REGENESIS®

Award-Winning PFAS Remediation at a Private Airfield

CASE STUDY

In situ PlumeStop barrier treatment unlocks site divestment and redevelopment in England, UK

INTRODUCTION

In a three-year collaboration, REGENESIS and Mott MacDonald have successfully implemented a sustainable remediation solution for Per- and Polyfluoroalkyl Substances (PFAS) contamination at a private airfield in England.

A milestone project
Remediation of PFAS impacted groundwater on this site was completed through the injection of PlumeStop to create a passive underground water filtration zone. This in situ treatment was the first of its kind in the UK.

The source of contamination
The airfield Fire Training Ground (FTG) was identified as the source of contamination. Historic use of PFAS containing Aqueous Film Forming Foam (AFFF) in this area resulted in a plume of contaminated groundwater under the site.

An award-winning collaboration
REGENESIS and Mott MacDonald worked closely together to devise a solution for the landowner to unlock divestment of a portion of the site for redevelopment. The project has won the 'Best application of remediation technologies' Award at the Brownfield Awards in 2023.

Figure 1. Fire Training Area

DESIGN APPROACH AND PLANNING

Mott MacDonald carried out a Remediation Options Sustainability Assessment following SuRF-UK guidance, which included a high-level assessment of each option's environmental, social and economic factors. A passive PlumeStop barrier approach came out as the preferred option.

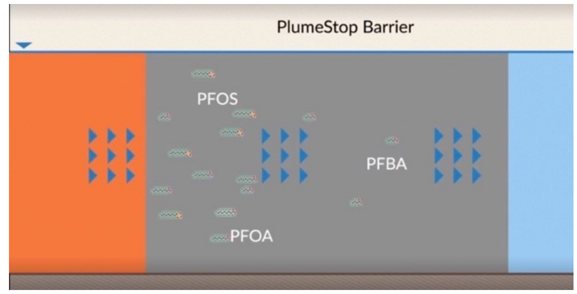


Figure 2. Schematic section view of an PFAS contaminated aquifer (orange), showing the sequential sorption of PFAS through a PlumeStop permeable reactive zone (grey).

Design Principles

Central to the design of this approach are the principles of the Contaminant Distribution Coefficient (Kd) and retardation. Coating the aquifer in a 1-2µm layer of activated carbon increases the Kd by 100-1000 times without altering the hydraulic conductivity. Hence PFAS retardation is significantly enhanced, allowing enhanced attenuation of the downgradient plume and reducing the risk to downgradient receptors.

The barrier design was completed using a specialised Fate and Transport model developed in-house by REGENESIS to model the retention of contaminants (and competing organics) on the site to create the requisite barrier configuration.

Design Verification Testing

REGENESIS undertook Design Verification Testing (DVT) before installing a 10m long pilot-scale barrier. These DVT works aimed to confirm a series of design assumptions regarding the flux of PFAS to confirm the suitability of a PlumeStop barrier for the site.

The importance of flux

The flux of PFAS is governed by the PFAS concentrations, groundwater seepage velocity and the geology of the target formation. These parameters could vary considerably vertically and laterally across the proposed barrier installation zone.

DVT works

The DVT works comprised: installation of additional boreholes and detailed soil logging; permeability testing to confirm the seepage velocity of the aquifer; groundwater sampling to identify compounds which may competitively absorb to the PlumeStop i-PRB; installation of passive samplers to confirm contaminant flux and its variability with depth; total Oxidizable Precursor Assay testing to ensure the total mass of PFAS entering the barrier; clean water injection testing confirming that the underlying geology will accept the proposed volume of PlumeStop.

Figures 3 and 4. Design Verification Testing (DVT) activities onsite to confirm design assumptions around PFAS flux

Figure 5. PlumeStop product stored at the Fire Training Area with work in progress in the background

DVT Outcomes
The DVT works demonstrated that PFAS flux had been under-estimated using conventional site investigation techniques and confirmed the need for passive sampling to attain high-resolution data on contaminant flux zones. Minor changes to the PlumeStop dose compensated for this difference with no impact on the pilot program and a <5% change in project costs.

PILOT TRIAL

Following the DVT, a pilot test was completed to prove efficacy and further refine the application method, spacing and dose prior to full-scale barrier application. The pilot consisted of a 10m long PlumeStop injected permeable reactive barrier (IPRB) installed perpendicular to groundwater flow downgradient of the fire training area .

Design Methodology
A series of nested wells were installed to monitor 'shallow' and 'deep' groundwater to evaluate and ensure effective treatment laterally and vertical across the target aquifer zone. The PlumeStop IPRB was installed close to existing groundwater monitoring wells with historical data. Additional monitoring wells were installed upgradient, within the barrier and downgradient to it, so that the PlumeStop performance could be measured against PFAS influx throughout the validation periods.

Pilot Barrier Application
the installation of the 10m long barrier by direct push injection of PlumeStop from 3-11mBGL at 12 locations (see figure 6 for Pilot Configuration).

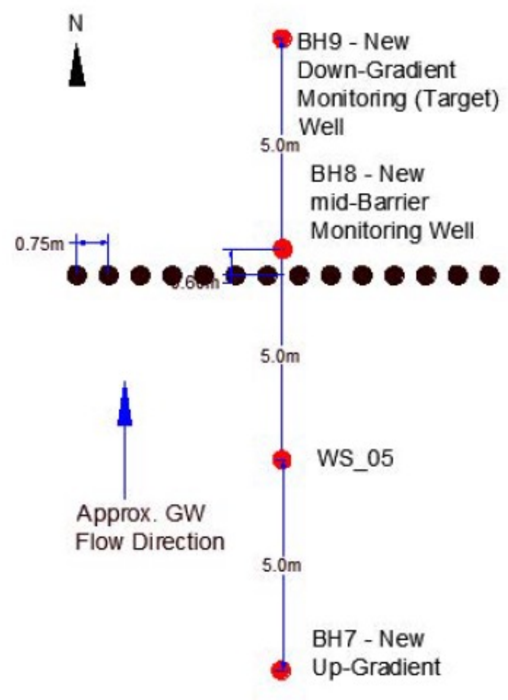


Figure 6. Pilot Test Configuration

PILOT RESULTS

Groundwater monitoring showed that the target compounds PFOS and PFOA were reduced to below detection limits and that the total PFAS concentrations were also significantly reduced. All reductions were maintained throughout the validation period. This considered, phased approach, combined with successful pilot study results, allowed permission to be granted for the progression of the full-scale works.

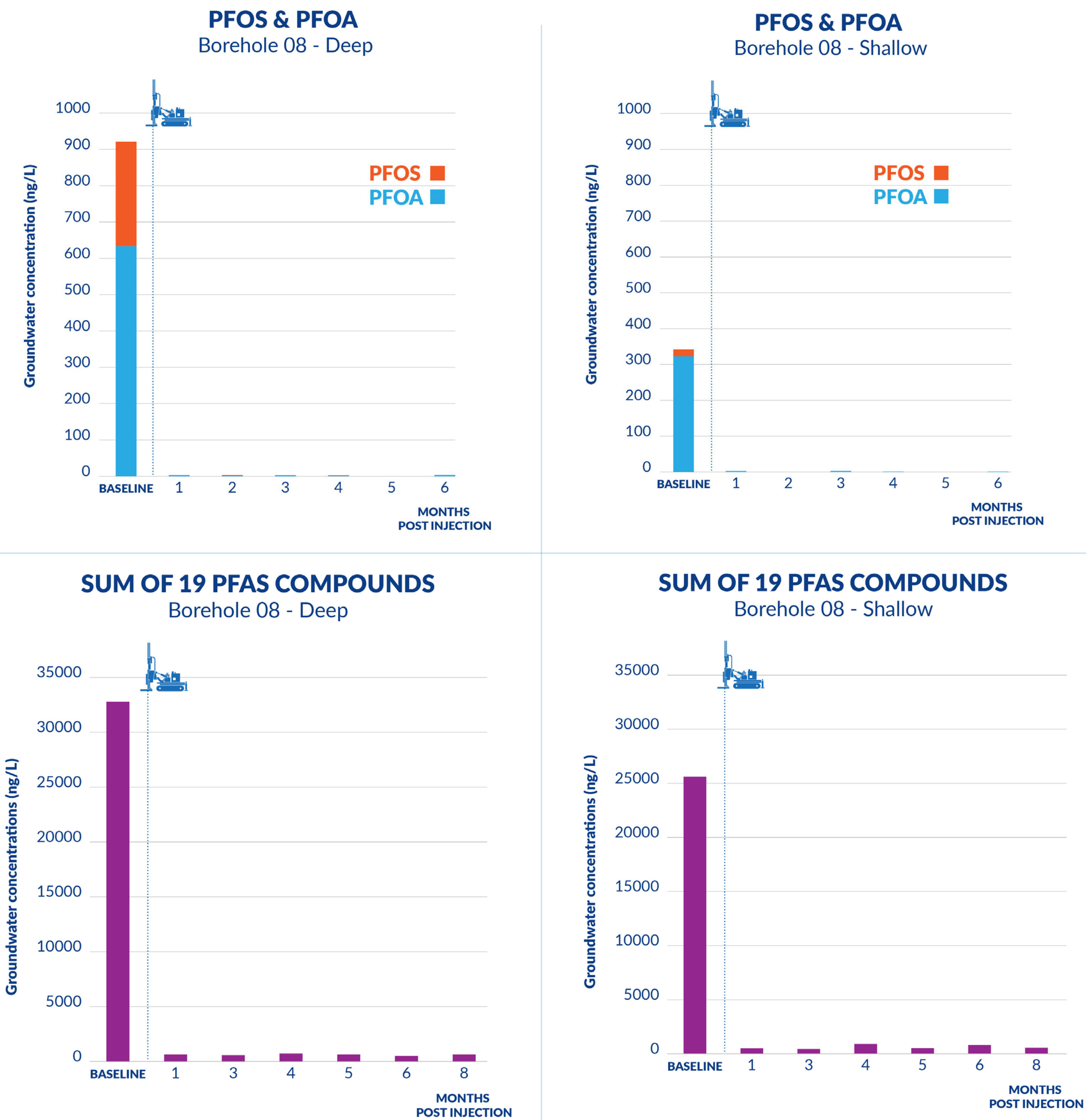


Figure 7. PFOS, PFOA and ∑PFAS Pilot Test Results
for the mid-barrier well (shallow and deep)

FULL-SCALE WORKS

The 277m long barrier comprises 400 injection points and required 477,000L of diluted PlumeStop to be injected between 3 and 11m BGL, targeting the weathered chalk formation.

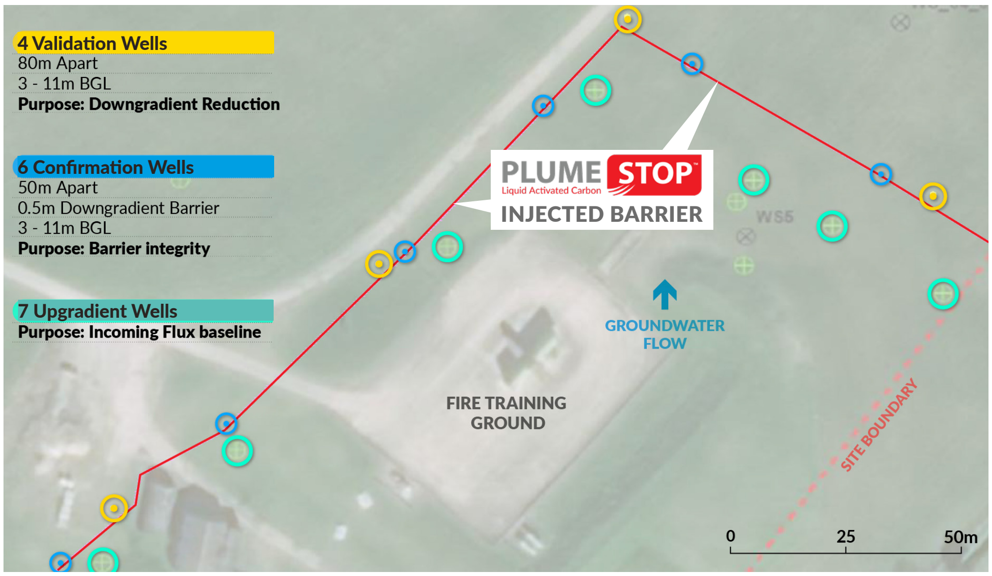


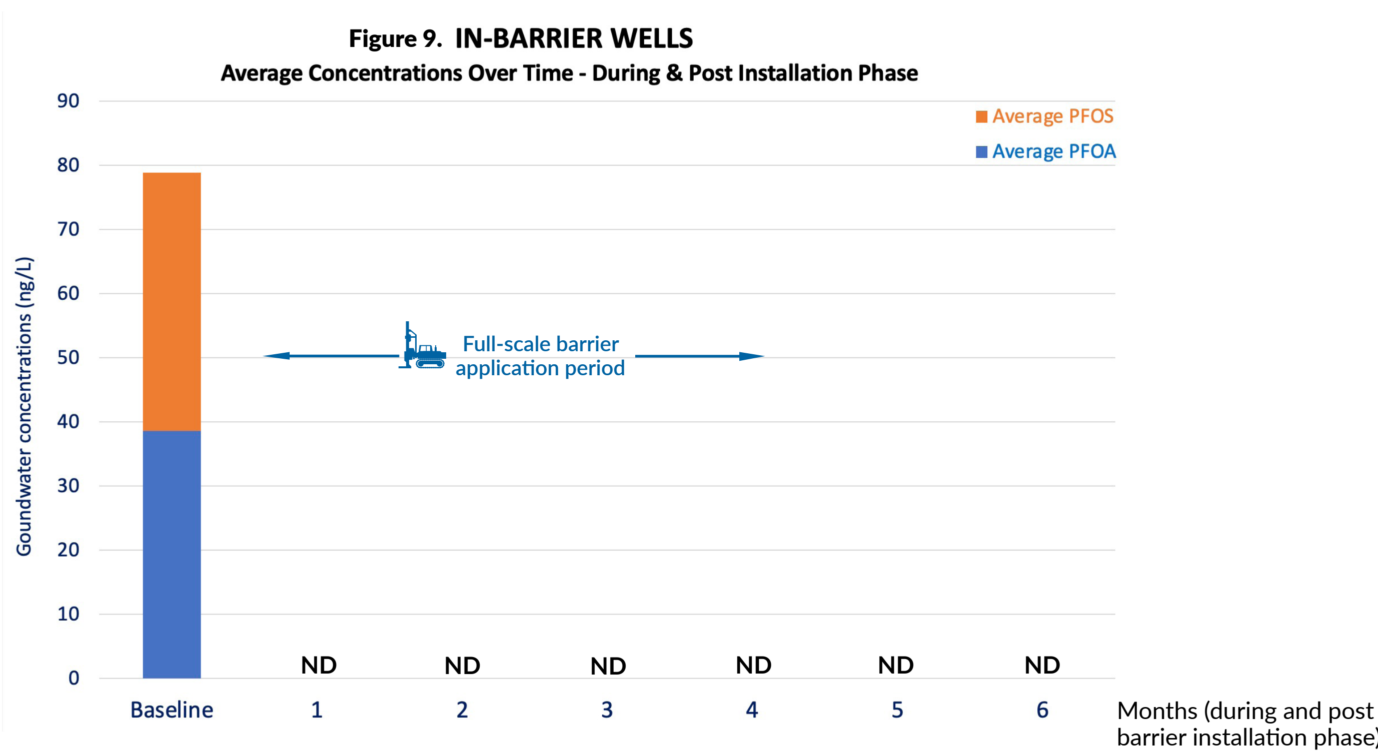
Figure 8. Full-Scale PlumeStop IPRB location and monitoring well configuration

Ongoing Testing
As the application proceeded, radius of influence testing was completed to ensure the PRB was installed with the designed dose and dimensions. The in-barrier wells were sampled to confirm that the requisite treatment was being achieved.

Performance Warranty
Once the barrier installation was completed, it was signed off by REGENESIS and a warranty was provided to the landowner.

RESULTS

The monitoring data from the in-barrier wells (during and after full barrier installation) demonstrates that all target PFAS compounds have been recorded below the detection limits (Non-Detect (ND)) for 6+ months.



In the downgradient monitoring wells the starting concentrations for PFOS and PFOA were approximately 180 ng/L. Following application, downgradient concentrations reduced to low concentrations/non-detect. As no further contamination is moving through the barrier, low downgradient concentrations are expected to be maintained, with residual downgradient mass attenuating over time through back-diffusion.

Figure 10. DOWNGRADIENT WELLS
Average Concentrations Over Time - Post Commissioning Phase

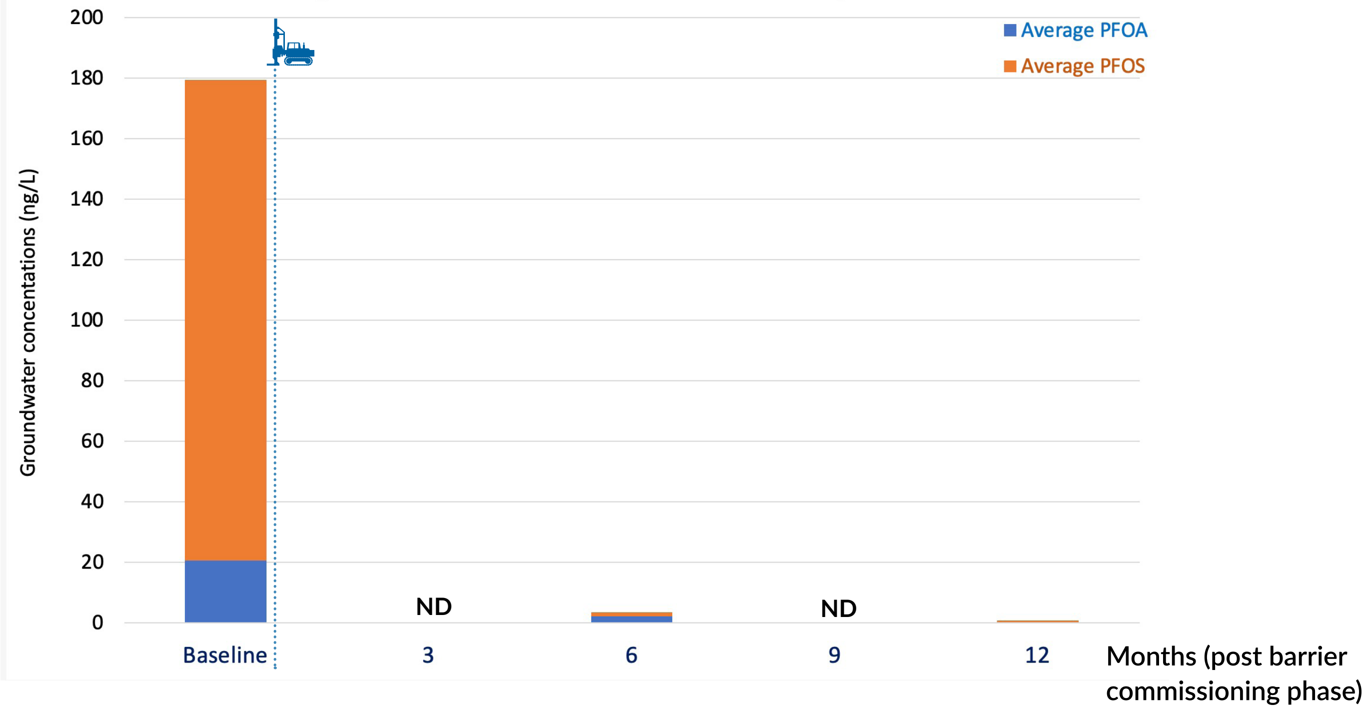


Figure 11. Full-scale PlumeStop IPRB installation in progress

PROJECT CLOSURE & VERIFICATION

The results, aided by the early and ongoing stakeholder engagement process, led to project closure in October 2022. This comprised regulatory sign-off on a series of planning conditions, allowing the landowner to proceed with divestment and development plans.

Redevelopment of the site includes the removal of the fire training ground and disposal of impacted soils, which will reduce future challenge concentration into the barrier, avoiding the need for reapplication. The site development includes green space to allow access to ongoing annual validation sampling by Mott MacDonald and contingency action should it be required.

BENEFITS

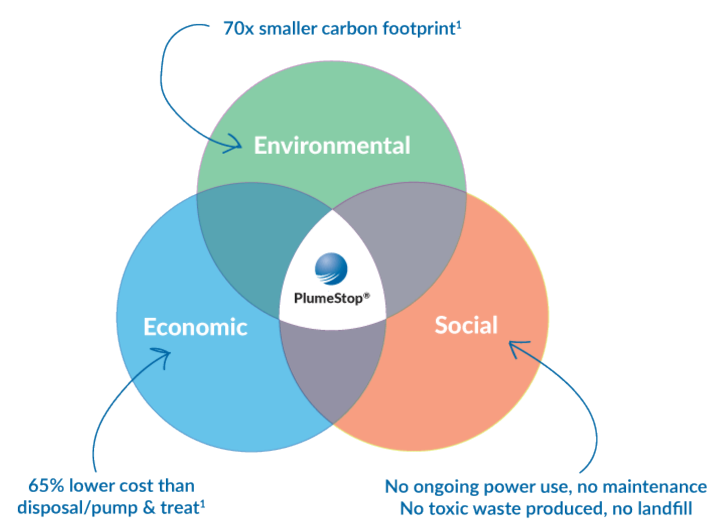
Certainty
The PlumeShield Warranty provided the site owner with peace of mind and certainty: a guaranteed price, as well as guaranteed effectiveness and performance of the PlumeStop underground filtration zone.
Learn more

Cost Effectiveness
Now that the barrier is in place, there are no further costs. A Life Cycle Cost Analysis of this approach on a similar site shows that in situ PRB treatment using PlumeStop is 60-65% lower Total Cost of Ownership in Net Present Value compared to the pump and treat (P&T) based remediation alternatives.

Sustainability
In situ retardation of PFAS in the subsurface is a highly sustainable remedial approach. The treatment avoids the production of contamination at the surface, the movement of contamination to landfill, ongoing fuel use, ongoing equipment replacement or onsite maintenance.

A third-party study on a later UK site showed that a PlumeStop barrier had a carbon footprint 70 times less than an equivalent (P&T), with a 100% higher sustainability score based on a SuRF-UK-compliant Tier 2 Sustainability Assessment. Learn more

100% higher sustainability score



CONCLUSIONS

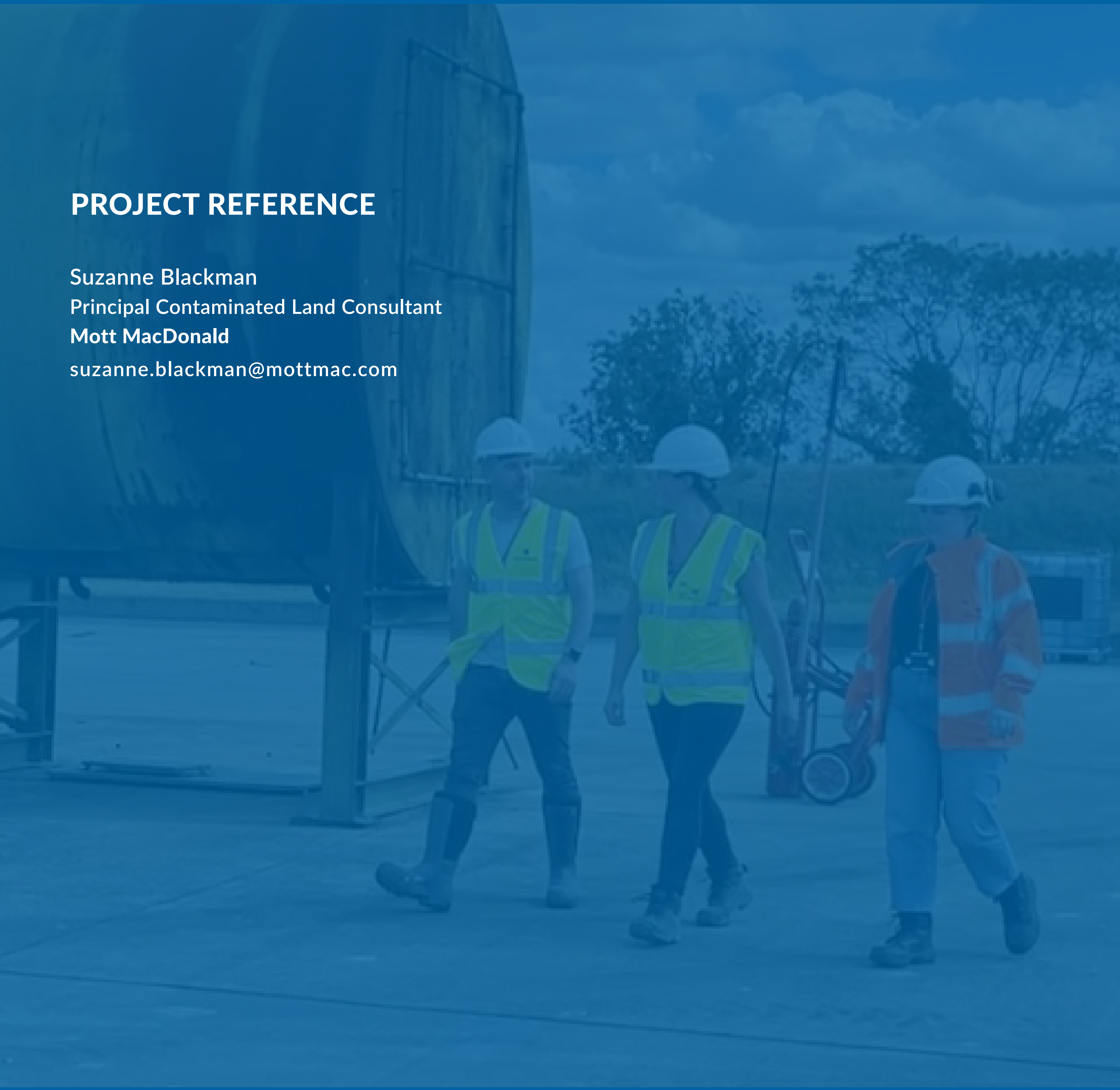
This project demonstrates excellent site investigation, remediation application-focused planning and testing, a thoughtful, step-wise and detailed remedial design, application and confirmation process, and clear and inclusive stakeholder and regulatory engagement.

This has resulted in an important and successful full-scale application to treat a problematic emerging contaminant using a highly sustainable and effective remedial approach.

It has won ‘Best Application of Remediation Technologies’ in the Brownfield Awards 2023.

“An excellent example of organisations working collaboratively to remediate a site where a chalk aquifer was impacted by PFAS.”

Judges’ quote, Brownfield Awards 2023



PROJECT REFERENCE

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