a real celebration of local gasworks heritage within local communities. It has run community photo competitions, organised a memorial event, commissioned large-scale artwork, and embarked on a project to capture the lived experience of gasworks. Working alongside a dedicated community relations consultant on every project has ensured best practice.

Salford innovation

One of the external walls of the gasworks was made famous in singer Ewan MacColl's 1949 song "*Dirty Old Town*" which starts with the lyrics, "I met my love by the gas works croft". The song was later covered by The Pogues in 1985.

After liaising with the local planning authority, to celebrate the important role the site played in Salford's industrial history, NG commissioned a wall mural, organised an unveiling event and invited members of the local community to visit the site during our gasholder dismantling works.

The mural was created by **Ordsall and Langworthy Community Arts Group**, which conducted research to establish what was important to the local community. Their efforts resulted in the production of a stunning piece that combined historic photographs, facts, and memories, to create artwork that truly depicted Salford's industrial past. Ordsall and **Langworthy Neighbourhood Forum, Salford Lads' Club** and representatives from **Salford Council** attended the mural unveiling in November 2018. The mural was installed on the wall featured in the song and is a constant reminder of Salford's industrial heritage value.

Manufacturing plates from the two gasholders are also being donated to the **Museum of Science and Industry in Manchester**, about 3km from the site.

Cost effectiveness and compliance

The cost benefits of good public engagement and participation are indirect. In the short-term, it lessens public resistance to projects, ensuring these are run smoothly and to time. In the longer term, enhanced engagement leads to a more positive public perception of future development and responsible regeneration of NG sites, which extends to other brownfield redevelopment in the local area. Haringey Heartlands is an example of where its gasholder dismantling activity has stimulated the expansion of the brownfield redevelopment in the vicinity as adjacent land, not in NG's ownership, has been included in the redevelopment scheme.

At Gas Hill, Norwich, NG identified significant local interest. The gasholders on the site were the last two remaining in the city, and their hillside location made them a prominent feature of the local skyline, along with the Cathedral. As such, there was a degree of affection for the structures and many in the city were vocal about their future.

With the aim of celebrating the gasholders' contribution to the city's skyline before they were dismantled, NG launched a photo competition. It invited amateur photographers of all ages to submit photos of the gasholders and attracted more than 100 entries. It promoted this competition in the local press, on social media, and via targeted engagement with key local stakeholders.

The competition successfully engaged the local history society, with the vice-chair joining the competition judging panel, and supporting promotion of the campaign. The campaign culminated in a local unveiling event where NG showcased a selection of the best entries, and was attended by nearly 150 community members, stakeholders and the local press. To mark the competition, it also produced a brochure which was shared at the event.

To demonstrate its commitment to reducing the impact of our activity on local communities and the environment, NG requires that all its dismantling contractors register with, and follow the guidance set out in, the Considerate Constructors Scheme (CCS).

Engagement

The Wavertree gasholders were located near St Hugh's Catholic Primary School, and there was a history of trespassing on the site. To promote site safety during the gasholder dismantling works, NG organised a safety assembly at the school and launched a design competition for a poster to be displayed on the site gates.

The aim was to highlight to local children the importance of staying off the site during the project. The winning poster was drawn by a nine-year-old boy and included a Czech and Romanian translation to reach all communities near the site. His prize was to see his poster installed on the site gates along with a framed copy for him to keep.

To ensure NG promotes an open and honest approach to communicating our activities, it has developed its own policy – Exceeding for our Communities. This sets out a standardised minimum approach to each dismantling project from the pre-planning submission stage, with a requirement for engagement with ward councillors, MPs, and relevant local authority/regulatory stakeholders.

Heritage recording

An important part of recognising UK industrial heritage is creating records and documenting structures in a manner consistent with **Historic England** guidelines. All NG's dismantling projects include formal heritage recording to a standard commensurate with its historical value.

Going above and beyond a traditional stakeholder engagement format, it has sought to celebrate the heritage and industry associated with gasworks, as each gasholder is dismantled. It has chosen to actively embrace gasworks legacy as part of its gasholder dismantling and brownfield development programme, and this led to the implementation of its tailored approach.

NG's Capturing Stories initiative addresses a gap in the national gas archive and seeks to document the routine, everyday experiences of former employees, neighbours and generations of friends and family living near former gasworks. This data gap has now been incorporated into guidance, out for consultation from Historic England, to include oral history testimony in heritage recording activities on gasworks sites.

Capturing stories and wider benefits

The Stretford Gasworks in Manchester was ideally located to launch this Capturing Stories initiative due to the tight-knit community and active local heritage groups it identified during early engagement events. Local councillors advised on the mailing distribution area and locations where the gasholders were particularly visible. NG invited members of the community to come along to a tea and cake event at a local community hall and share their memories of the gasworks.

The event was well attended, and five people took part in the filming, including two former employees of the Stretford Gasworks: a 98-year-old man and an engineer who was part of the team that established the Stretford Process. Residents who grew up near the site were also interviewed.

Generally, the environmental and economic benefits of the stakeholder engagement programme are more tangible to demonstrate. For example, more than 50 acres of brownfield land have been released for regeneration and potentially contaminating waters and sludges within gasholders have been removed. The social benefits are more challenging to measure. However, one of the most tangible and poignant social benefits NG can demonstrate arose from an opportunity to commemorate a devastating event in Sheffield's history.

Unveiling the memorial plaque

Sheffield memorial event

In 1973, an explosion from a tank used to store gas killed six people at the Effingham Street Gasworks. NG's dismantling works were underway on the site exactly 45 years after the disaster, and it felt appropriate to host a memorial event given no permanent memorial existed.

It launched a sensitive press appeal to trace the relatives of those who died. The memorial was about doing the right thing and it was important to NG that the families involved understood this. The appeal was taken up by the BBC, resulting in more than 25 calls from relatives and friends of those killed, and members of the emergency services who attended the incident. Many relatives and those present at the incident were still deeply affected, with raw emotions and memories. NG involved the families in agreeing the wording of a plaque, and the event was attended by more than 100 people affected by the incident. The plaque was unveiled by the former secretary of the Retired Employees' Association who knew some of the families affected by the incident, and a permanent memorial is now installed at the site.

A robust, sustainable, and defensible solution

NG maintains a minimum standard of community engagement on all its gasholder dismantling projects. The rich social and industrial heritage it has inherited puts it in a special position within the brownfield sector, being able to experiment and lead different approaches to public participation. By developing and tailoring its approach site by site, it has reached the point where the needs of the community can drive our engagement strategy, and gasworks heritage can be celebrated by all. This has also led to NG's growing reputation as a responsible steward for the UK's industrial heritage assets, aligned with Historic England's guidelines.

Achieving the trust and buy-in of the communities where NG works - fostered by maintaining an open and honest approach to engagement, and being a considerate neighbour – has had positive implications for its brownfield development, and for other brownfield land nearby.

Following NG's successes so far, it is excited to keep refining its approach to public participation. It looks forward to hearing new stories and celebrating gasworks legacy in the towns and cities where its remaining 90+ gasholders are still standing.

In summary, it has developed a proactive programme of stakeholder engagement and participation associated with its work to dismantle redundant gasholders. The last year saw the dismantling of its 100th gasholder, coupled with several innovative and leading initiatives that sought to celebrate more than a century of industrial heritage. It has actively sought to understand the importance of former gasworks to local communities and has worked with them to celebrate their local heritage.

In the process, NG has highlighted the importance of brownfield land regeneration, and the opportunities that arise from returning brownfield land to beneficial use.

JUDGES' QUOTE:

The judges said: "We were disappointed in the small number of entries for this award when some exemplary public engagement and participation has been shown in many of the entries for other categories. One to consider for next year. However, out of the small number of well-presented high quality entries, this one best matched the criteria."

CONSULTANCY & TESTING SERVICES

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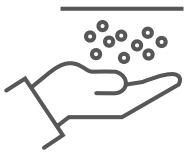
EXPERT SUPPORT AND GUIDANCE

Our LQE services deliver technical risk management in line with NHBC standards for land quality, for clients looking to undertake remediation or reclamation of their sites, before they are sold on for residential development.

LQE is fast becoming a pre-requisite for many land developers managing large brownfield sites, with typical locations including landfills, quarries, gas works, mine works, industrial complexes and collieries.



To find out more

visit **nhbc.co.uk/lqe**
or call
0344 633 1000
and ask for 'LQE'

NHBC

Raising Standards. Protecting Homeowners

P473 09/19

WINNER

Former chemical plot remediation

ORGANISATIONS

WSP and AstraZeneca

The innovative and sustainable work at **AstraZeneca's** Macclesfield site focused on the design and application of best practice investigation, remediation and enabling technologies to support the sustainable remediation of toluene impacted soils and groundwater.

This approach included: a combination of traditional site investigation supported by a membrane interface probe (MIP) to provide chemical data in real time and high-resolution contaminant profiling; effective deployment of high-speed guillotine breakers to reduce noise, vibration and programme impacts during the breaking out of concrete slabs; and in-situ and ex-situ remediation technologies to effectively treat toluene to the agreed remediation standard.

The team's combination of technologies resulted in a 95% reduction in contaminant mass, zero disposal of material to landfill, and a significantly reduced programme – all delivered within a highly constrained and sensitive working environment.

Background

WSP was appointed by the multinational pharmaceutical company AstraZeneca to assist in the regeneration of a redundant parcel of land in the heart of their Macclesfield campus. As one of the largest employers in the area this was an important stepping stone in their goal to commit to the Macclesfield campus and increase its manufacturing capacity at this historic site.

The former chemical plant, known locally as the 'chemical plot', is a rectangular plot of land of approximately 1.3 hectares. Historical investigations carried out in the 1990s estimated that 3 tonnes of toluene were present at depths between 6.5m and 8m bgl in saturated soils. However, following 21 years of pump and treat, an estimated 50 tonnes of contamination had already been recovered.

The chemical plot, which was demolished in 2011, was situated in a densely built up part of the Macclesfield campus. The operational nature of the site had previously restricted the scope of intrusive investigations and there were significant gaps in the site data which introduced potential risks for scope, cost and programme for the planned remediation works.

Before remediation, WSP and AstraZeneca liaised with the **Environment Agency (EA)** and **Cheshire East Council** to agree the scope and extent of the voluntary remediation works. The purpose of the works was to allow future development of the site for continued industrial use. It was agreed with the EA and local authority that the works would follow the planning regime structure to streamline the process of applying for future planning consent.

The team addressed regulatory queries during the conceptualisation and design stages of the project and, in the absence of a planning led approach, it was agreed that the site would be remediated to the limit of the technology employed. The final remediation strategy was developed in line with current best practices, including CLR11, SuRF UK, CL: AIRE Definition of Waste COP and the EA Groundwater Protection Guidance (previously GP3).

Data approach and safe work systems

The design-led approach to sustainable risk-based remediation relies on the collation and interrogation of all available data and enhancing data and design through gathering robust lines of evidence. A review of the historical data indicated that the contamination and ground conditions were well suited to MIP and this could be a valuable tool for improving characterisation of the toluene distribution in a heterogeneous drift deposit.

Soil and groundwater samples located near MIP locations were used to establish a correlation and calibration between MIP results and quantitative lab results. The team also used the MIP data to corroborate historical site investigation data with contemporary data. It gathered data from more than 100 locations across this relatively small site and in known areas of impact it increased the sampling density to enhance the resolution of the sub-surface profile. The data was used to provide a 3D model of the vertical and lateral distribution of volatile solvent-based contamination, enabling a targeted approach to remediation.

The site investigation established maximum concentrations of 5,670mg/kg of toluene in soil and 239mg/l in groundwater – both significantly above Generic Assessment Criteria (GAC).

The team undertook the site investigation in accordance with its in-house and AstraZeneca's safe systems of work, including liaison with eight different stakeholders. To be more cost efficient and provide better H&S management, it introduced AstraZeneca to vacuum extraction (vac-ex) to support utility avoidance and this was demonstrated via a trial to 15 site stakeholders. The health and safety benefits of vac-ex are now recognised and adopted by AstraZeneca as a site-wide protocol when working near live services.

Remediation and enabling works

Following the site investigation, remediation option appraisal, and final remediation design, the selected remediation technologies were bioremediation of soils, perched groundwater treatment, supplemented with the in-situ use of chemical oxidation in restricted access areas. The remediation works were designed to reduce the contaminant mass to the limit of technology, to future-proof long-term development at the site, and reduce the immediate impact to the site's commercial, industrial and research residents. The final remediation targets were agreed with the regulators.

Due to the clean manufacturing

protocols on site and the use of vibration sensitive equipment, removal of the concrete slab prior to remediation works needed to be vibration free or sufficiently quick so that exposure times were reduced. The team chose a closed pulverisation technique using a self-propelling guillotine breaker that was more than 20 times quicker than traditional breaking techniques. The breaking out was undertaken over a two-day period and aligned with the servicing of vibration-sensitive analytical equipment located in the basement of the adjacent building.

Following completion of the breaking works, the vibration-sensitive equipment was recalibrated with no additional down-time for AstraZeneca. Processed concrete was reused on-site where possible. Materials were screened and anything greater than 40mm was used as a running layer for the on-site treatment bed. Materials less than 40mm were conveyed to a local recycling centre to limit the carbon footprint associated with off-site travel. Topsoil was sent off-site to a local recycled aggregate and soil business and 0% was sent to landfill.

The advanced MIP investigations resulted in a smaller volume of soil being excavated and treated (a reduction of about 4,000m³), which was a notable advantage for such a highly constrained site. In line with legislation controlling drug production, the buildings on the AstraZeneca site are subject to Good Manufacturing Practice that controls the authorisation and licensing of the manufacture and sale of pharmaceutical products and this means that the end product must be free from contamination.

The team designed the remediation works so that fugitive emissions were reduced as far as reasonably practicable. VOC monitoring of toluene vapours was undertaken using real-time data logging and communicated daily to the adjacent site occupants via a noticeboard. The VOC monitor was calibrated to toluene as the primary contaminant of concern and set to alarm if it exceeded the occupational odour levels. All recorded odour levels were orders of magnitude below the occupational exposure limit, and this proactive approach was a key part of the wider site stakeholder engagement process.

JUDGES' QUOTE:

The judges said: "This was a sound remediation project that overcame various site obstacles and had a good use of MIP site investigation to assist characterisation."

The process was designed to minimise the amount of vapours being released from contaminated soils during the bioremediation process. A total of 5,124m³ of contaminated soils required treatment prior to re-use onsite. The bioremediation windrows were set up on a vacuum extraction bed, with vapours being drawn out of the soils and treated through a Granular Activated Carbon (GAC) system to remove contaminants in the vapour. The GAC incorporated an air water separator to reduce the carbon compounds in the air and released into the atmosphere. An LEL meter was incorporated into the design with appropriate safety mechanisms to ensure there wasn't an explosive atmosphere.

WSP undertook well point dewatering rather than mass scale dewatering during the excavation of contaminated soils below the water table to limit exposure to impacted groundwater and manage potential subsidence risks to nearby structures from running sands. The MIP and BH information were used to target the right areas.

Odour nuisance was managed through a high-pressure suppression system. The odour system was established around the perimeter to mask the odour of the toluene. As the odour system used fresh water, deployed as a mist, we worked with the in-house legionella specialist. We incorporated a range of measures to monitor and mitigate the odour risk that included daily and weekly monitoring, installing potable waterlines in trenches below ground, and sterilising the water lines.

The original options appraisal included a contingency to excavate elevated concentrations of the contaminants of concern beneath Road 10, an active thoroughfare immediately adjacent to the north of the chemical plot. This would have required significant sheet piling to approximately 12 m BGL to allow safe excavation adjacent to retained businesses and critical buried services.

To avoid this disruption and cost, in-situ chemical oxidation (ISCO) using potassium permanganate solution was developed as a better approach. Potassium permanganate was selected as the optimum oxidant based on treatment efficacy and suitability for use in sensitive settings where live services and infrastructure are present.

In December 2017, approximately 2,500kg of potassium permanganate was batched into IBCs at a concentration of 5% on the existing treatment bed and then transported to each injection location by a telescopic handler, where a temporary bund was set-up, and the solution injected into the affected area under gravity within pre-installed injection locations.

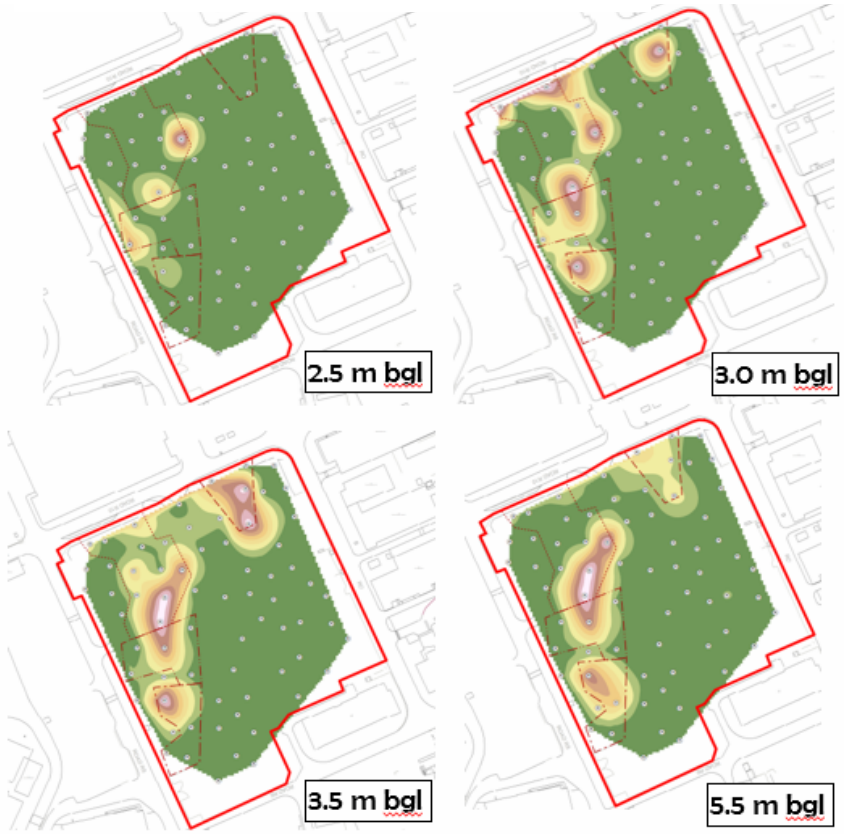
Following injection, colorimetric monitoring determined if the oxidant was still active and established the radius of influence. Post remediation monitoring was undertaken for several months after injection and showed a reduction in toluene concentration, significantly below the derived remedial target for groundwater. The revised approach, using ISCO, reduced the costs of remediation associated with "Road 10" for our client from £240,000 to £90,000.

Outcomes

WSP designed and delivered a remediation scheme for a redundant chemical plot at the AstraZeneca Macclesfield campus that significantly reduced the contaminant mass removed the need for a long-term soil vapour extraction and pump and treatment system and delivered a site ready for future redevelopment.

While these works constituted voluntary remediation, the stakeholder consultations and agreements with the authorities will enable redevelopment of the site without any conditions relating to land contamination.

More than 10,000m³ of contaminated soils have been excavated, treated and re-used under a **CL:AIRE** compliant MMP to create a development platform for future site development. An estimated 4,000m³ of excavation was either avoided or soils were diverted from treatment via the use of MIP to characterise the excavation requirements in three dimensions. As a consequence of the team's remediation work, there has been an average 95% reduction in the contaminant mass.



Using MiP to provide a detailed VOC profile in soils

WINNER

Sharpness Docks

ORGANISATION

Sanctus Ltd

A fire blazed in a recycling and composting facility located at Sharpness docks, Gloucestershire, for nine months, causing significant damage, disturbance, and distress to people and the environment.

Prior to the team's involvement, there was considerable strain between the landowners, **Stroud District Council,** the **Environment Agency (EA)** and the general public; a significant number of complaints were made regarding the smell, smoke, and dust from the fire.

The combustible nature of the compost material involved meant that the fire was self-sustaining, and that the conventional fire-fighting techniques of introducing water caused an exothermic reaction refuelling the fire. The situation was complicated by the building being condemned as unsafe for access and comprising significant proportions of hazardous materials. When **Sanctus** was instructed, the fire was still raging and had consumed much of the facility, including the structure, the plant, equipment and compost-like output (CLO) that was stored inside.

Sanctus took part in a public consultation with the relevant stakeholders, acting on behalf of the **Canal and Rivers Trust** as consultant and principal contractor. It quickly developed an innovative solution to addressing the ongoing problem, using robotic equipment to extinguish the fire.

Sanctus used a Brokk excavator, remotely controlled to remove burning waste and reduce the potential for waste fuelling the fire, by spreading the CLO across the floor of the facility to aid cooling and treat the fire in manageable sections. The Brokk enabled minor demolition activities to make the area safe without operatives needing to enter the building, reducing the risk exposure to smoke, fire and falling debris. This use of specialist equipment allowed firefighters to control and ultimately extinguish the fire safely and more effectively, enabling the fire to be extinguished within two days.

The team also provided an emergency site presence and worked alongside the **Fire Brigade** to provide advice on asbestos containing materials and hazardous waste that was burning inside the facility. The priority was to avoid risk to people operating in the vicinity of the fire and protect against impacts on the wider environment.

Innovative thinking and best practice

Following the cessation of the fire, Sanctus deployed a drone to inspect and assess the extent of the fire damage, including surveying the facility roof, which was constructed from cement-bonded asbestos sheeting. The aerial inspection demonstrated that the roof was severely damaged, and posed a high risk of collapse and significant health and safety risk. Based upon the asbestos type, volume and state, the works were classified as NNLW (notifiable, non-licensed works) and were conducted in line with exemplary processes and procedures.

The team developed a detailed Plan of Works to dismantle and demolish the asbestos roof structure in the safest possible manner, outlining the control measures required in accordance with HSE best practice guidance.

The site was set up for works with asbestos. This included the deployment of decontamination facilities and a perimeter dust suppression system, with clear segregation of works areas.

The asbestos containing material was dampened using Motofog and dust suppression equipment. A long-reach telehandler was positioned outside the building and used to gather the asbestos debris remotely. This approach removed the risk of entering the unsafe structure and eliminated the potential for exposure to asbestos to site workers.

Following the removal of the asbestos roofing and debris from the slab, Sanctus undertook a soft strip

Guillotine breaker deployed at site

demolition of the building fabric within the offices and welfare block adjacent to the warehousing. Sanctus then completed the controlled demolition of the remainder of the building using demolition-spec excavators, mobile elevated working platforms and cutting equipment.

The cleanliness and organisation achieved on site was such that it was later used as an example of the dust suppression manufacturers' equipment, for use in their official advertisement on their website and social media channels.

Air pumps were deployed around the site boundaries and during specific works activities to determine any potential for fibre release. Samples were taken and analysed by an independent UKAS accredited consultant in a mobile laboratory. The control limit of 0.1f/ml was never exceeded, which indicated that the dust suppression control measures deployed to eliminate airborne asbestos fibres were highly effective.

Sanctus provided the Fire Brigade with advice on asbestos containing materials and hazardous waste

Cost-effectiveness

Sanctus' extensive contracting experience, knowledge of waste classification, commitment to sustainable recovery and use of materials informed our approach to the restoration of the site.

The combination of materials meant the team had to consult with the EA and establish an innovative "problematic waste" stream designation to allow processing and disposal, saving millions of pounds in the specialist bulk incineration cost. It also saved the client time and avoided potentially negative publicity.

Sanctus identified several different waste streams at the site. As a result of the material produced at the facility, the fire damage and the subsequent demolition of the structure presented different challenges. Each waste stream was therefore segregated at source, and a suitable facility identified that could accept the material. Where possible, material was sent the shortest distance to reduce the impact on the local infrastructure and the carbon footprint of the works.

The CLO was sent to a local restoration site for landscaping purposes; LECA (light expanding clay pellets) and general waste were removed from site for recycling at the nearest economically viable facility. Asbestos containing materials including cement-bonded sheeting were segregated under controlled conditions, loaded into sealed skips and removed from site to a licensed disposal facility. Waste oil and water were sent to a neighbouring facility for treatment and recycling.

Hydrocarbon contaminated materials, including concrete, and the impacted underlying soils were sent to treatment centres. Metals – both ferrous and non-ferrous, found as part of the facility structure were cut into smaller sections and removed for recycling in Sharpness. Wood-based material and plastics found as part of the facility structure were segregated and sent for recycling. Difficult (burnt) waste was the only material sent to landfill, significantly reducing further impact on the environment.

Following the demolition of the structure and some areas of the ground slab, clean hardcore material was recovered from the process and transported to a local visitor attraction, for reuse as a sub base for new access roads.

Compliance

During demolition work, a number of trenches, totalling more than 200 linear metres, were identified within the concrete slab. These interconnected with sub-surface underground oil storage tanks, which were not detailed on existing site plans, recorded or registered. Sanctus consulted with the EA and the local authority; the client's tenant at the site held an Environmental Permit for the recycling and composting operations, which was required to be surrendered. To facilitate the surrender of the permit and to ensure the site was not listed under Part 2A of the Environmental Protection Act 1990 as Contaminated Land, further site investigation and remediation was required.

Sanctus was instructed to undertake a Phase 1 Contaminated Land Desk Study and a Phase 2 Site Investigation on the site. The Phase 1 study included: a review of historical maps of the area dating back to 1881; environmental information collected from regulatory bodies and national agencies; and geological, hydrogeological and hydrological information.

The targeted Phase 2 intrusive site investigation enabled the characterisation of the site's subsurface and the position of the trenches and associated tanks. The SI comprised 20 trial pits excavated with a 13t tracked excavator, and the advancement of 6No boreholes undertaken using cable percussion techniques – two of which were selected to install groundwater monitoring wells to a depth of 6m bgl. Selected soil and water samples were sent to an independent MCERTS and UKAS accredited laboratory for chemical testing, with soil samples being compared against two criteria: Natural Background Concentrations of the soils from BGS data; and Generic Assessment Criteria for an industrial/commercial land use scenario. Data loggers placed in the boreholes provided evidence that the groundwater at the site was not tidally influenced by the nearby Severn Estuary.

Based upon the data obtained from the site investigation, Sanctus undertook a qualitative risk assessment and revised the conceptual site model. It concluded that the excessive petroleum hydrocarbon and metal concentrations were from the operations undertaken at the site, with a moderate risk to controlled waters and that, should piled foundations or deep services be required, the risk could grow.

Sanctus therefore produced a remediation strategy for the site. Excavation was undertaken to remove petroleum hydrocarbon-impacted soils

and contaminated perched waters. The excavation was extended due to the presence of visually impacted soils and ceased when no visual or olfactory evidence of contamination was identified.

The contents of the main underground tank were removed via pumping, and the tank was decommissioned by cleaning and later by filling with resin so it could be left in situ, on site in a state that didn't pose any liability.

As part of the remediation strategy, soil validation samples were obtained from faces and bases of the remedial hotspot excavation and compared with the soil remediation target criteria. Samples were sent to an independent MCERTS and UKAS accredited laboratory for chemical testing. Twelve samples were analysed to determine that the contamination source had been suitably removed.

The contaminated concrete hardstanding, hydrocarbon impacted soils, and impacted perched waters were removed from site by licenced waste carriers to suitably permitted facilities. All excavated trenches were backfilled and levelled using local quarried stone to reduce environmental impact.

Public/stakeholder engagement

This site was hugely problematic for the community, the environment, the local authority and the EA. Almost daily complaints were received for more than nine months due to odour, flies, and emissions from the fire. The situation became so challenging that tensions began to develop between the respective authorities.

Sanctus believes its work should benefit people and the environment so it prioritised working with partners to meet the local community to understand their views. They jointly held a community engagement event at the Dockers Club and listened to the frustrated community.

This information helped inform planning and communication with residents, through the respective authority, as work began on site. Following this involvement and the extinguishing of the fire, not further complaints were made about the site. Instead, it received positive feedback.

JUDGES' QUOTE:

The judges said: "This was an Interesting project with little time to plan in advance. The public interest and engagement with this scheme are clear and obvious. There was exceptionally good handling of the significance issue. Real benefit was shown in the submission and it ticks the boxes for a great project."

Economic, environmental and social benefits

The team's innovative approach to observation, access, demolition, environment monitoring and management solved an environment crisis for the community in Sharpness and did so at a fraction of the potential cost.

The final requirement of the site-works was to make safe the existing substation that fed the former facility. Sanctus installed tamper-proof fencing with a small easement around the substation, and left the site safe and ready for future development.

What once was an impossible problem is now a site ready for a brighter future.

WINNER

A former town gasworks risk assessment and cost benefit analysis

ORGANISATIONS

National Grid Property and Wood E&IS UK Ltd

National Grid Property Holdings (NGPH) owns a 0.2 hectare site on part of a former gasworks in the North of England. The site is used as a car park for a sensitive adjacent business and is surrounded by commercial and residential properties.

The site has been subject to several stages of assessment including site investigation and detailed risk assessment since 1994. This included remediation of five key source areas – former purifiers, two former gasholders, contaminant hotspots and an area of identified tar contamination – in the early 2000s, which was constrained by the depth to groundwater, below ground structures, and safe excavation/battering techniques.

Further investigations at the site in 2015 identified non-aqueous phase liquid (NAPL) and aqueous phase contamination remaining at depth (more than 6m) within the underlying glacio-fluvial deposits. A detailed quantitative risk assessment (DQRA) undertaken by others in 2015 indicated a potentially unacceptable risk to water resources and a potential off-site vapour inhalation risk.

To ensure the site wasn't causing a significant or unacceptable risk to human health and controlled waters receptors, additional works were required to support the site to be "closed out" in accordance with the client's internal policy, the regulatory framework, and BS ISO 18504 (Soil Quality – Sustainable Remediation).

Risk evaluation

Wood completed a review of the previous DQRA. During this review, it was identified that uncertainties underpinning the conceptual model may have resulted in an overestimation of the vapour inhalation risk. Therefore, further site investigation was undertaken to install a series of vapour wells targeted to collect vapour data from appropriate and varying depths along the potential migration pathway to allow a more robust risk assessment.

The supplementary site investigation concluded that all concentrations of vapours were below residential screening criteria and as such there was no unacceptable risk via the inhalation of vapours pathway and that remediation was, therefore, not required on this basis. The remaining potentially unacceptable risks associated with contamination beneath the site were therefore associated with controlled waters receptors. To identify the most appropriate way forward, a cost benefit analysis (CBA) was subsequently undertaken.

Options appraisal

A remediation options appraisal was conducted to identify remediation techniques capable of reducing the risks and associated potential liabilities on the site with respect to the protection of down-gradient controlled waters. A short-list of viable remediation techniques was developed, which comprised: belt skimmers (physical NAPL removal), a cut-off wall (containment), pump and treat with chemical oxidation (source reduction through a chemical process), stabilisation (containment), full excavation (source removal), or "do nothing".

Each option was considered against its applicability within the local site-specific circumstances. The review recognised that no one option was suitably practicable when considering all site-specific constraints.

The site was considered potentially unreasonable to remediate based on a range of site constraints.

Firstly, the site was constrained on the eastern and southern boundaries by brick retaining walls. The site wa also situated in the centre of a village. Access roads were narrow with little manoeuvrability, and consideration would need to have been made regarding materials management and mobilisation of vehicles, plant, and equipment.

Residential housing adjacent to the site, particularly those located on the eastern site boundary, were sensitive receptors to nuisance (excessive noise, odour and vapours) associated with remediation operations. The lateral extent of contamination was also likely to move beyond the northern boundary line of the site, constraining the extent of remedial works in the direction of groundwater flow.

There was the problem of low voltage electricity cables crossing the site. Work close to these utilities would have been limited or required isolation/diversion. Gas mains also crossed the site and if works were required in the vicinity of the pipes, these would have required careful management or the pipes re-routing.

It was noted that the glacio-fluvial sands and gravels were highly unstable when excavated due to a high proportion of cobbles and boulders. Furthermore, the NAPL observed at the site was shown to have been degraded and was undeterminable by interface probe. From experience, the team found residual weathered coal tar difficult to remove.

Finally, it was recognised that a remediation scheme would not remove all NAPL as there would have been an immobile residual fraction that was bound to the soil matrix and retained in dead-end pores by capillary forces.

JUDGES' QUOTE:

The judges said: "This was an honest and frank assessment of what can happen with sites that are too small or too inaccessible for physical remediation to be viable. An innovative approach was taken, with reference to guidance and use of cost benefit analysis, together with considerations such as social and financial viability. It was a good submission with a thorough and defensible approach."

Cost benefit analysis

Recognising these constraints, a CBA was undertaken using Decision Making

under Uncertainty techniques (best practice) to assess the most appropriate course of action to comply with the client's internal policy and the regulatory framework. The aspects of the regulatory framework considered were:

- The objective of Part 2A of the Environmental Protection Act 1990 as set out in the Statutory Guidance "to ensure that the burdens faced by individuals, companies and society as a whole are proportionate, manageable and compatible with the principles of sustainable development".
- The test of reasonableness for actions under the Water Framework Directive as set out in the Statutory Guidance that: "the aim should be to consider the various benefits and costs of taking action, with a view to ensuring that the regime produces net benefits, taking account of local circumstances."

The CBA comprised quantification of direct and indirect costs and benefits for a range of remedial works, sensitivity analysis of key input assumptions and scenario analysis to assess future viability. These complementary techniques were used to rigorously and robustly assess the most appropriate remedial actions for the site under current and future conditions. The analysis considered environmental, social, and economic costs and benefits to ensure compliance with the principles of sustainable development.

Given the location and use of the site, several interlinked socio-economic and environmental components were relevant to the assessment. As such, the CBA considered social value and environmental sustainability as integral parts of the assessment. Site specific net present values (NPVs) were derived for the CBA. A NPV was assigned to represent 1m³ of groundwater based on its sensitivity as a secondary aquifer within an urban environment. A groundwater remediation model was used to estimate the volume of water "cleaned up" using each remedial option over time and the distance travelled from the source.

The CBA adopted a holistic approach that considered factors other than costs. NPVs were assigned to represent environmental and social costs such as carbon dioxide emissions, increased traffic movements, nuisance (noise, odour, vibration), property damage, property blight and community health and also environmental and social benefits, for example the re-use of land (bring back the site into beneficial use for the local community), community stability and local employment. The costs and benefits were tailored to each remedial option dependant on the duration of works and use of plant. Further costed assumptions within the CBA also included the value of the site, rental income, and site idling.

The site was challenging to remediate due to a range of site constraints

The assessment revealed that the short-listed remedial options all produced negative NPVs and were subject to significant sunk costs (and risks) in the form of high CAPEX costs, comparably low OPEX costs, and marginal environmental and social costs/benefits derived for the site. Recognising these challenges, a range of recommendations were proposed to ensure the sites current and long-term sustainability.

Outcome of re-evaluation

The most sustainable recommended course of action was "do nothing"; this conclusion was based on the forecast NPV of this option that far exceeded the other options considered by the CBA. This recommendation was consistent with results obtained from sensitivity analysis and scenario testing. The CBA was subsequently submitted to the regulator who agreed and approved the recommendation based on this comprehensive CBA analysis, which was praised for its innovative nature, consideration of social, environmental and sustainability factors, and the approachable and non-technical way in which the results and recommendations were communicated.

The approach closed out the liability for a small but constrained site in a robust and defensible way, using best practice techniques incorporating social value and environmental sustainability to determine the most appropriate solution for the site.

WINNER

Gloucester Quays Regeneration

ORGANISATIONS

Soilfix Ltd, Peel Land and Property Group, RPS Consulting Services, Cotswold Archaeology

The Gloucester Docks site

The land around Gloucester Docks has a long history of industrial use since the construction of the Gloucester and Sharpness canal and railways in the 1800s. **Peel Land and Property Group** has led the regeneration of the wider Gloucester Docks area, including redevelopment of the historic conservation area to the east of the canal into a successful retail outlet.

The Gloucester Quays site comprised eight derelict land parcels situated to the west of the canal. The areas were physically separated by public roads and split into: parcels 2 and 3; parcels 5 and 6; parcel 7; and parcels 8, 9 and 10.

Historic land uses, including a fuel/oil depot, vehicle maintenance yard, grain store, timber yard, and waste recycling operation had left a long legacy of ground contamination on the six-hectare site.

Previous attempts to regenerate the site had stalled due to the extensive contamination and waste materials present, as well as nationally important archaeological remains present in parcels 2 and 3. This led to the site being left in a derelict state for more than 10 years.

The challenge

The challenges facing remediation and enabling of the site to unlock its value to the city of Gloucester included the location of parcels 2 and 3 within the Scheduled Ancient Monument of Llanthony Secunda Priory, a 12th century monastery. Any intrusive ground works would require significant stakeholder negotiations to produce suitable development plans and methods of working sympathetic to the protection of known remains.

Significant variability in the made ground materials was also present, as well as 19,500m³ of historically stockpiled above ground material that was known to include deleterious materials such as tyres, timber, gas bottles and metal.

There was also the presence of frequent buried obstructions including relic structures associated with the large historic grain store, a disused oil depot on parcel 10 that included extensive buried fuel pipelines, extensive diesel and asbestos contamination within the made ground, and underlying soft alluvial clays locally that contained free-phase diesel contamination.

Furthermore, there were logistical challenges due to the physical separation of the four areas of land, and there were several sensitive receptors surrounding the site including the canal, boat residents, residential properties, and neighbouring businesses including a supermarket.

Development of solutions

Remediation contractor **Soilfix** (employed by Peel as client and landowner) worked with geo-environmental and geotechnical consultancy **RPS**, and **Cotswold Archaeology** to develop a sustainable, yet robust Remediation Strategy for the site. The strategy was based on site investigations and a conceptual site model developed by the client's consultant, **Coopers**.

A key aspect was the sustainable reuse of materials and management of development levels, to maximise material retention on-site and minimise off-site waste disposal. Soilfix undertook iterative 3D volumetric modelling during the planning and implementation stages in close liaison with future developers of the site, to set development platform levels for each parcel and deliver a neutrally balanced site, i.e. no surplus of materials requiring costly off-site disposal.

Following a Tier 2 Sustainable Remediation Framework (SuRF) Assessment, a broad suite of techniques including site-wide turnover, segregation, pre-processing and screening, ex-situ bioremediation, soil conditioning and stabilisation, and engineered placement were selected as the preferred and most sustainable remedial solutions.

This approach enabled treatment of the diesel-range soil contamination, removal of buried obstructions, management of asbestos containing materials and deleterious materials, and provided an opportunity to re-engineer materials to provide geotechnically robust development platforms.

An innovative three-tier risk based soil remediation criteria system was developed for the contaminants of concern (hydrocarbons and asbestos), with target concentrations linked to the depth of re-use below the proposed finish level. This approach mitigated human health risks in the future development while maximising the retention of soils on-site, and avoiding unnecessarily intensive and prolonged soil treatment.

A Materials Management Plan (MMP) was developed in accordance with the **CL:AIRE** Definition of Waste Code of Practice (DoWCoP) to regulate re-use as "non-waste". Technically robust remedial targets were developed through a DQRA by Firth Consultants, and geotechnical conformance criteria were agreed with the **NHBC**.

For parcels 2 and 3, a Written Scheme of Investigation was developed by Cotswold Archaeology, with extensive stakeholder consultation between **Historic England** and **Gloucester City Council.**

Best practice

A range of works started in January 2018 and were completed in October 2018.

Vegetation, fly-tipped wastes, and hypodermic needles were cleared across the parcels. Archaeological horizons were exposed and cleaned in parcels 2 and 3 to characterise and record the remains to enable future construction. Protective backfill soils were then placedvaround and over the archaeological remains.

The former oil depot was decontaminated, decommissioned, and demolished. Buried fuel pipelines and drainage infrastructure were cleaned and chased out across the site.

Localised LNAPL and hydrocarbon contaminated perched groundwater was removed using an on-site water treatment plant. A controlled excavation and segregation of existing above-ground historic stockpiles was completed, with over 800m³ of deleterious materials segregated. A total of 11,000m² of concrete hardstanding was broken out across Parcels 8, 9 and 10.

A controlled turnover and excavation of more than 70,000m³ of soils was carried out across all Parcels, segregating obstructions and contaminated soils. The made ground was screened and sorted to segregate fines and oversize aggregate; and fines were stockpiled and given unique stockpile numbers, before being sampled to determine requirements for further treatment.

About 12,000m³ of concrete breakout and separated oversize materials were processed to a 6F2 aggregate. The team completed the ex-situ bioremediation of 4500m³ of hydrocarbon-impacted soils in biopiles and windrows, and compliance against the three tiers of remedial targets was assessed to determine at which depth each stockpile could be re-used.

Almost 20 tonnes of asbestos containing materials were hand-picked by competent asbestos operatives. Lime/cement conditioning and stabilisation of soft alluvial clays were carried out to improve geotechnical properties.

The backfilling and re-engineering of processed suitable soils were undertaken to construct development platforms that achieved an average CBR of 15%, significantly higher than the 5% CBR included in the Remediation Strategy. This significantly reduced the requirement to import of virgin materials during the follow-on construction phase.

The site had a long history of industrial use

A crushed concrete layer was installed to leave a working platform for follow-on development.

Excavations, treated soils, and backfilled soils were verified independently by RPS; and materials tracked from origin to final destination provided a transparent audit trail and verified that recovered materials complied with the Remediation Strategy. Finally, stringent earthworks verification included nuclear density gauge testing and post-remediation settlement monitoring to verify settlement behaviour for future construction.

In total, 101,384m³ of materials were excavated and processed, with 100,060m³ of materials re-used and only 1,324m³ of waste removed off-site, delivering an impressive total materials recovery and re-use ratio of 99%.

The remediation and enabling works were completed two weeks ahead of programme, within contract cost, and regulatory sign off was achieved shortly after site completion.

Re-use of materials

The full remediation and enabling works, including all demolition, breakout, crushing, reinstatement and verification, was completed for approximately £2m. In contrast, to dispose of 4,500m³ of hydrocarbon-impacted soils and 19,500m³ of historically stockpiled mixed waste/soil materials offsite (along with import of an equivalent replacement volume) would have cost an estimated £6m alone.

The sustainable re-use of materials on-site has avoided an estimated 30 tonnes of CO_2 emissions from lorry movements, avoided associated local air pollution and congestion, and eliminated the need to import finite virgin materials such as subsoil and quarried stone.

In addition, the majority of the deleterious materials unsuitable for re-use were sent to recycling facilities off-site, with the only materials disposed to landfill being asbestos wastes and non-recyclable general waste.

The actual materials balance came in very close to that predicted by pre-start modelling, with a slight soil deficit. This worked well as Soilfix was able to modify its MMP to import and re-use 500m³ of surplus soils from a neighbouring Peel site, serving both sites well and further supporting sustainability.

Smith's Gloucester Ltd provided local labour, plant, and waste recycling services to keep employment in the local area and minimise vehicle emissions.

Health, safety, and stakeholder engagement

The remediation works were carried out under the highest standards of health and safety, with zero lost-time accidents during the nine-month contract and about 28,000 person hours worked. The site

was monitored daily for dust, odours, and noise. Airborne fibre monitoring ensured there was no unacceptable release of asbestos fibres, and industry-leading Scanning Electron Microscopy-based techniques were used to achieve a limit of quantification 1,000 times lower than exposure limits stipulated by the HSE in compliance with CIRIA C733.

Gloucester City Council's City Archaeologist, Historic England, and Cotswold Archaeology worked closely with Soilfix during the works on Parcel 2 and 3 including regular site coordination meetings. This was crucial to the successful exposure, recording, and protection of the historic foundations, walls and features of the Llanthony Secunda Priory.

The NHBC had a keen interest in the remediation works, with both geo-environmental and geotechnical oversight. Proactive engagement by RPS and Soilfix was key in providing confidence that works were meeting the Remediation Strategy and included NHBC site visits during the works.

During the works, Soilfix provided regular updates with interested parties and the general public via social media, including updates on the archaeology works and other notable events.

JUDGES' QUOTE:

The judges said: "A well-presented entry illustrating how effective regeneration of a derelict former industrial site can be achieved with a very high percentage of appropriate and beneficial materials reuse."

One very notable event was the discovery of a suspected World War 2 anti-aircraft bomb found during excavation of above ground waste materials. This needed the attendance of the **Royal Ordnance Engineers** and the temporary closure of the local supermarket's car park. Thankfully, the item was a redundant shell.

This project was only possible due to positive engagement and teamwork between multiple parties including client, prospective developers, designers, remediation contractor, consultants, archaeological specialists, regulators and industry bodies, all working in an open and collaborative manner.

Site development

After more than 10 years of dereliction and following 37 weeks of sustainable and robust remediation and enabling works, redevelopment of this valuable inner city site has now commenced. The re-engineered development platforms have enabled significant cost savings to be made on foundation design requirements during construction. Soilfix continues to be involved in the site, driving sustainable management of construction arisings under a new MMP.

Parcels 2 and 3 are being developed into canal side retirement and assisted living apartments, with the remainder of the Parcels being developed into residential houses and apartment blocks. This will remove the historical blight from this once stagnant site, ease pressure on the local green belt, and drive further regeneration of the strategic and highly attractive Docks area of Gloucester for the benefit of the local community.

HIGHLY COMMENDED

Former ordnance facility site, Hooton

ORGANISATION

McAuliffe

Blighted by the perception that it was too high risk to remediate, the 15ha site of the former Roften royal ordinance facility sat derelict for five years. This stemmed from preliminary site investigations, which had identified extensive zinc contamination across the site.

The clever re-use of materials unlocked **Roften** for development, enabling housebuilder **Stewart Milne** to begin building 265 family and affordable homes, a care home, 25,000m² of public open space, a pond for local fauna and flora, and a dedicated habitat zone.

The early involvement of **McAuliffe** and its specialist remediation arm, **Geostream UK**, brought the project back from the brink, with the team's robust and DoWCoP-compliant approach to material re-use.

In summer 2018, McAuliffe was appointed by Stewart Milne to complete an extensive programme of remediation and earthworks at the former Royal Ordinance Facility No.10 near Ellesmere Port. Working with Stewart Milne, McAuliffe provided advice from the land acquisition stage to give the client confidence to make the purchase. Despite the land being caught up in regulatory issues and remaining unsold for five years, the team knew it could find a viable remediation solution.

Roften had a legacy of contamination, having been exposed to 30 years of industrial use as a factory and mill, before being converted into an auxiliary munitions' storage facility in WW2. Initial site investigations identified extensive zinc contamination of the soil up to 52,000 mg/kg, with zinc contamination in the made ground deemed the main risk-driver to impacted surface water. Metal contamination was compounded by the presence of 25,000m³ of asbestos-contaminated stockpiles left on site.

There was a distinct lack of site investigation data around the key risk areas, which had been presented to the regulator alongside a limited and impractical remediation options appraisal. Uncertainty left the regulator with no choice but to set a cautionary remediation threshold of 1,000mg/kg for zinc contamination, which would have led to large volumes of material being taken to landfill.

The former ordnance facility site at Hooton

Previous partial demolition works had also left behind significant underground structures and hard-standings, with large swathes of the site not investigated due to obstructions. Thanks to its early involvement, the team provided a robust solution, revising the delineation and quantifying contamination issues, as well as establishing practical, cost-effective remediation technologies.

Its novel approach included delineating the site into a digitally generated grid for precise sampling, which reduced the predicted contamination zone by 50% to 29,000m². The team's GPS-enabled excavators and dozers worked directly with BIM models, ensuring excavations were clearly and accurately set out. Other efficient processes carried out include bioremediation and the re-use of demolition materials and green waste

It also made effective use of regulatory tools at its disposal, including the deployment of its Environmental Permit - the **CL:AIRE** DoWCoP MMPs and **CAR:SOIL** assessment - to ensure development could proceed.

The works: saved the client £1.8m; achieved 117,500m³ of re-used material; prevented 57,000m³ of waste from being removed to landfill; saved a potential 20,200 wagon movements; facilitated the delivery of five lorry loads of tree chippings to feed giraffes at Chester Zoo; processed 12,106m³ of demolition waste into valuable site aggregates; and completed the works without any health and safety or environmental incidents. In all, the team's approach led to a 99.88% re-use of material on-site.

Material	Volume re-used
Zinc-impacted soils	29,429m³
Asbestos-impacted soils	25,000m³
Processed hard materials	12,106m³
6F2	10,606m³
Type 1	1,500m³
TPH/VOC soils	933m³
Giraffe feed	60m³
Re-use of site-won clean cover	17,000m³
Import of clean sub soil (diversion from landfill)	33,000m³
Total re-use estimated	117,500m³ 250,000t
Material	**Volume Disposed**
Offsite Disposal	
Green waste	160t
Asbestos	19 t
General Waste	125t

WINNER

Highly Commended: Enfield Council, Wood E&IS UK Ltd, Turnkey Regeneration Ltd for their project Meridian Water - Meridian One (see page 43)

Goodyear, Former Tyre Factory Works, Wolverhampton

ORGANISATIONS

St. Modwen, Rodgers Leask Environmental

The tradename may be familiar to many, but the area where the UK manufacturing of the iconic tyre brand took place is less famous.

The former tyre manufacturing site is nestled within residential streets of Wolverhampton, 1.25 miles north of the city centre. The regionally important century-old site endured near to the population that served it while modern industry moved towards better connections along motorway corridors.

St. Modwen, after purchasing the site in 2004, was on hand to regenerate the 96 acre facility. The lease back agreement to **Goodyear** enabled the sequential completion of the missing part of the local tapestry of residential land whilst ensuring manufacturing continued as long as it was economically viable. The regeneration with key community investment in a modest area of Wolverhampton was welcomed by the local population. The multidisciplinary team formed by St. Modwen comprised the architects **Glancy Nicholls**, project management from **Wakemans**, planning liaison from **Planning Prospects** and engineering consultancy from **Rodgers Leask**.

The £25m regeneration scheme may not be the largest but is outstanding for seamlessly, and without disturbance, providing an understated sense of place and community to this Black Country city.

Historic context and masterplan development

The Goodyear site, formerly an enamelware factory from the early 1900s until 1926, began operation in the 1930s growing to a 96 acre site employing 6,500 at its peak. The decline of the facility was apparent from 2000 onwards, with the lease agreement seeing Goodyear relinquish parcels of land incrementally to St. Modwen and the main Factory Site ceasing operation in 2017. The agreement allowed the formation of a masterplan, tailored to address scars of the heavy industry and sewing in connections to the existing community. A combination of residential land for 850 units with a new 12 acre community park, local centre, school extension and retention of the iconic Goodyear clocktower was approved as the fabric for the regeneration.

Contamination and remediation

The remediation approach focussed on flexibility and sustainability, given the phased hand back of the site from Goodyear. The industrial legacy of the site meant there was residual contamination including asbestos, landfilling of rubber crumb, hotspots of volatile organics and hydrocarbon residues including LNAPL in both the soils and the perched groundwater. Complex ground conditions including historical tips, former clay pits and over a hundred years of overlapping development leaving many levels of ground obstructions (factory foundations and basements) at the site. This required the reclamation and remediation process to be robust but also targeted and cost effective, to ensure project viability.

JUDGES' QUOTE:

The judges said: "The careful demolition design was innovative and the sequential remediation was diligently planned. There was good community engagement and serious consideration of potential nuisance along with robust health and safety procedures. Materials were reused well and there was respect for the industrial legacy retention of significant heritage."

The approved remediation strategies targeted the significant reduction in key contaminant concentrations utilising a progressive turnover and reclamation strategy to identify and excavate areas heavily impacted ground. This was undertaken concurrently with isolated removal of free phase hydrocarbons and solvents. The sitewide turnover excavated and recompacted approximately 600,000m^3 material. A Site of Local Importance for Nature Conservation (SLINC) was present within the eastern boundary having developed in a former tipping area for the Goodyear operations. The careful reclamation works included the reprocessing and reuse of over 10,000m^3 of material from this historical onsite tip and the translocation of the natural amenity to Neighbourhood Park.

An area of benzene contamination was identified in the centre of the site associated with former Texine tanks. Following a 10-month Monitored Natural Attenuation (NMA) study and remedial options appraisal, targeted trial pitting and active pump and treat of the perched groundwater was considered the most effective approach. Approximately 30,000m^3 of impacted material was treated to make it suitable for reuse by windrowing and ex-situ bioremediation, with a proprietary nutrient mix added to supplement microbial degradation of hydrocarbons.

Preventative demolition design

The demolition of the former factory also shows excellent planning and mitigation of the risks associated with razing a building to the ground in such a sensitive setting. Establishing the requirements of the neighbouring school and community during the remaining demolition works allowed St. Modwen to provide confidence that robust demolition techniques and boundary management systems were adopted to prevent nuisance. Carbon black, the main feedstock used in rubber tyre production, had discoloured the brickwork after decades of exposure. The plan to control dust and noise, whilst retaining the former factory façade, had many benefits. The

Demolition, remediation, construction and re-occupation of the Goodyear Site

concern that the hydrophobic carbon black would be liberated as the masonry was disturbed required a physical barrier to reduce air movement and contain material not readily supressed by water.

The outward facing buildings disguised the extensive demolition operation but also served to reduce noise, dust and vehicle movements meaning that many residents were unaware anything was going on until the final sections where removed. This simple but effective sequencing of the work was a key example of how well considered the residents and school children were in the regeneration of the site.

Open space, community engagement, and infrastructure

The site, having been served by the people of Wolverhampton, now needed to serve the community it helped raise. The 12 acre neighbourhood park, opened in 2018 by **Councillor Evans** & **Emily Guest** (St. Modwen), with its green space, tennis courts, multiuse games area and wildlife ponds is a developing amenity.

The former factory's social club was refurbished and re-purposed into a children's nursery and studio before being handed back to the local community.

Pupils at the local primary school, adjacent to the final phase of development, were encouraged to understand the reclamation process being undertaken on the other side of their school fence. Emily Guest from St. Modwen invited the children on a tour of the demolition, reclamation and landscape construction. A special order for tiny PPE was placed and the children made the visit, a highlight for all involved.

The primary school children will soon see the benefit of this regeneration project as the final phase is due to be finished in 2019. The land given to the school will be handed over as a newly landscaped area comprising a safe drop-off and pick up area, woodland classroom and grassed area framing the entrance to the site where children have been educated since 1832.

The Goodyear Clock Tower has been retained as a central reminder of the site's former use adjacent to the local centre with its supermarket and restaurant/pub.

Regulator appraisal

The senior scientific officer at Wolverhampton City Council, **Martin Dye** said: "The regeneration and transformation of the Goodyear site, from one of the largest factory sites in Wolverhampton to a residential estate with numerous amenities, has been a real success. It has been a massive undertaking, but a phased approach to the development of the area has meant that works have always been tightly controlled, which in turn dramatically reduced the impact on the local community of those perennial problems with large-scale regeneration – noise, odour and dust."

Project summary & legacy

The key points of this project are not about scientific innovation or monetary value but the exemplary consideration given to the residents and community outlined within this project summary. The best practice is evident in the ability to control the undertaking of the demolition, turnover, remediation and earthworks reclamation within the residential community without interfering or unduly disturbing the existing residents. This was a challenge that increased each time a phase was completed, as the residents moved closer and the area within which to work grew smaller.

The project worked to minimise removal of material from site leading to a sustainable and ultimately cost-effective project due to early regulator engagement, excellent planning of the demolition and remediation. The repurposing of buildings for community use, retention of the Clock Tower and enhancement of the existing school shows an intention to retain and improve with careful design, rather than demolish before introducing low cost design in contrast to the surrounding architecture and community. All this was undertaken to maximise the value of funds used within a part of the country where regeneration is vital but residual land value less obvious.

The preparation, design and undertaking of the demolition, remediation, earthworks, materials management, drainage, highways and landscaping was in accordance with the appropriate legislation. The compliance of the scheme is clear from the response of the local authority but also evident from the statement is the benefit of the early involvement of the authority, who oversaw the public engagement and assisted in the liaison with the **Environment Agency**.

The excellent work to treat organic contaminants whilst retaining material within the small but suitable deep features of the post-factory landscape with the resounding approval of the local authority and Environment Agency.

The regeneration of this urban brownfield site has had a tangible benefit to the local community in providing a place to live that secured and improved many elements central to a thriving community. Many new residents see this site, with the new Neighbourhood Park, the extended Oxley School and the local centre, as the ideal location to bring up their family whilst being within walking distance of the city centre. Many near city centre schemes would not afford the open space and community centres opting for high density enclosed living.

The legacy of the regeneration is not one of monetary value but one of the discrete, understated return of this site to serve the community, giving a place to live, learn and play where the hard labour of the past century is evident only when looking for the time of day.

WINNER

Full-Scale Treatment of PFAS-impacted Wastewater Using Ozofractionation Validated Using Total Oxidisable Precursor Assay

ORGANISATIONS

Arcadis, EVOCRA

The challenge

In April 2017, approximately 22,000l of a fluorotelomer fire-fighting foam concentrate containing PFASs, with the principle fluorosurfactant reported to comprise 6:2 fluorotelomer-mercaptoalkylamido sulfonate (6:2 FTSAS) was accidentally released at a hangar near Brisbane International Airport and entered a nearby surface water creek, stormwater and sewage drainage systems. The release resulted in fish kills, warnings to recreational anglers, gained national and international media coverage and caused significant public concern.

Emergency response activities recovered >20,000m^3 of water impacted with up to 9,580µg/l PFASs from the creek, sewer and from decontamination activities which had to be stored in hundreds of isotainers on operational areas of a major international airport with considerable ongoing costs & disruption. **Arcadis** identified that established water treatment technologies could not effect removal of PFASs considering the complex nature of the waste waters and considering the challenging regulatory target of 0.25µg/l sum PFAS (via TOP assay). The co-contaminants in the multiple types of waste water requiring treatment included solids, very high BOD and COD from industrial sewer waste, brackish creek water, plus caustic and alcohol solvent rich water from decontamination activities.

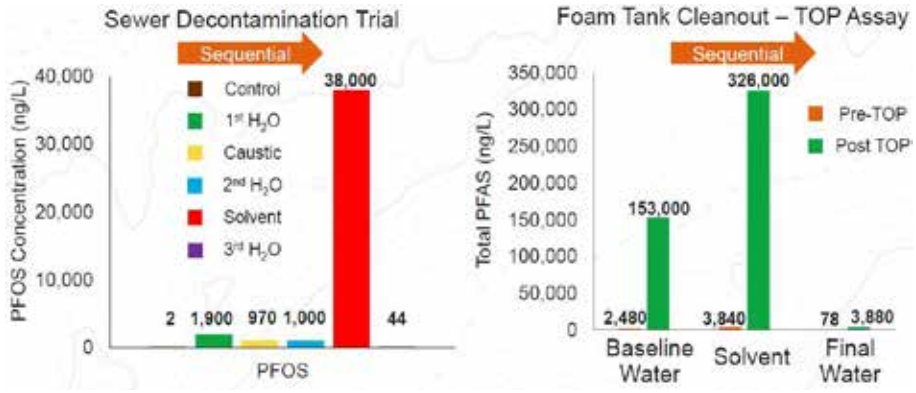


Figure 1: Example Decontamination Results

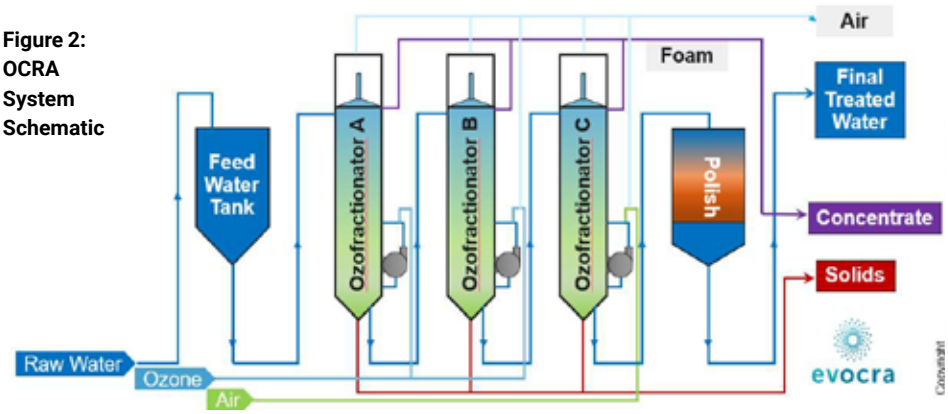


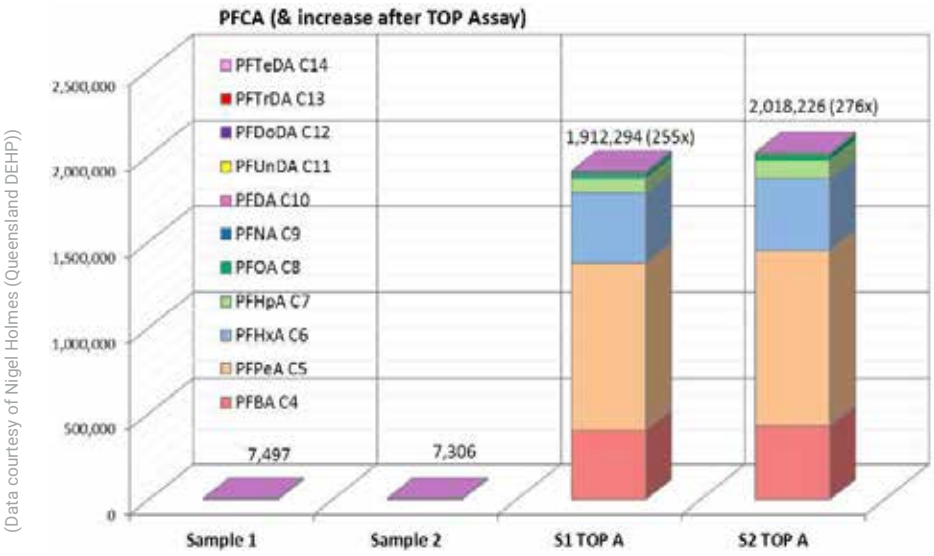
Figure 2: OCRA System Schematic

Best practice in analytical tools

The complexity of PFASs as a class of contaminants necessitated the development of a team of specialists from across the globe working across multiple time zones to deliver a viable solution for the client. Arcadis UK took the technical project lead, design of remedial approach, analytical and PFAS chemistry expertise; Arcadis Australia looked after client and regulatory liaison, systems engineering, project management, and treatment validation; Arcadis US took care of systems engineering support; and **EVOCRA** provided Ozofractionative catalysed reagent addition (OCRA®) technology provider, system operation.

The challenge was to treat water to 0.25µg/l for sum PFASs (via TOP assay) rather than to assess the concentration individual PFASs (using traditional analysis) as there are no analytical standards for 6:2 FTSAS and it cannot be quantified. 6:2 FTSAS is a precursor PFAS it will over time biotransform in the environment into detectable perfluoroalkly acids (PFAAs), not quantifying it and other PFAA precursors presents a significant latent liability. The TOP assay employs an oxidative digest to convert precursors, which cannot be quantitatively detected to PFAAs which can be measured by traditional LC-MS/MS techniques. The increase in measurable PFAAs following the oxidative digest gives an indication of the total PFASs present, hence informing the presence of precursors, as well as providing information on precursor chain length helping to characterise and identify the foam(s) impacts.

The use of TOP assay to verify remediation is understood to be a world first and required the dependable application of this new analytical methodology. The TOP Assay was commercialised in Australia by ALS in 2016 and is the only widely available commercial methodology which can assess a wide range of PFASs, including short chain PFASs and polyfluorinated precursors to the low detection limits



(Data courtesy of Nigel Holmes (Queensland DEHP))

Figure 3: TOP Assay of Surface Water Samples (ng/L)

specified.

Figure 1 illustrates that the PFASs in the concentrate lost in the spill are not those typically assessed as part of analytical suites to measure PFASs. The two samples on the left are from the surface water at the Brisbane site, results on the right show the same samples after the TOP assay digest. The results demonstrate that TOP assay can be essential for assessment of PFASs especially when considering recent releases, as over time these undetected precursors will transform into PFAAs in the environment.

JUDGES' QUOTE:

The judges said: "In a new category that attracted a number of quality entries from around the world, this Australian project clearly demonstrated the successful treatment of what is an emerging contaminant of worldwide concern."

Best practice in infrastructure decontamination

Recent research has demonstrated that PFASs can sorb to concrete , and therefore infrastructure can act as a secondary source of contaminants long after the initial exposure. Arcadis recognised that following pumping of waste water and foam from sewer and stormwater drainage, there was the requirement to remove residual PFASs which may have sorbed to the network. Drawing on extensive knowledge of PFASs properties, Arcadis trialled and assessed a sequential flushing approach using water, caustic and a mixture of biodegradable alcohol based solvents. Around 3.5km of domestic and industrial sewers were flushed with the recovery of PFASs assessed after each flush (Figure 2).

The solvent flush dramatically increased PFASs recovery (compared with water and caustic flushes) resulting in minimal residual contamination within the network significantly reducing the risks of ongoing leaching of PFASs from the infrastructure. This is understood to be the first large scale decontamination of drainage infrastructure conducted for PFAS.

The solvent mixture was also used to decontaminate the hangar fire suppression system (Figure 2) prior to its recommissioning with a fluorine free foams (F3). The innovative technique was used to remove residual PFAS from the concentrate storage tanks and distribution pipework so the new F3 foam would not be contaminated. Decontamination works were validated using TOP assay which not only identified significant sorbed PFASs on the infrastructure not detected by conventional technique but also confirmed the effectiveness of the cleaning process.

Best practice in water treatment

The remedial options available to address PFASs contamination are limited by the unique and diverse physical and chemical properties of these compounds as they are highly soluble and resistant to biodegradation and chemical oxidants. As the waste was highly complex with high concentrations of organics and inorganics from multiple sources and the treatment target was for sum PFASs, existing technologies such as anion exchange resins (AIX) and granular activated carbon (GAC) were not suitable. These technologies would also have required extensive pre-treatment of the water due to the presence of co-contaminants within the matrix, and resulted in significant spent media to manage. Prior to the implementation of this project the only feasible alternative treatment for PFASs in such complex wastes was high temperature (>1,000□C) incineration which would have been prohibitively costly and unsustainable.

Arcadis collaborated with Australian company EVOCRA to rapidly develop and deploy the patented OCRA® water treatment process developed for acid mine drainage that had not previously been employed to treat PFASs. Arcadis had identified that the technology had the potential to treat PFASs due to the propensity of PFASs to migrate to the gas:water interface and worked with EVOCRA to design, permit, and install a novel 5,000L/hr full scale system at the

Identification	Influent (µg/L)	Ozofraction % Removal	Polish % Removal	Total % Removal
PFOS	2.61	98.2%	81.3%	99.7%
PFOA	1.37	97.4%	94.4%	99.9%
6:2 FtS	87.4	95.6%	89.2%	99.5%
PFPeA	2.08	-66.3%	83.4%	72.4%
PFHxA	6.91	-66.4%	99.7%	99.5%
Sum PFAS	103	78.8%	95.1%	99.0%
Total PFAS, TOPA	**3,950**	**99.6%**	**89.6%**	**99.96%**

Table 1: Performance of Remediation System

airport in approximately five weeks.

The OCRA® system is a separation and concentration water treatment technology which comprises a series of vessels (Figure 3) in which micro-nano bubbles (MNBs) of ozone gas are passed through impacted wastewater to facilitate PFAS mass transfer to the gas:liquid interface, with the MNBs forming an emulsion which slowly raise to the top of the vessel partitioning into foam rich in PFASs, which is collected for further treatment. The use of ozone rather than air facilitates the formation of MNBs which are essential for effective removal of PFASs to maximize the gas:liquid interface via generation of a very high bubble surface area as a result of the small bubble sizes. The organic co-contaminants present in the waste water (i.e., sewage related organic matter <1,500mg/L COD, and decontamination solvents) can be oxidized by the ozone, or solids are floated out and do not impact the overall effectiveness of PFAS removal, a significant benefit compared to AIX and GAC. The OCRA system does not create any spent media requiring disposal and solid wastes are limited to suspended solids within the wastewater.

The OCRA® technology was optimised based on the chemistry of influent water and in order to meet the compliance target was deployed as part of a treatment train approach with a polishing step. Arcadis undertook trials using two technologies a novel regeneratable modified silica adsorbent media (Osorb), and nanofiltration (NF). Following data review the NF technology was selected with the rejectate transferred back into the OCRA® process for further treatment. The bulk of the PFASs and co-contaminants were removed by the OCRA® system thus protecting the NF membranes which are vulnerable to fouling and thus extending their lifespan. The performance of the combined system reached the challenging regulatory standards required.

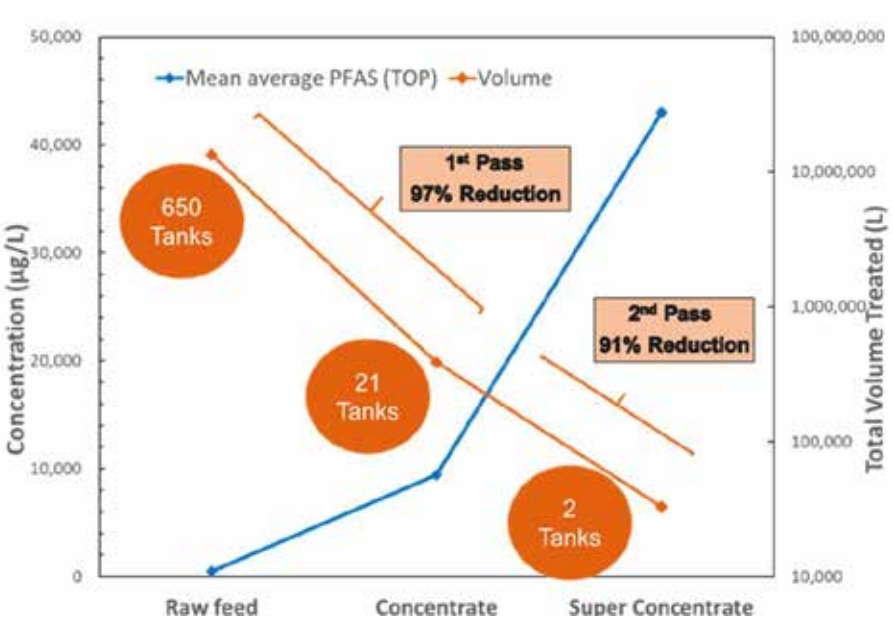


Figure 4: PFAS Concentration Using OCRA

First pass treatment of the 20,000m^3 water by the OCRA® system reduced the volume containing PFAS above the discharge criteria by 97%. This foam fraction rich in PFASs was then combined with the NF rejectate and fed back into the OCRA® system which reduced the volume by a further 91% (Figure 4).

Table 1 presents data for the treatment of a batch of impacted brackish creek water, the bulk of the PFASs removal was achieved by the OCRA® system which demonstrated highly effective removal (>95%) of long chain PFAAs and C6 PFAA precursors such as 6:2 fluorotelomer sulphonate (6:2 FTS). The highly oxidizing nature of ozofractionation converted some C6 precursors such as 6:2 FTSAS into PFAAs which was indicated by a net increase in perfluorohexanoic acid (PFHxA) and perfluoropentanoic acid (PFPeA) after ORCA®. Short chain PFPeA proved the most difficult PFAS to remove from the wastewater. Overall the treatment process achieved 99.96% removal of total PFASs validated by TOPA.

The bulk of the PFAS was removed from the wastewater into the foam fraction in the first vessel of the OCRA® system. The data also shows the importance of using TOPA to assess system performance with the bulk of the PFASs present not detected by conventional PFAS analysis.

Water treatment was completed in early 2018. The final volume of PFAS impacted water requiring incineration was less than 1% of the original volume recovered following the incident with just the superconcentrate requiring disposal via this route.

With potentially hazardous chemicals including caustic and ozone, 24/7 operations, and a treatment system being continuously optimised with major daily variations due to different influent streams, health and safety was crucial on the project.

Innovation in the Reduction of Pollution Burden and Waste Minimisation

The novel approach to PFAS treatment demonstrates a sustainable, high performance approach for complex aqueous wastes. A summary of the key performance metrics are highlighted below:

- Rapid emergency response to protect a sensitive receptor used by local people
- Commercial & recreational fishing restrictions lifted from nearby creeks, water quality within recreational guidelines and full amenity restored
- Novel application of an emerging remediation technology, taken from laboratory to full scale in one month and demonstrated to outperform established treatment technologies
- A world first in infrastructure decontamination to reduce future PFAS leaching
- A world first in achieving a treatment criteria for sum PFASs
- A world first in the use of TOP assay for validation and compliance assessment
- Greater than 99% reduction in contaminant mass sent for incineration, two 20,000L ISO containers rather than 650 ISO containers, leading to significant carbon savings
- No generation of spent adsorption media requiring management.

HIGHLY COMMENDED

Onondaga Lake Cleanup and Restoration, Syracuse, New York, United States of America

ORGANISATION

Honeywell

After two decades of environmental investigations, the dredging and capping of lake sediments, and habitat restoration, the remediation of one of the most polluted lakes in America is now complete.

Onondaga Lake is a 4.6-square-mile (3,000 acre) urban lake located in Onondaga County, adjacent to the City of Syracuse. Over a century of industrialization and municipal development resulted in impaired water quality from municipal sewage and contamination of lake sediments. Industrial contaminants of concern included mercury from a former chlor-alkali facility, multiple organic contaminants from other chemical/manufacturing operations, and hyperalkaline (pH greater than 12) inorganic materials.

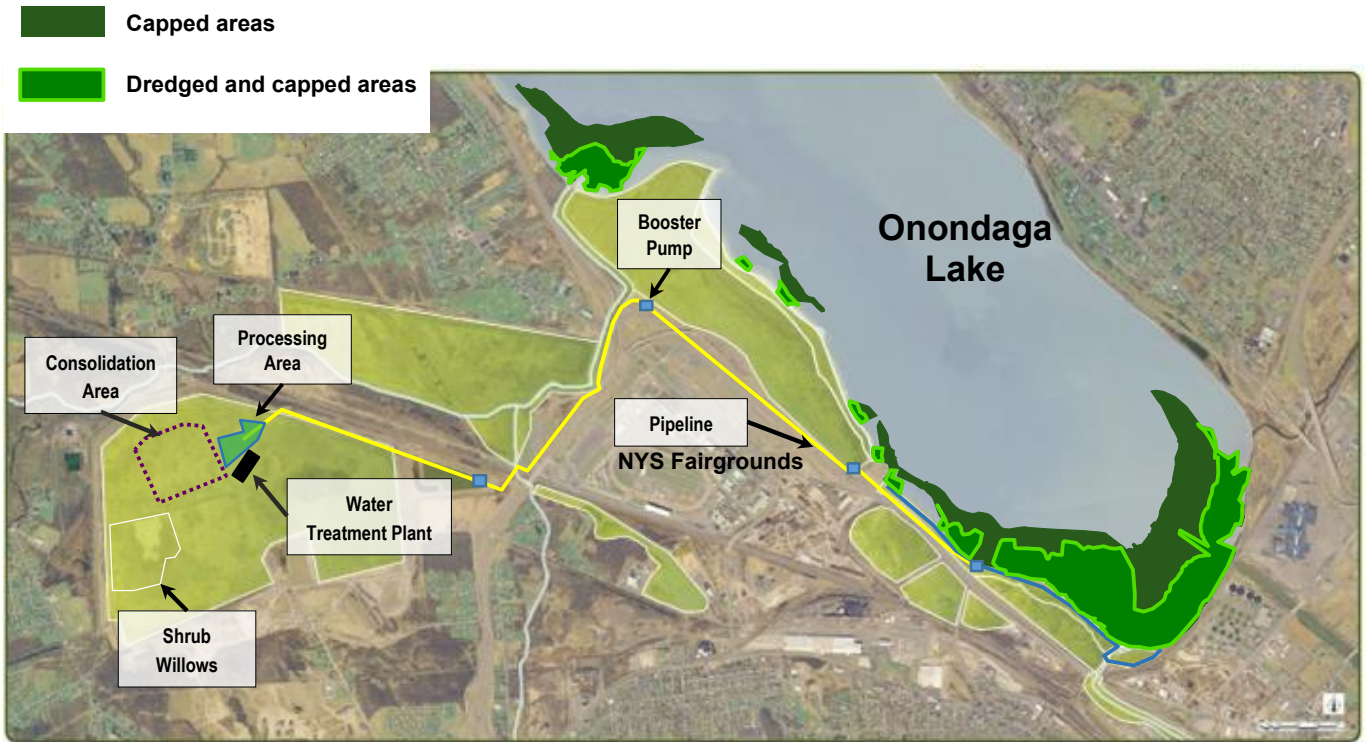
Recognized as one of the largest cleanup projects in North America, the Onondaga Lake restoration was completed through a focus on sound science, technical excellence, community engagement, sustainable practices, and a commitment to health and safety.

Project innovations resulted in significant advancements in sediment remediation technology. The multifunction cap design incorporated innovative components including site-specific biodegradation and reactive media to meet performance requirements for long-term chemical isolation and habitat restoration.

The cleanup combined dredging and capping with long-term habitat restoration, leading to an environmentally protective solution. Hydraulic dredges removed about 2.2 million cubic yards of material from the bottom of the lake. The 475-acre lake bottom was capped with over 3 million cubic yards of material consisting primarily of sand, activated carbon, and stone, providing a new habitat layer.

A major focus of the remedy was habitat restoration. As part of the cleanup, Honeywell has restored about 90 acres of wetlands, and about 1.1 million native plants are being planted. These areas in and around Onondaga Lake are now home to over 260 wildlife species, 130 unique bird species, and 65 species of fish (compared to nine to 12 species in the 1970s). Bird species threatened in New York State, including the bald eagle, pied-billed grebe, and northern harrier, have been observed in restored areas near the lake. Honeywell is also working with federal and state government on the creation of 100 acres of new native grassland habitats and the conservation of about 1,600 acres within the Onondaga Lake watershed.

Innovative approaches used in the dredging and capping design have combined with long-term habitat restoration initiatives which has led to an optimized, environmentally protective and cost-effective solution for Onondaga Lake, yielding long-term ecosystem, recreation, and economic benefits.



WINNER

Highly Commended: Elmbridge Borough Council for their project Part 2A Investigation of Former Gasworks Site (see p4)

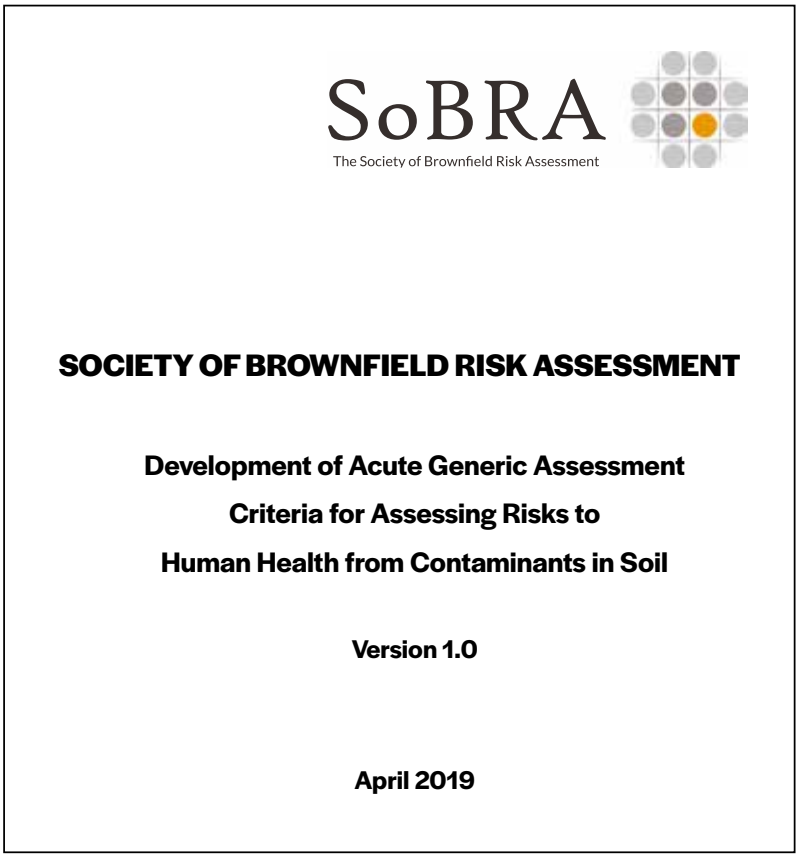
Acute Generic Assessment Criteria Subgroup

ORGANISATION

Society of Brownfield Risk Assessment (SoBRA)

There are a number of topics which **SoBRA** believes attribute to significant uncertainty in assessing land: a lack of information or research which leads to a lack of formal reliable guidance and subsequently no/ inconsistent assessment across the sector; increased unnecessary and/or unsustainable remediation or perhaps worse – a potentially unacceptable risk to receptors. SoBRA has stepped in to fill this void.

One example of SoBRA's development of good practice guidance is the Acute Generic Assessment (AGAC) guidance and spreadsheets published in April 2019.



Acute Generic Assessment Criteria Good Practice Guidance

The problem

Traditional risk assessment for contaminated land has been based on assessment of long-term exposure to substances in soil which tend to be based upon average exposure over a period. However, this approach may not be suitable for some substances (such as arsenic and free cyanide) where effects from short term or one-off exposure to concentrations are only marginally higher than the long-term thresholds can cause severe adverse effects. Guidance produced by **Defra** as part of the Category 4 Screening Level (C4SL) project and the **Environment Agency's** technical background to the Contaminated Land Exposure Assessment (CLEA) model highlighted this limitation but did not provide a solution.

The SoBRA membership identified that the gap for assessing short term soil exposure was leading to inconsistent assessment across the industry, or worse still, no assessment at all. Volunteers subsequently formed the AGAC subgroup and their collaborative work researching, and reporting plugs the gap and provides a solution to the problem.

The approach

The methodological steps undertaken by the subgroup included:

- Developing aims and objectives
- Collating information on the different approaches taken in UK and international literature on assessing acute exposure including in different industries such as water supply and fire response
- Defining the timescales for the acute exposures (a critical factor)
- Developing a methodology for developing toxicological acute risk thresholds including a first pass screening of substances as to whether acute risks need to be considered
- Defining common acute exposure scenarios to demonstrate the use of the assessment and parameterising the scenarios
- Identifying 'Setting out' criteria and developing an appropriate approach to algorithms
- Identifying substances commonly found in soil which could potentially pose an acute risk under the defined scenario to demonstrate the approach
- Developing acute risk assessment guidance including derivation of AGAC for specific substances demonstrating the methodology
- Peer review and communicating progress to the Executive Committee and wider SoBRA membership including at the annual meeting and other relevant meetings.

Working Group

The subgroup comprised 10 individual volunteers who contributed at least 150-200 days' work over the project period. The subgroup included consultants with a range of experience in

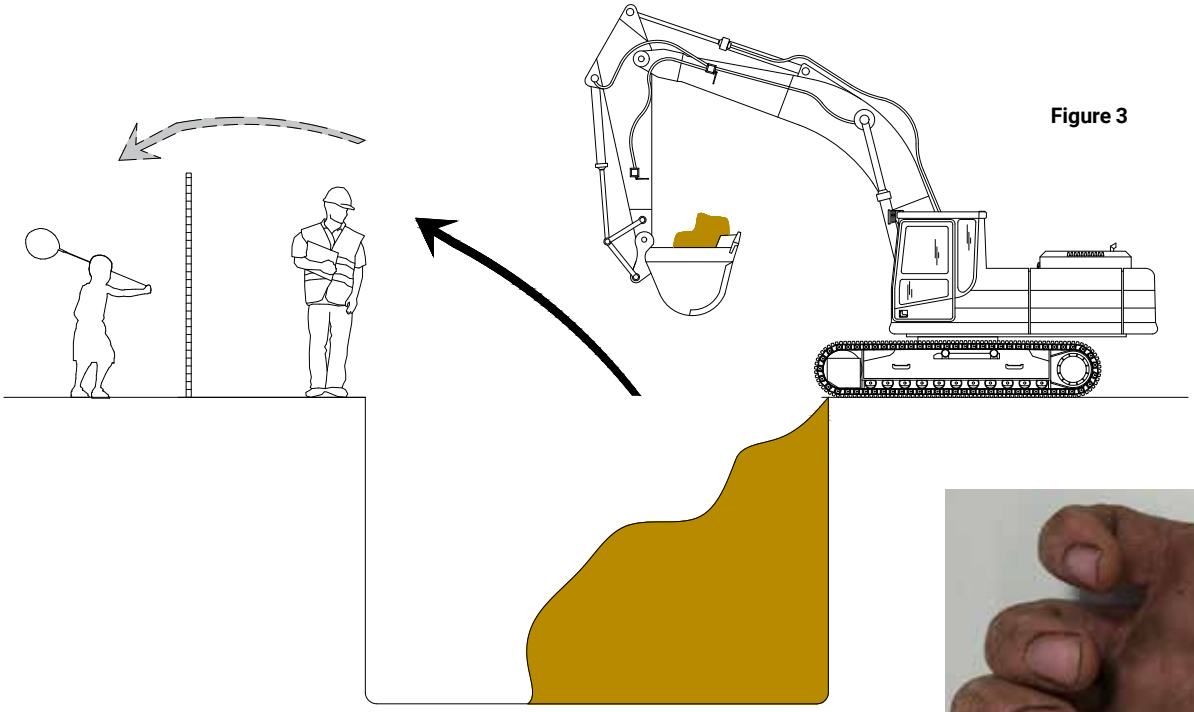


Figure 3

Figure 4

carrying human health risk assessment – some of who are accredited as risk assessors under the SoBRA accreditation scheme (ASoBRA) or registered (RSoBRA). Others included volunteers who had helped with a previous **CL:AIRE/EIC/AGS** project to develop the Soil Generic Assessment Criteria for Human Health Risk Assessment, a toxicologist, an exposure modeller from the Category 4 Screening Level (C4SL) consortium, as well as volunteers from **Public Health England** (PHE). The latter were particularly helpful in developing an acceptable approach for the toxicology.

Key features of the AGAC project

Toxicology

A significant part of this type of acute exposure risk assessment is the timescale dependent toxicology that underpins it. Because previous **Environment Agency** and Defra guidance has been focussed on long term exposure, the subgroup had to design an innovative new approach. They therefore considered information from other jurisdictions, adapted the guidance to be applicable to the UK context and developed a framework for using acute and sub-chronic exposure criteria to assess acute risks. Developing a methodology is a key step change for the UK.

As toxicology is a very time consuming and specialist activity, the group developed a methodology to screen the substance for acute risks, drawing on hazard codes and statement from the harmonised Classification, Labelling and Packaging (CLP) of Substances Regulations which have also been used in waste classification. Future assessments for novel compounds can therefore replicate the approach without needing initial specialist input.

The substances selected to demonstrate the methodology were also amongst the most common substance found in soil that may pose an acute risk. This meant that the toxicological basis underpinning these criteria was peer-reviewed.

Exposure scenarios

Site conceptual site models (CSM) (e.g. Fig 3) and conceptual exposure models (e.g. Fig 4) for a variety of situations where acute exposure was plausible were considered and the team worked out how to assess and model them. The key information sources are listed in the SoBRA report so a user can consider them in developing other future scenarios.

Two key receptor groups were selected following a receptor sensitivity screening process; members of the public, and construction workers involved with excavations. The key pathways of dermal contact, ingestion and inhalation were then identified, consistent with the CLEA guidance. Algorithms which would model these pathways were then selected following reviews of available applicable literature. Innovative algorithm modification was applied to make the algorithms fit for purpose.

The group then researched and identified reasonable maximal exposure levels for the required exposure input parameters used to characterise each receptor. This style of approach is best practice and in line with all UK guidance and legislation.

Limitations

The group also considered the potential misapplication of the AGAC and identified some common

JUDGES' QUOTE:

The judges said: "This volunteer-led project demonstrated a robust and transparent approach. The individuals involved showed dedication and significant personal contribution to ensuring the project was successful. The methodology and background material is available for use by others for other contaminant scenarios. And it might even save lives."

misconceptions and situations where the AGAC are not applicable. Examples of these include the impact of odours, specific behaviour such as pica (eating or mouthing non-edible items, such as stones, dirt, over a prolonged period) and assessment of free oils which behave differently to soil bound substances.

Demonstrating the suitability of the method

The subgroup combined the toxicology with the exposure assumptions, using the selected algorithms and derived a set of AGAC for each route (oral, dermal, inhalation) for each receptor (child, adult) for their defined exposure scenarios, for eight contaminants. The subgroup report details the approach taken, the decisions made and the resulting criteria.

A long period of QA and peer review ensured that the group were confident that the AGAC could be relied upon (another example of good/best practice). This included cross reference to chronic exposure criteria and reference to criteria in scientific and regulator position papers published in Europe, the US and UK.

Cost effectiveness

There are limited funding bodies prepared to create acute guidance. This report fills a significant gap in the risk assessment arena and is highly valuable as a risk assessment framework to improve consistency and scientific rigour. The methodology includes specific screening to target the acute risk assessment approach to substances of concern that may require it.

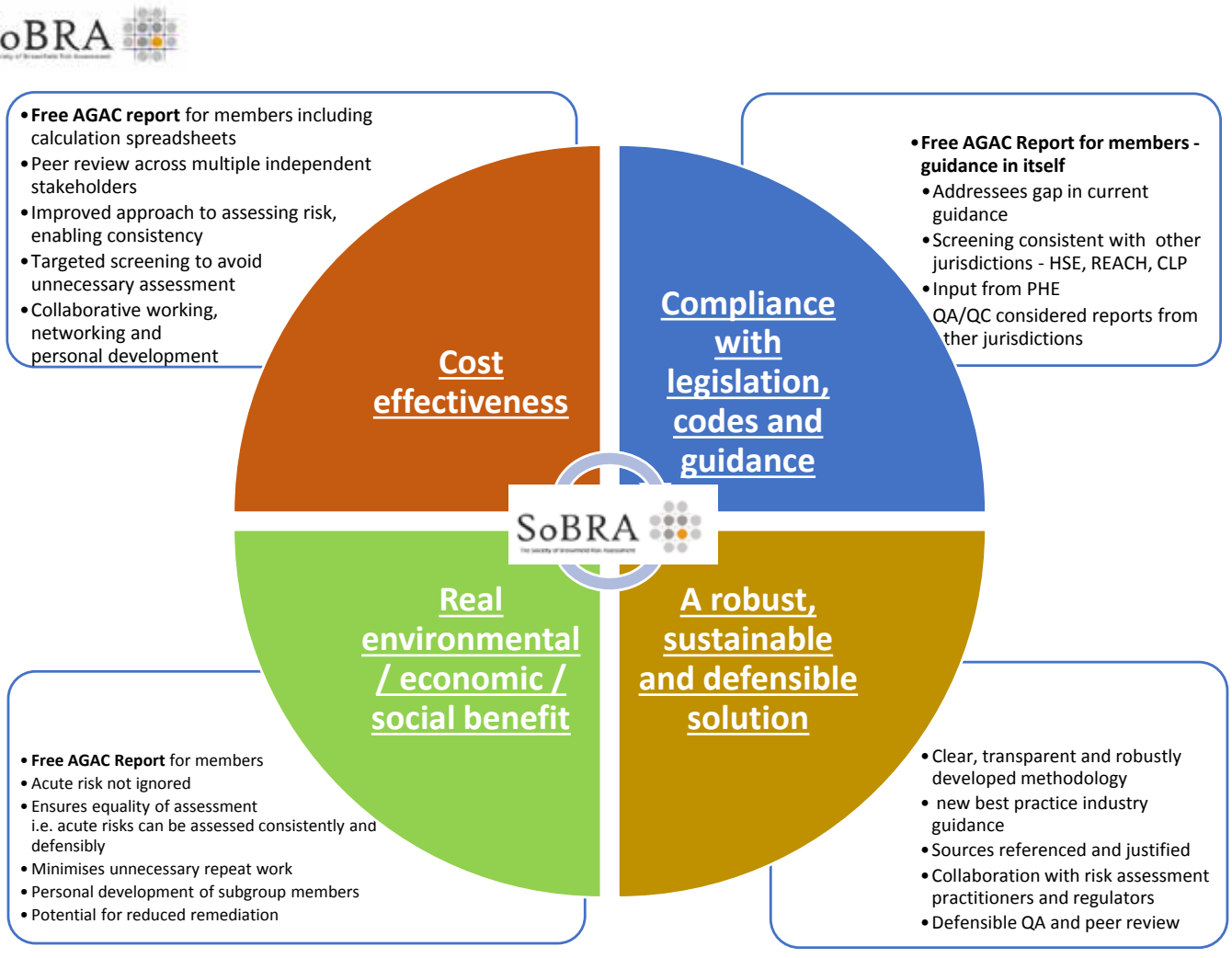
The document was prepared at minimal monetary cost as the work was developed through volunteers and time support from their employers. The approach enables the companies to pool their resources and to receive cost effective independent peer review (including by UK regulators) on their work to increase its robustness. Each company would otherwise have needed to develop this individually – probably without the same level of peer review.

It also provided an effective means for risk assessors to meet other like-minded individuals and network. Risk assessors had an opportunity to be involved in authoring technical guidance which might otherwise never cross their paths to write – improving their profile, experience, skillset, working methods, career satisfaction and reputation. Those who are not yet experts and are broadening their expertise are able to access and learn from other experts. This is invaluable to smaller companies where there are no in-house experts, enabling and providing an excellent training opportunity.

The guidance is free to SoBRA members. It will improve the efficiency and reliability of acute assessments, reducing the likelihood of inappropriate risk management decisions. It will provide a cost-effective benefit to the industry, a good practice framework for the training of regulators and consultants and a consistent deliverable to clients.

Compliance with legislation, codes and guidance

Whilst there is no UK guidance on acute risk assessment for land contamination, the subgroup paid attention to what international guidance was available and



Acute General Assessment Criteria summarised

what other jurisdictions do in this field. This included a detailed assessment of what other acute values were based upon and what that meant throughout the world, in addition to reference to HSE guidance on short term occupation exposure. The screening of substances based on the REACH and CLP was also consistent with other health, safety and waste regimes.

The AGAC report is therefore compliant with UK legislation, codes and guidance, appropriately uses guidance from other countries and is innovatively creating a new set of guidance.

Real environmental / economic / social benefit

The benefit of this publication is yet to be fully realised as it was only published in April 2019. However, SoBRA has undertaken a qualitative cost benefit analysis – the output will mean that money and time will be saved across several projects and will also result in better awareness.

It will enable a consistent approach to assessing acute risk assessment generically across the industry with a defined level of conservatism in the first instance. It also has the environmentally sustainable benefit that land will not be over/under remediated based on acute risk, which in turn will have an economic and sustainable benefit or mean that people are not put at risk unnecessarily.

We are aware that PHE have been approached by regulators in other countries for their insight in the key issues in developing soil guidance for acute risks in their jurisdiction.

A robust, sustainable and defensible solution

Existing UK and international human health risk assessment guidance explicitly excluded assessment of risk from short-term exposure to soil contamination and hence such risks were not being assessed consistently or appropriately.

SoBRA's publication fills this gap providing a clear, consistent and robust methodology to prevent all practitioners re-inventing the wheel (i.e. enables sustainable assessment) or remediate unnecessarily (environmentally sustainable). The collaborative approach, QA steps and stakeholder liaison means that the product is also robustly defensible. By providing the calculation spreadsheets, it also means that practitioners can replicate the work completed by the subgroup and it is fully transparent.

WINNER

Fulham Former Gasworks, London

ORGANISATIONS

Atkins, Cadent, Erith, National Grid

All gasworks site

The former gasworks at Fulham is one of the most complicated brownfield projects within the **National Grid** portfolio.

It has recently undergone numerous, interdependent phases of gas infrastructure removal and renewal works, alongside demolition and remediation in order to subsequently allow the site to deliver a large-scale residential mixed-use development, with over 1,800 new homes – with one-third of these being affordable housing and including a food bank and youth centre – commercial space, and open public areas.

Relocation of the Pressure Reduction Station (PRS) into a one-acre self-contained compound and diversion of over 1,000 metres of high-, medium-, and low-pressure gas pipelines was required to safeguard the energy supply for 250,000 homes in this area of West London while allowing the remainder of the site, located within the South Fulham Riverside Regeneration Area, to be released for the proposed development.

There has been a gasworks in Fulham for almost 200 years, with land first being purchased and developed into Imperial Road Gasworks from approximately 1824 onwards. This gasworks covered a large proportion of the surrounding area, which has been revitalised in phases into mixed-use residential and commercial developments over the past 18 years.

The project, led by National Grid Property Holdings Limited, required close coordination with **Cadent Gas Limited**, who undertook the relocation of the original PRS as well as constructing the three large diameter gas main pipelines within a constricted corridor. Cadent and their specialist contractor worked alongside **Atkins Limited** as Principal Designer and **Erith Contractors Limited** as Principal Contractor for the demolition and remediation works, which enabled the construction of critical infrastructure on a highly complex brownfield site. Careful project planning, cooperation, and interface management was required across a wide multidisciplinary team to ensure timely completion of the technical deliverables and find solutions to arising challenges that could not have been foreseen when the project commenced.

Application of best practice and compliance with legislation, codes and guidance

Successfully undertaking a high-profile project of such complexity required significant commitment across the entire project team to approach the work with care, diligence and to meet all their responsibilities in relation to current best practice and legislation. All phases of the work – from demolition to depot relocation to remediation – were driven in large part by exacting planning conditions in accordance with the

requirements of the *National Planning Policy Framework*, which allowed the site to be successfully divested to the follow-on developer after sign-off was completed following the submission of various verification reports.

Before the demolition and remediation works commenced, Erith was fully committed to providing a safe and well-organised site, frequently liaising with all parties to ensure the Construction Design Management (CDM) 2015 Regulations and all other relevant health and safety legislation were fully implemented throughout the works. All delivery vehicles were FORS (Fleet Operator Recognition Scheme), CLOCS (Construction Logistics and Community Safety) and LEZ (Low Emission Zone) compliant, with Erith coordinating a CLOCS cycle awareness day alongside local police.

Although two incidents causing minor injury to contractor staff occurred over the entire project length of more than two years, the learnings from one incident led to a safer, more robust standard operating procedure being rolled out across the entirety of the Erith business which enabled safer refuelling of large plant from a temporary fuel tank.

Erith continually adjusted, improved, and innovated their demolition methods due to shifting timescales and the highly constrained nature of the site, including diamond cutting through a section of a gasholder wall to form the entry ramp as live above-ground gas mains ran very close to the gasholder.

An area of the southern section of the site contained live buried gas mains throughout the demolition and infilling works, which required specific consideration and working methods to be adopted to ensure the works could proceed safely including remote telemetry strain gauges fitted directly onto the high-pressure gas main. Atkins produced a Ground Movement Assessment Report, using live-feed remote monitoring points placed on two gasholders and the surrounding ground to assess the potential ground movement effects of dewatering, demolition and infilling on the nearby main. One gasholder was completed first, and the data gathered from this process were used to inform likely effects on the ground closest to the main. This led to the development of a site-specific ground model which enabled the dismantling, demolition, and infilling of a column-guided gasholder to continue within 15m of a live high-pressure gas main.

In order to minimise waste going to landfill in accordance with the waste hierarchy, excavated soils within the southern area of the site were considered potentially suitable for reuse as infill material within one of the gasholders. A sampling regime was undertaken to ensure that the nature of the waste soils was understood, alongside detailed quantitative risk assessment to define further the site-specific reuse criteria. This led to a Materials Management Plan (MMP) being produced under the CL:AIRE Definition of Waste: Development Industry Code of Practice (DoW CoP) for the site which allowed for the excavation and reuse of these soils, diverting over 4,200m^3 of waste from going to landfill.

JUDGES' QUOTE:

The judges said: "This was a complicated infrastructure project with multidisciplinary working, showing collaborative efforts between contractors to minimise financial, environmental and time impacts, including preventing material being sentenced to landfill. Significant amounts of infrastructure were relocated and there was excellent stakeholder engagement with history and legacy addressed."

Cost effectiveness

Over numerous points of the project, opportunities were identified to aid in efficiency and cost effectiveness and a collaborative approach to the project scope was encouraged by National Grid to better manage an intricate, multifaceted project. Some examples of where the multidisciplinary team was able to contribute to the overall cost effectiveness of the project included:

- To enable gas infrastructure replacement works to continue without interrupting supply to homes in the area, the existing Cadent Depot needed to be moved twice during the works. One Erith team designed and constructed Temporary Depot 1 while another Erith team constructed the Atkins-designed Temporary Depot 2, which allowed resources to be shared across all project phases. Erith managed all subcontractors including electrical, water supply, and waste disposal providers
- Rather than both Cadent and Erith managing their waste soil disposal individually, potentially increasing lorry movements, sampling budgets, and hours spent managing disposal, Erith took over waste management responsibility for the arisings from both Cadent's and Erith's work phases allowing for a streamlined approach to stockpiling, sampling, and logistics
- Erith was able to crush concrete and brick from both their own and Cadent's

Completed PRS and gas main installation (top right)

work under an appropriate environmental permit for reuse on site, reducing the need for Cadent to dispose of useful arisings from their works

- The reuse of the excavated soils from the southern area saved the project from sending over 4,200m³ of soils to landfill and lessened the requirement to purchase this same volume in recycled aggregates – this saved over 600 lorry movements when considering the waste alone. With the additional requirement for imported fill this would have doubled, saving thousands of miles of road traffic overall
- Significant flexibility and coordination across the project team to manage changing aspects of scope which allowed for a large reduction in preliminary costs, mobilisation time, and potentially costly programme implications.

Effective Public/Stakeholder Engagement

National Grid utilised the services of a communications advisor to help manage engagement around the project, notably as the project was a large-scale demolition and remediation programme over two years surrounded on three sides by sensitive residential properties.

The project team implemented distribution of a regular newsletter, a project-specific website and a bespoke booklet. Local interest groups were invited to site for discussions and walk-arounds on numerous occasions. A local school visit to the site was organised with students learning about construction site management and operations along with running an art contest inspired by the gasworks and the gasholder structures.

The project team were very supportive of the local community when concerns were raised about the works, regularly liaising with nearby residents when the demolition works were seen potentially to impact upon them. Erith achieved a "Performance Beyond Compliance" score as part of the Considerate Constructors Scheme.

Real Environmental/Economic/ Social Benefit

The very nature of the project has significant benefits entrained within, as it brought a large-scale derelict, underused, and contaminated site to a condition where it can be redeveloped into a something valuable for the people of London – 35% affordable housing, new commercial spaces and opportunities. Community infrastructure along with a significant amount of public, open parkland which includes the incorporation of a Grade II* listed structure signposting the industrial heritage of the site. Some specific benefits the project achieved were:

- Removal of over 8,400m³ of hazardous soils, including tar and sludge from numerous previously unidentified below-ground tar tanks which will have a positive impact on groundwater quality
- Removal of asbestos from a number of buildings and overhead gas mains, making the future redevelopment works safer for workers and the surrounding communities
- Preparation of 5.7ha of land within a highly populated area of West London for mixed-use residential development, providing housing, open parkland, and commercial opportunities to the community
- Retention of key historical features – including elements of a column-guided gasholder frame, the oldest gasholder in Europe, and two Grade II listed buildings – to enable the important industrial heritage of the site to remain intrinsic to its identity
- Diversion of over 4,200m³ of waste from landfill through the CL:AIRE DoW CoP
- Over 5,300t of metal from the demolition of the gasholders sent to recycling
- Crushing and reusing approximately 12,000 t (~6,700m³) of concrete and brick on-site under an appropriate environmental permit to reduce significantly the requirement for imported recycled aggregates
- The way the works were managed – such as recycling site-won materials for re-use, sending all steel from the gasholder structures for recycling, reducing waste to landfill including treatment of hazardous soils wherever possible as opposed to landfilling and reusing site-won soils for infilling, and minimising lorry movements and time on-site – all contributed to energy and carbon savings across the project programme.

Gasholders, storage of heritage parts

GeoShield

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WINNER

Silvertown Tunnel Natural Capital Offsetting

ORGANISATIONS

Arcadis

Transport for London (TfL) engaged **Arcadis** to deliver environmental services for Silvertown Tunnel, a proposed tunnel under the River Thames between Silvertown and Greenwich.

This is a Nationally Significant Infrastructure Project (NSIP) and therefore required an application for a Development Consent Order (DCO). In line with national policy, the TfL and Arcadis vision and to secure the DCO, Arcadis was required to demonstrate, through the Environmental Impact Assessment (EIA) process that there would be no residual effects on biodiversity.

Arcadis and TfL wanted to go one step further and demonstrate an overall biodiversity net gain. The lack of fixed landscaping plan to accompany the submission drove the need for a novel approach to provide maximum flexibility for the client but to ensure net gain. Mitigation was delivered via a Biodiversity Action Plan and Mitigation Strategy (BAP MS) by maximising on-site benefits and using a natural capital accounting offsetting approach to maximise off-site benefits.

The site was a typical fragmented, poor quality, urban brownfield habitat, generally undervalued in terms of biodiversity and other natural capital values. The goal of the BAP MS was to minimise, quantify, qualify and monetise biodiversity impacts and ultimately deliver a net gain and enhancement in biodiversity and ecosystem services. In addition to setting out detailed design parameters for on-site habitat creation as mitigation, which maximised biodiversity value, clear targets were also set for off-site mitigation. To facilitate the off-site delivery, the natural capital value of the baseline was estimated and a potential natural capital maximum deficit value was assigned to the scheme.

These calculations were based on the capitalisation of the ecosystem service benefits that come from the land, (i.e. water quality and quantity regulation, carbon sequestration, air quality benefits, biodiversity etc.). This facilitated communication and negotiation around a commuted sum to be provided by the client for investment in local off-site mitigation projects as well as targets and auditable values for such mitigation.

Design principles and natural capital-based offsetting strategy

The approach included the following:

- Natural capital accounting combined with a project specific Biodiversity Action Plan
- Areas available for landscaping were used to calculate potential residual losses of habitat
- Design parameters and planting palettes for replacement habitat were designed for brownfield and artificial habitats for the rare black redstart bird as well as invertebrates
- Ecosystem service assessment to calculate habitat values
- Potential worst-case deficit capitalised over a 100-year period with appropriate discounting applied as per the Green Book for temporary and permanent loss to generate a capital sum
- Production of a template for local project applications for fund allocation
- Checklist with numerical values attached to aid the evaluation of project applications and an audit of performance.

The project

Silvertown Tunnel is a new highways tunnel under the River Thames between Silvertown and Greenwich and it is one of the UK's NSIPs. The habitat around the scheme is typical of a poor-quality urban brownfield site which is traditionally undervalued in terms of biodiversity and natural capital. A combination of the relatively high land value, the restricted land availability on the site itself (the land subject to Compulsory Purchase Order (CPO) and included within the scheme's redline line should be minimised) the multiple stakeholders and the technical design constraints led to uncertainties over the detail of the landscape plan for the scheme. Therefore there were uncertainties over the type, quantum and location of ecological mitigation that could be guaranteed. However, despite these uncertainties confidence was required in the mitigation for the Environmental Statement (ES) that the scheme would deliver net biodiversity and environmental gain.

The selected approach and outcomes

Arcadis produced an associated BAP MS to accompany the ES which included identification of planting palettes and general physical designs to present a clear quantum of habitats required to be replaced on site or off site (i.e. to be offset). To aid the progression of the offsetting required for the on-site shortfall, each habitat was assigned a Natural Capital Value (NCV) based on the ecosystem services supported and a potential "worst case scenario" for the on-site deficit to calculate the budget for offsetting to ensure that the scheme would deliver a net gain for biodiversity and the environment.

The NCV calculations were made for temporary and permanent habitat loss to provide scope for the project to offset all its potential residual effects. The mitigation hierarchy of avoid, reduce, mitigate, compensate was adhered to. The valuation included qualifying, quantifying and monetising. This value was used as a position for initial budget identification and discussion to be carried forward to spend on projects in the local community that support the habitat design principles and key receptors as outlined in the associated BAP MS. The BAP MS was also designed to be

JUDGES' QUOTE:

The judges said: "The application of Natural Capital was innovative in this community focused scheme, which also saw good stakeholder engagement. Biodiversity Net Gain was the starting point, which underpinned the strategies."

carried forward with the engagement of stakeholders and a Scheme Design Review Panel. Therefore, the BAP MS provided confidence in the prediction of residual effects for the Ecological Impact Assessment of the Ecology chapter in the ES.

Following submission of the DCO application, Arcadis provided evidence at the DCO examination to explain the approach. It also engaged with the Local Planning Authority at the **Royal Borough of Greenwich** (RBG) to evolve the Section 106 agreement for the monetary offset by liaising with their sustainability officers and legal team. This resulted in Arcadis writing project application templates and Key Performance Indicator (KPI) checklists for RBG to evaluate suitable projects and to demonstrate their value in line with the BAP MS along with a method to measure compliance. This approach provided ultimate flexibility for the design whilst maximising the value of any habitat creation.

Notable innovation or exemplary best practice

It is believed that the selected method was the first natural capital offsetting approach implemented in the UK for an NSIP and was successfully defended during the examination process.

Cost effectiveness

The proposed solution maximised the site value and at same time minimised the overall cost for providing mitigation. The land, that would have otherwise been purchased to implement the required mitigation measures locally, is of extremely high land value and subject to third party acquisition. In addition, the client had restricted purchasing powers. By introducing local social value into the offsetting opportunities, the capital value and overall value for biodiversity was maximised.

Compliance with legislation, codes and guidance

This approach ensured that a net gain would be delivered despite uncertainties at the design stage which could be secured in the DCO.

Effective public/stakeholder engagement

This approach fully engaged the LPA and the local community in shaping biodiversity. Effective stakeholder engagement ensured the approach was well understood and accepted as the most appropriate way forward.

In conversations with **Natural England**, brownfield habitat was highlighted as a key receptor requiring mitigation. One of the main challenges was to meet the key regulator expectations for adequate mitigation without a fixed outline design and no landscape detail. Another challenge was to reach an agreement with RBG with regard to their role as a key stakeholder and the off-setting monetary value of the brownfield habitat.

In a series of meetings and discussions, Arcadis managed to lead the planners through the rationale, method and findings as well as the practicalities of the implementation and monitoring at the following stages. Agreement was reached to deliver the offsetting project, and a few valuable lessons were learnt throughout the process.

Key points

Monetising mitigation definitely drew stakeholders into discussions that were previously not at the top of the agenda, so as an engagement piece it is certainly effective.

Stakeholders attributed value to items that environmental specialists did not - for example, non-native invasive species as an ecological resource. Engagement is critical.

Key biodiversity receptors was the focus to a bespoke approach to natural capital offsetting.

Providing a monetary sum alone is not the end of the mitigation but the beginning. It is vital to work with Local Planning Authorities to provide detailed plans around how to spend the money provided to ensure that money is spent on biodiversity rather than administration.

Real environmental/economic/social benefits

The approach secured the following benefits:

- Raising environmental awareness with regard to the importance of brownfield habitats for invertebrates and some bird species, including the black redstart
- A biodiversity 'net gain' will be achieved in an area in London which will foresee significant development in the next 20 years
- Creating and incorporating in the BAP MS a practical delivery and auditing mechanism which will ensure that the money is spent on a project that meets the biodiversity criteria
- Providing examples of potential habitats and their maintenance requirements within the BAP to facilitate

and encourage stakeholder engagement
- Design parameters and planting palettes were targeted towards brownfield and artificial habitats for the rare black redstart and invertebrates
- Monetising the ecosystem services process provided by land in an urban setting provided a mechanism for providing certainty in terms of a net gain where detailed designs were yet to be confirmed
- Providing an opportunity for the local authorities to engage with local conservation groups or schools to explore potential project options
- Creating a potential for local communities to initiate a small-scale project and apply for financing it to RBG
- Reducing the potential overall cost for the project by avoiding the need to CPO land specifically for ecological mitigation
- By providing the design principles, key stakeholders, key receptors, habitat quantum and budgets in one document (for both on and off-site provision) and in a clear cohesive fashion the mitigation can be progressed through detailed design process without losing sight of the vision
- Delivering project application templates and audit checklists progressed the vision from consultancy design to application more smoothly with reduced administrations costs.

A robust, sustainable and defensible solution

The proposed approach successfully combined environmental, economic and social benefits, making it a real sustainable solution. The approach was successfully defended and secured via a DCO requirement which guarantees the delivery of the mitigation. There is a template for project submissions directed towards brownfield targets and a checklist to score project submissions and audit success. By combing social engagement with the community with natural capital and biodiversity values, there is potential for maximising environmental and social net gain.

WINNER

Meridian Water – Meridian One

ORGANISATIONS

Wood, Enfield Council, Turnkey Regeneration

Meridian One is at the heart of Meridian Water and was a 7ha heavily contaminated and constrained former gas works site lying vacant for over 40 years since town gas production stopped.

The site was acquired by **Enfield Council** in 2015 to unlock the initial stage of the wider masterplan through remediation and enabling works for the residential-led development. Coupled with key transport infrastructure improvements will be the opening of the first of the green and blue gateways through the development. The station is anticipated to serve up to four million passengers per year on the East Anglia mainline. The phased nature of the overall development allows 'meanwhile' use areas for temporary 'makers and creators', cultural arts and entertainment pop-ups; the plots not part of the 725 new homes development, are being considered for green uses such as tree nurseries. The Meridian One design incorporates a green eco-corridor along the public station access and will open up a blue corridor of water features including the canalised Pymmes Brook and water attenuation features within the site. The site further integrates public foot and cycle access with social and community infrastructure including Meridian Angel Primary school and the adjacent Ladysmith Park.

Due to its historical use the gasworks site was heavily contaminated, including by Light and Dense Non-Aqueous Phase Liquid (LNAPL and DNAPL) in a shallow gravel aquifer. Remediation in 1998 removed some below-ground structures and grossly contaminated soils, and between 2001-2006, ~100m^3 of NAPL was extracted from the aquifer using total fluids pump and treat.

Whilst the previous remediation was successful in terms of mass removal there remained significant volumes of residual NAPL beneath the site. There also remained a high level of uncertainty as to the risk NAPL presented to the development e.g. remobilisation during enabling works, migration into deeper underlying aquifers during piling and the extent of remediation that would be required to achieve regulatory approval.In addition, there were significant potential risks in time and cost predictions to reach closure. The significance of the remediation could not be understated – it was critical to the delivery of the entire project as without regulatory acceptance of an economically viable and timely scheme, it could not go ahead.

A preliminary Conceptual Site Model (CSM) that had been developed for the earlier remediation had been over-simplified. This was because it only considered the shallow subsurface environment and did not account for significant variations in the ground model at greater depth. Using newly-acquired information on the deeper groundwater, a revised, complex CSM was developed on Enfield Council acquiring the site. The data supporting the CSM was consolidated into a database and supplemented by monitoring to create a 4D conceptual understanding of the site and contaminant loading. The CSM formed the basis for early and regular engagement with the **Environment Agency** (EA) and provided a visual tool to communicate risks and understand key drivers for remediation to stakeholders so that they were confident in the understanding of the site and decisions based on the CSM. Early consultation with regulators was important as it allowed investigations to be adapted to address their concerns. The project followed principles set out in CLR11 and ensured site investigations were delivered in accordance with BS10175 and BS5930.

The London Major Sadiq Khan visits Meridian Water

JUDGES' QUOTE:

The judges said: "This was a complex and effective use of redundant brownfield with clear stakeholder/ community engagement with benefits beyond the immediate site apparent. The fact it is a deprived area means that the local authority must lead and this development has been looked at by many areas as something to follow. The project also dealt with a variety of contamination scenarios. 2019 is "the year" for this project because the remediation was completed, the railway station was opened and the contract agreed to develop the site."

Developing the remediation strategy and design

The client and consultant team used innovative and recent guidance-driven risk assessments to develop a remediation strategy and design to address environmental liabilities within the constraints of time and cost. The groundwater remediation focused on NAPL recoverability rather than thicknesses and therefore remediation close-out was not targeted at a concentration or thickness, but on reducing the volume of mobile NAPL to an agreed target. This ensured that a sustainable and proportionate approach was taken to remediation that did not entail reducing NAPL to a target that would require significantly more time and resources to achieve. The EA accepted the risk assessment and approach to remediation that once NAPL removal rates were below a certain level it could be determined as 'non-recoverable'. Whilst best-practice risk assessment was employed for human health, given the high-density nature of the proposed development, direct contact exposure risks could be managed through clean cover systems and hard cover in areas of public realm, supplemented by implementation of locally deeper clean service corridors. Vapour modelling indicated that installation of vapour membranes in ground-level structures would mitigate this exposure pathway.

Implementation of the remediation design supported the strategy of maximising reuse of site won materials. Soils were pre-classified using site investigation data, further segregated at source and managed on site through detailed stockpiled management processes. The final pre-construction development levels were designed to allow profiling to mirror the form of development to ensure future arisings would be minimised for the developer.

Innovation and delivery

The options appraisal for NAPL remediation focused on sustainability of the approach and ability for the technology achieve recovery at low rates. The US invented NET System was chosen as the preferred technique, which was bolstered by key training through supplier **Environmental International Corporation** (EIC). The technology is relatively simple but uses specialist developed hydrophilic fabric with recovery downhole on a continuous belt system. While a relatively low-tech low-cost solution, the novel technique had only been used at one site in the UK and was a pioneering technology for the sector. The equipment had the benefits of working remotely by using battery power, so was not in the way of soils remediation, thereby also increasing sustainability through its low intensity recovery and autonomous operation. The technique proved to be a significant success for such a complex site where other traditional recovery methods had not succeeded or suffered from inefficient operation. The method allowed recovery of a further 15m^3 of NAPL at a 95% fluid recovery, thereby successfully 'mopping-up' residual NAPL to reach the required recoverability end point.

Historical gas works and Lea Valley in background

Typical gasworks contaminants, e.g. TPHs/PAHs, metals, cyanide and asbestos, were handled within the overall 100,000m^3 cut and fill balance of the site. Site dewatering was passed through an onsite water treatment plant with recycled water used for damping down dusts. Japanese knotweed and Giant Hogweed went through a process of treatment and eradication. Furthermore, stabilisation of 1,000m^3 of soil, allowed geotechnical improvement for use below rail station public realm areas of the site. Naphthalene-impacted soils were excavated, placed in an on-site 'soil hospital' and a drone survey completed to determine the 5000m^3 volume. The material was subjected to bioremediation trials before the 'Skyhawk Hydroeater' product was selected to successfully treat the material; again this was a new entry to the UK, demonstrating the projects ethos in seeking unique and novel solutions for site-specific problems that would drive maximum benefit.

The bioremediation works were completed within 8 weeks prior to seasonal colder weather (predictions were for a 12-16 week treatment period based on typical expectations). This was very important for the project as it enabled method compaction for time critical rail station works to be commenced linked to the opening of a new rail station. Naphthalene was the risk driver, reducing 99% from an initial average of 1,108 mg/kg to 9 mg/kg, a magnitude lower than the required remedial criteria.

These methods helped the project to achieve a goal of zero off-site disposal of site won soils. The on-site treatment removed the need for road haulage movements as well as the associated mileage, minimising congestion on local vehicle routes and address the excessive costs of both exporting contaminated soils and importing replacement materials to site. Concrete recovered from the significant below ground structures at the site was crushed,

tested and re-used as a capping cover layer across the site. The works were undertaken in accordance with Environment Agency (EA) guidance and the **CL:AIRE** Definition of Waste: Development Industry Code of Practice via an approved Materials Management Plan.

Infrastructure improvements included the construction of a new highway junction into the site from Leeside Road, the new rail station and the relocation of a medium pressure gas main through the site. A future phase will involve the relocation of an existing Pressure Reducing Station. There were many project interfaces with **Haringey Council, Network Rail, Volker Fitzpatrick Rail & Civils, UKPN, Thames Water** and **Cadent Gas** that required effective co-ordination and management.

Community engagement and benefits

As part of all Council tendering opportunities, scoring is weighted towards benefits to the community. This is to support the build up towards the permanent housing, jobs and parks that will benefit local people. Benefits to local people includes a programme of traineeships and apprenticeships throughout construction phases. Where possible, local people have undertaken

NAPL recovery NET System in operation

roles during remediation – one example is 'Grace', a lady who lives on the adjacent street and cleans at the site; previously she worked nights an hour away – over the last two years she has been able to walk her young children to school and return home for bedtime each evening.

Ensuring the developer introduces high-speed broadband digital connectivity and low carbon heat will be of benefit to new and existing residents; the latter will be supplied by the Council's own energy company, **Energetic**, reducing the carbon footprint for heating by 60%. An incinerator to the north-east of Meridian One will provide steam-driven heat for distribution to the new development and beyond.

Once developed, the increased ecological value through additional green pockets and waterside space gives a connection with the Lee Valley and social benefit through a genuine sense of place and natural capital.

The Meridian Water team has been highly proactive in engaging with residents' groups, schools and colleges. Community engagement 'drop-in' events commenced early in the planning stages and have continued at regular intervals, supported by resident's newsletters during the main stages of remediation. The local school helped design a park for local communities at Ladysmith Park and the remediation team arranged STEM events at schools in the area. The EA were invited to site and attended with a team of Technical Officers to learn about the NET system technology and to have a walk around to gain understanding of a construction site in action.

2019 is a key year for the scheme as the soil and groundwater remediation has been successfully completed, the new rail station has been opened and Enfield Council have entered into contract with **Galliford Try** to develop the site, marking the point at which the scheme can confidently step forward into the next stage of its visionary transformation.

CGI of waterside living and workspace by scheme architect KCA

WINNER

Amy Juden

ORGANISATION

Arup

Amy is a consultant with the Arup contaminated land team. She has seven years of experience working on brownfield site investigation, assessment and remediation projects.

She has produced desk study and preliminary risk assessment reports for sites with a variety of industrial histories and ground conditions across the South east and experience of project managing and undertaking intrusive ground investigations on a variety of sites and utilising a wide range of investigation techniques. She has provided generic and site-specific contamination risk assessments for soil, groundwater and gas and has experience in specification of remediation works and providing verification services and reports.

Amy's diligence and attention to detail is key in her repeated success in forging relationships with a variety of regulators. This is key to her role at Arup easing her projects through the planning process, will full consideration of the environmental requirements.

She has specialist expertise in asbestos in soil investigation and human health risk assessment and is developing skills in site specific ground gas assessments. Amy is also keen to ensure that appropriate automation, data capture, management and analysis techniques are developed and applied in ground investigation and contaminated land assessment work where possible.

Amy is a skilled contaminated land consultant with expertise in managing ground contamination workflows within large multidisciplinary projects as evidenced by the following:

2015 to present Whitecliffe (formerly Eastern Quarry), Kent

Working for the land developer, Amy is managing the ground contamination and land quality aspects of this large residential development project. Her involvement in the project so far has included:

- Delivery of a detailed land quality desk study and interpretive reports, including risk assessment and earthworks strategy for reuse of materials on the 150ha former chalk quarry site
- Supervision of complex phased geotechnical and Geo-environmental ground investigations
- Innovative ground gas investigation strategies and risk Assessments using industry-leading data capture and analysis tools
- Hydrogeological risk assessments, consultation with the **Environment Agency** and **Thames Water**, and provision of long-term groundwater monitoring strategy to ensure safeguarding local groundwater resources and future abstractions from the chalk
- Materials management plan for reuse of all soils on site under the **CL:AIRE** definition of waste code of practice
- Environmental specialist advice and verification supervision of the earthworks' contractor
- Open and regular consultation with the **NHBC** to ensure successful land quality endorsement certification for the scheme.

JUDGES' QUOTE:

The judges said: "The winner is clearly a diligent and enthusiastic professional who has well developed technical and business skills.

"Their role in industry bodies with research, contribution to guidance as well as convenor of conferences shows dedication to skills and career development.

"The judges were very pleased to see a strong (in numbers and quality) set of entries for this important award – a bellwether for the industry. Submissions ranging from ecologists to risk assessors and digital specialists illustrate the broad scope of brownfield work.

"The winner is clearly a diligent and enthusiastic professional who has developed a broad range of technical and business skills. A well-presented entry demonstrates their role in industry bodies, contribution to guidance, conference participation and contains excellent client references."

2016 to 2018 Watermeadow Court, West London

Amy managed the contractor during her full-time supervision of this detailed ground investigation of a BDA-Red category contaminated site in West London. She helped ensure the collection of high quality environmental and geotechnical data from this complex intrusive investigation.

This former fuel depot had contaminated groundwater and LNAPL. Amy refined the conceptual site model through time, taking account of the complex history, ground conditions, variable permeability aquifer, tidal influence, and historic (partial) remediation.

Amy delivered a remediation cost analysis for a basement optioneering exercise, considering multiple development layouts and construction scenarios working closely with the quantity surveyor and specialist remediation contractors and clearly communicated uncertainties.

She produced a highly detailed interpretive report and risk assessment; and throughconsultation with the robust local regulator has facilitated development of this heavily contaminated high value residential development site in West London.

Amy was a trusted advisor to her client, providing detailed remediation cost appraisal services to assist the developer in determining the most cost-effective basement design and construction methods. Consideration of groundwater treatment, containment, soil waste disposal and vapour protection required to develop this.

Tom Larsson, Design Director, **Stanhope** said: "The site in question is the most complex contamination case we have worked on. [..] As such Amy had an even more pivotal role in the site analysis and scheme design process than would otherwise have been the case.

"Her role in early strategic advice, as well as managing the ground investigation works and contractor, producing reports in support of the planning application, consultation with [the local authority] and the work on remediation costs for

basement optimisation, was performed with care, diligence, attention to detail and, moreover, delivered with conviction that reassured myself and the client body of the proposed strategy."

2016 Wood Wharf, Canary Wharf

During this large-scale ground investigation on a highly constrained and complex active construction site, Amy provided supervision and technical guidance to the site investigation contractor for all geo-environmental aspects. She has compiled information over several contractors' works packages for production of the verification report for the first phase of development.

2015 Earls Court, West London

Amy produced a detailed ground contamination desk study and preliminary risk assessment for this large Masterplan development site. She has also scoped and supervised various phases of ground investigation on this active demolition site.

2014 Waterside Drive, Walton-on-Thames (Leap)

Working within a strict timeframe and budget Amy was the lead engineer managing and undertaking a detailed site investigation into a historic landfill site alongside the Thames.She produced of a detailed interpretive report including site specific assessments for human health and controlled waters risks. The project was to facilitate development of new sports facilities in Elmbridge.

Amy Juden

Extracurricular activities

Geological Society

Amy serves as Secretary of the Early Careers sub-committee of the Contaminated Land Group of the **Geological Society** since it's inauguration in 2016. It involves significantvoluntary time.

She acted as convenor for three conferences since 2016, shaping a technically diverse and interesting programme, contributing to marketing and chairing conference sessions.

SoBRA and Asbestos in soils

Amy is a recognised skills leader in **Arup** for asbestos in soils. Her interest in the topic was sparked during the early part of her career working on several sites with problematic low levels of asbestos fibres. She has contributed to research projects with **SoBRA** (2014 and 2019) and authored Arup guidance for asbestos HHRA2.

In April 2019 Amy hosted a one-day asbestos in soil HHRA workshop with the SoBRA working group. Approaches to toxicological assessment and exposure modelling were discussed. This was a pivotal meeting for the group attended by regulators, major consultancies and asbestos experts. Amy's aim is to contribute to a published industry guide on asbestos in soil risk assessment.

Meet the judges

Clive Boyle
Managing Director
CRB Environmental

Ian Grant
Director
Environment Analyst

James Cartwright
Director
McAuliffe

Lisa Hathway
Principal Land Quality Engineer
NHBC

Alex Ferguson
Managing Director
Delta Simons

Jonathan Atkinson
Technical Specialist Groundwater and Contaminated Land
Environment Agency

Ann Barker
Lead Officer Contaminated Land, Environmental Health,
City of Bradford MDC

Dr Richard Boyle
Senior Technical Manager
Homes England

Stephan Jefferis
Director
Environmental Geotechnics

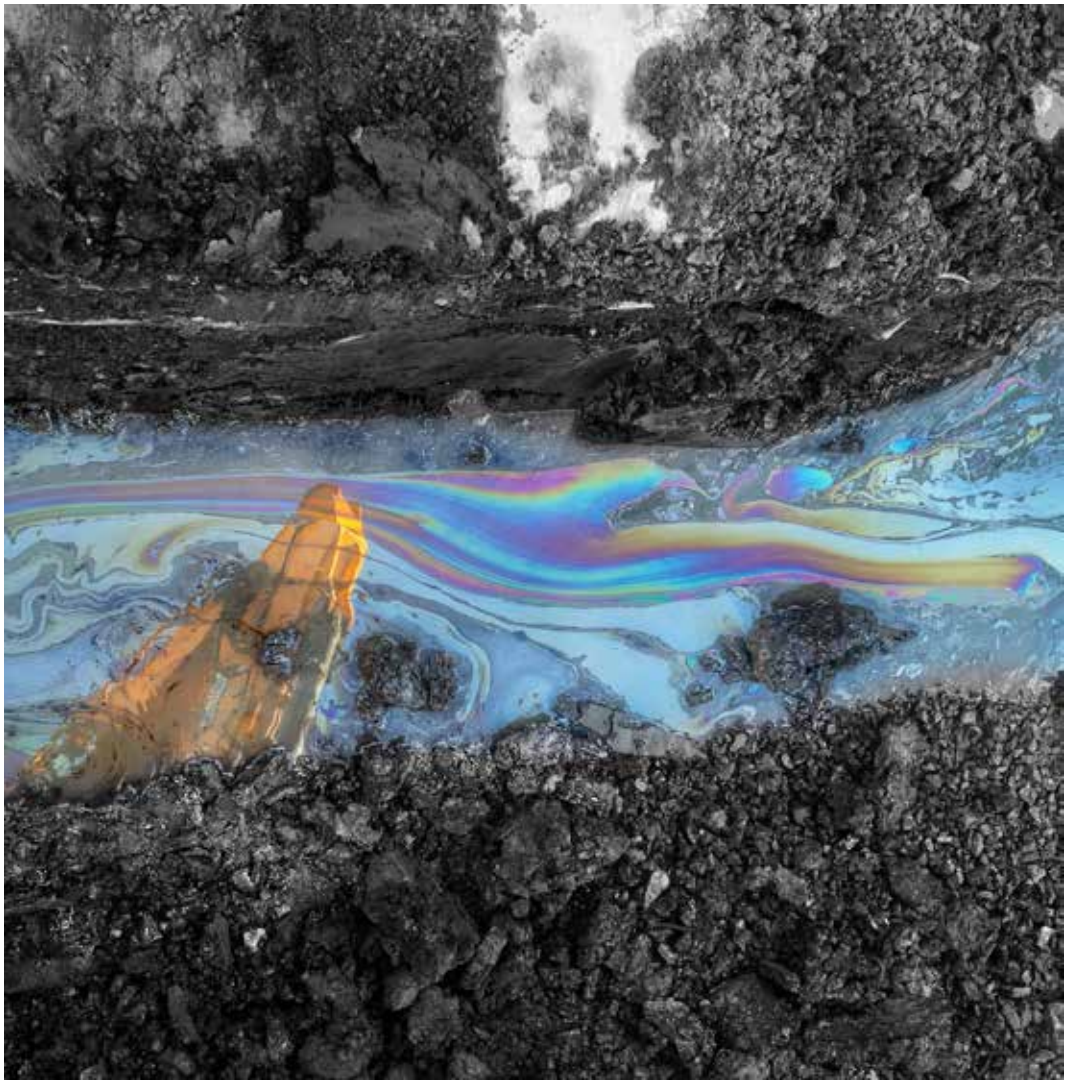
Christine Mardle
Technical Director
WSP

David Rudland
Contaminated Land Officer and Remediation Project Manager
Swindon Borough Council

Jonathan Steeds
Technical Director
Atkins

Frank Westcott
Director
Westenviro

Beautiful brownfield photographic competition



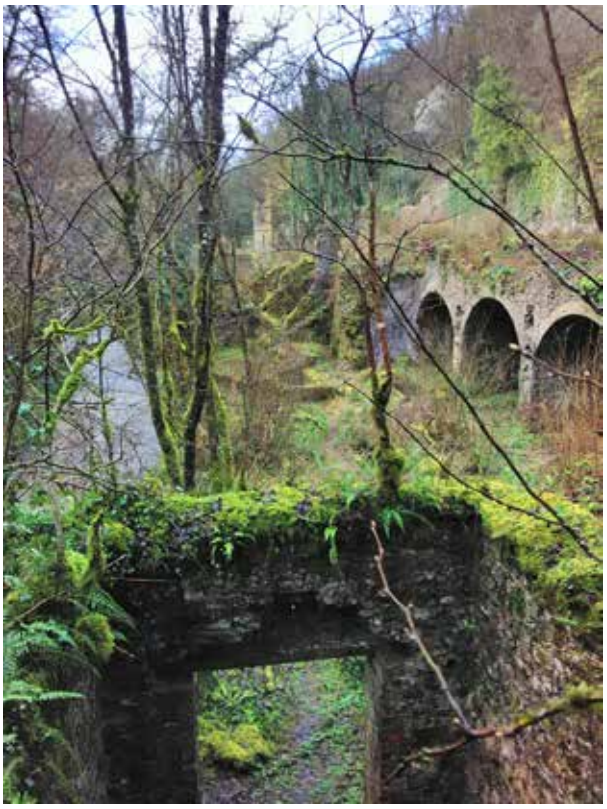
Winning photograph by Jonathan Russell, Sanctus Ltd

Window to a future, photograph courtesy of National Grid

Snailbeach lead mine chimney by Hannah Fraser

Photograph courtesy of Brownfield24

Meridian One, by Mitch Thomas, Wood



Fussel Iron Works by Will Thorpe, Southwest Environmental Ltd

Making waves by Richard Stockdale, Sanctus

Service Provider Directory

Below is a selection of service providers including land remediation consultants and contractors. For our full directory, please visit our website **www.environment-analyst.com/dis/directory**

AECOM

A Fortune 500 firm, AECOM is the world's largest remediation company with more than 5,000 remediation staff world-wide and a gross annual revenue from remediation projects alone of over $1 billion. We design, build, finance and operate infrastructure assets for governments, businesses and organisations in more than 150 countries.

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Campbell Reith

Campbell Reith is an independent firm of consulting engineers providing structural, civil, environmental, geotechnical, highways and transportation services. With a reputation for producing imaginative and cost effective design solutions, we are recognised by our clients as a firm of innovative and pragmatic thinkers.

James Clay, Partner
Tel: 01737 784500
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Web: www.campbellreith.com

Celtic EnGlobe

Celtic-EnGlobe is one of the leading remediation and brownfield enabling works contractors in the UK, with a proven track record of delivery after more than 25 years in the industry. Celtic-EnGlobe is part of EnGlobe Corp, a world leader in providing integrated environmental services which operates in the UK, France, Middle East, USA and Canada. By partnering with us, you are able to rely on our extensive experience and delivery capability.

Kathy Newall, Business Development Manager
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Tel: 07985 836227 | Tel: 01189 167340
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Web: http://celtic-ltd.com

DEME

DEME Environmental Contractors UK Ltd

DEC is one of Europe's leading environmental remediation contractors with more than 25 years' worldwide experience in the treatment of contaminated soil, sediment and groundwater using both in-situ and ex-situ technologies (on and off site). Projects undertaken range from small petrol station clean-ups to large-scale, complex, multidisciplinary remediation schemes.

Jim McNeilly, General Manager UK
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Ecologia

Ecologia is a multi-disciplinary, specialist contaminated land contractor that provides advice and undertakes remediation projects across the UK and Europe. We also have an established and excellent reputation for the construction and operation of in-situ remediation plant for soil and groundwater.

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Web: www.ecologia-environmental.com

GeoStream UK Ltd

GeoStream UK is the only single source provider of tried and tested remediation technologies in the UK, offering the full range of physical, chemical and biological treatment techniques for soils and groundwater and exclusive providers of Trap & Treat® (BOS 100® & BOS 200®) and the full range of injectable substrates supplied by Carus Remediation Technologies for the UK and Ireland.

Chris Evans, Technical Director
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Web: www.remediation.com

John F Hunt

JFHR undertake innovative and sustainable soil and groundwater remediation projects across the UK. We work in a collaborative manner to deliver projects on time and on budget. As part of the wider JFH group, we are able to integrate other disciplines including demolition, civils and infrastructure, and asbestos consultancy.

Ben Williams, Managing Director
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McAuliffe Civil Engineering Ltd

McAuliffe delivers solutions in brownfield site transformation at land acquisition and build-out stages. The business offers a full turnkey service, with core capabilities including soil and groundwater remediation, haulage and materials management, ground improvement and foundation solutions, and demolition services.

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PeroxyChem UK & Eire

PeroxyChem is a speciality chemicals company which, through our Environmental Solutions division, provides remediation practitioners with an unparalleled portfolio of field-proven and innovative remediation technologies. These chemistries are designed to support soil, sediment and groundwater treatment of in situ and ex situ applications/designs. Our business model is designed to aid project implementation from start to finish – dedicated support staff HELP to develop remedial designs and solutions.

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Ramboll

Ramboll is a leading engineering, design and consultancy company employing 13,000 experts. Our presence is global with especially strong representation in the Nordics, UK, North America, Continental Europe, Middle East and Asia Pacific. We constantly strive to achieve inspiring and exacting solutions that make a genuine difference to our clients, end-users and society at large. Our globally recognised environment and health practice has earned a reputation for technical and scientific excellence, innovation and client service. Advances in science and technology and evolving regulatory, legal and social pressures create increasingly complex challenges for our clients. We evolve to keep pace with these changes – by adding new services, contributing to scientific advances or expanding geographically.

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Sanctus Ltd

Sanctus is a specialist remediation contractor offering solutions for all issues associated with brownfield land development, including a wide range of in-situ and ex-situ soil and groundwater remediation techniques. Sanctus holds a bespoke environmental permit for the onsite treatment of hazardous waste and is also a licensed asbestos contractor.

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Shawcity Ltd

Shawcity is an independent business focused on bringing the latest technology from the world's leading manufacturers to the UK and Ireland. We enable customers working in Environmental, Occupational Hygiene and Health & Safety applications to achieve the highest levels of monitoring performance. We have the UK's largest hire fleet of GasClams, the world's first in-situ borehole gas monitor which gives high frequency unmanned data readings for up to three months at a time. Manufacturer-trained and approved, our technical team also offer in-house servicing, calibration, repairs and training as well as unlimited technical support.

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Soilfix Limited

Soilfix is an award-winning remediation solutions provider to the development, industrial, commercial and public sectors. Our mission is "to understand and manage risk in the ground". Soilfix has developed an outstanding track record for delivering innovative remedial solutions for contaminated and brownfield sites.

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Director
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Waterman Infrastructure and Environment

Delivers multidisciplinary engineering solutions to the property, construction and redevelopment sectors. Services include site investigations, risk assessment, cost effective remediation and contract management, reporting to facilitate planning conditions discharge, and waste classification advice on excavated materials during development and contract negotiations. Our experience brings strategic advice to minimise risk and costs.

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If you would like to appear in our online directory, please email sales@environment-analyst.com

Environmental Services Directory

For our full directory, please visit our website **www.environment-analyst.com/dis/directory**

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