# Tracer tests to examine flow and transport between pairs of wells in landfill

UNIVERSITY OF Southampton
Engineering and the Environment

**Tristan Rees-White, Nick Woodman, Richard Beaven**
University of Southampton, U.K.
tcrw@soton.ac.uk

## Introduction

In many older landfills in the UK, significant depths of saturated waste exist in sites benefiting from natural containment. To help accelerate solute flushing in these sites, the introduction of water and removal of leachate between vertical wells is a practical option.

The simplest hydraulic unit for such a flushing system is a pair of injection-abstraction wells. Such a pair is often called a dipole or a doublet. Understanding flow and solute movement in this simple dipole can, thereafter, be used to design more elaborate field-scale systems.

## Tracer Tests

Well-controlled tracer tests in waste enable important contaminant transport parameters to be estimated.

Carrying out the tests at different scales (e.g. well spacings) and with a range of different tracers, gives insights into the effect and significance of scaling, waste heterogeneity and the practical use of tracers in waste.

Data from large-scale tracer tests, can be used to refine models and help in the interpretation of smaller scale tests (such as single well echo tests) which are quicker, simpler and more cost effective to perform.

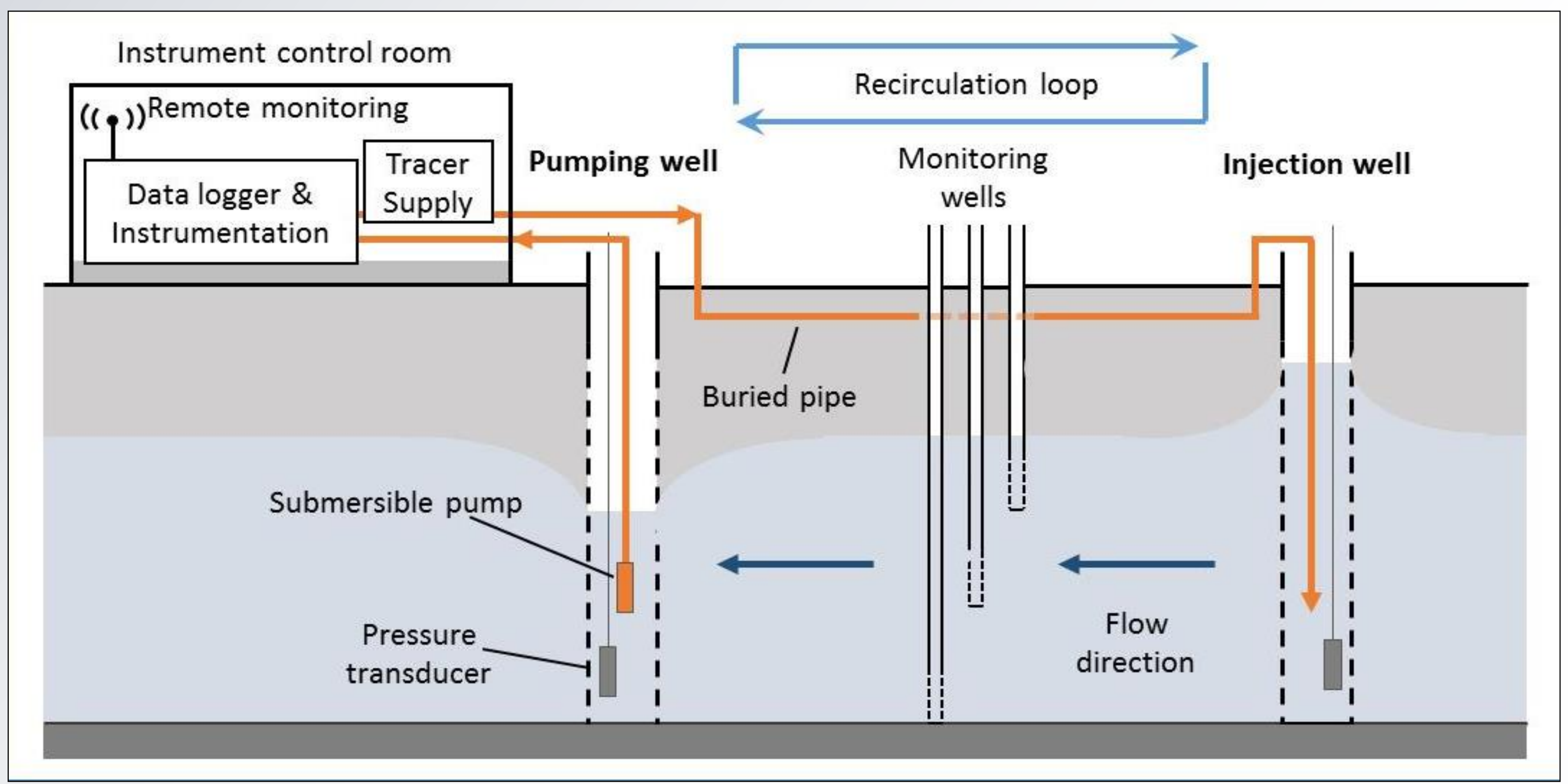



*Figure 1 – Experimental setup*

## Method

A dipole is created by pumping leachate from an abstraction well at a constant rate and pumping it directly back into the landfill via an injection well to form a recirculation loop.

When pressures have equilibrated, a tracer is added to the recirculating leachate and the concentration of the tracer monitored at the pumping well.

The tests described were carried out at a purpose-built research site on a restored landfill with a waste depth of ~25 m and a saturated depth of ~15 m.

Four new fully screened wells and two observation piezometers were installed in line with an existing leachate extraction well (Figure 2).

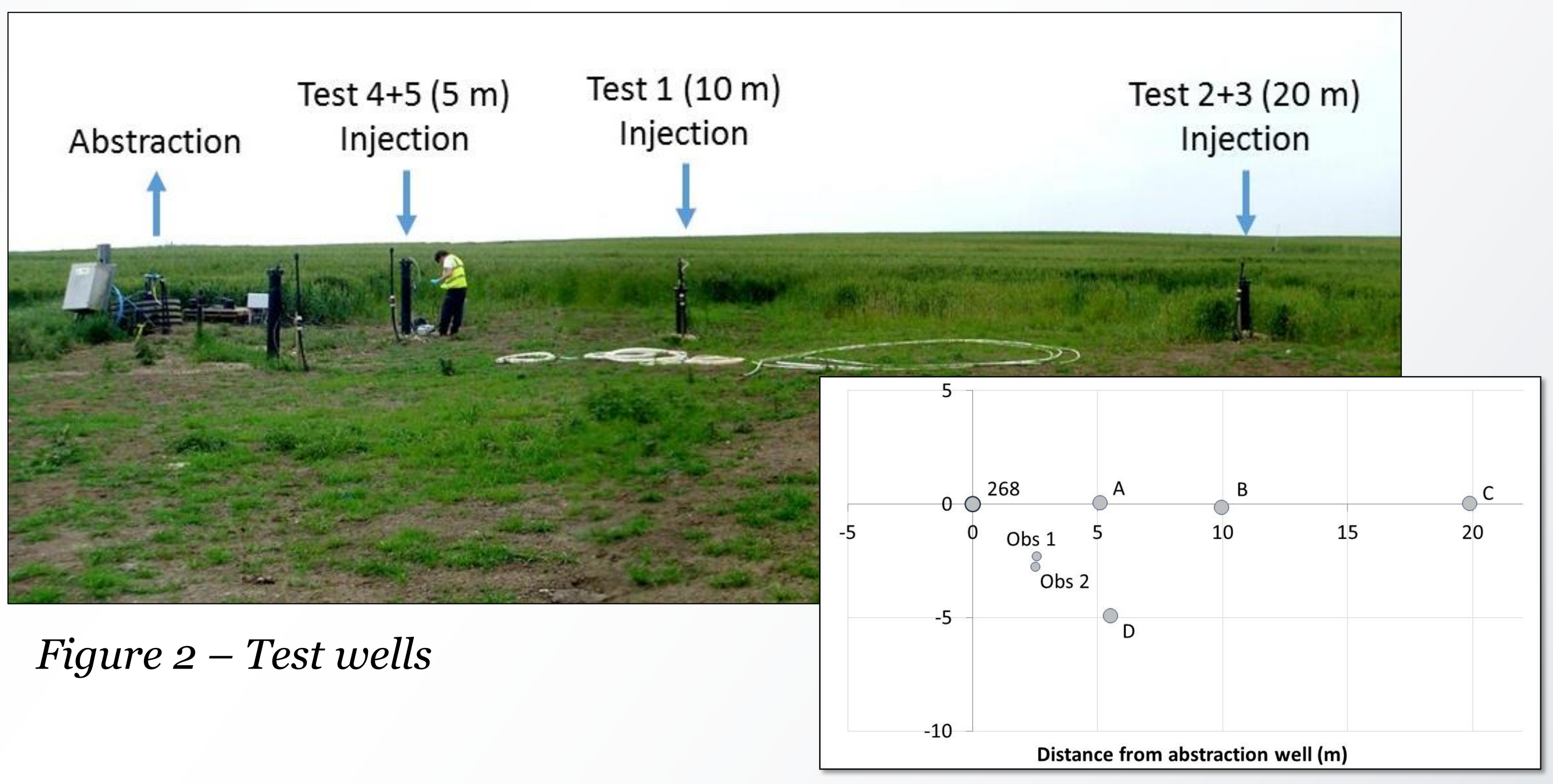



*Figure 2 – Test wells*

## Results

Three dipole tests have been carried out at 10 and 20 m well spacings. A mix of tracers have been used either singularly or on their own. Details of the tests are given in Table 1. Two further tests are planned, each at 5 m.

| | Test No. | Dipole Spacing | Tracer | Mass tracer/ Inj. concentration | | Duration of test | Breakthrough time |
|---|---|---|---|---|---|---|---|
| Completed | 1 | 10 m | Bromide + | 107 kg | 2 g/l | 140 days | 4.8 Hours |
| | | | Rhodamine WT | 0.9 kg | 8 g/l | | |
| | 2 | 20 m | Rhodamine WT | 1.0 kg | 17 g/l | 45 days | 17.8 Hours |
| | 3 | 20 m | Lithium | 5.7 kg | 175 mg/l | 80 days | 16.9 Hours |
| In Progress | 4 | 5 m | Lithium + | 0.8 kg | 24 mg/l | Est. 40-50 days | |
| | | | Bromide | 9.2 kg | 272 mg/l | | |
| | 5 | 5 m | Rhodamine WT | 0.5 kg | ~9 g/l | Est. 40-50 days | |

Figure 3 shows the test data from each of the four tracer breakthrough curves collected so far. Flow rate was constant at 2 $m^3$/hour in each, tracer injection ranged between 17-54 hours. Breakthrough is extremely rapid at each dipole spacing, ~5 hours at 10 m and ~17 hours at 20 m.

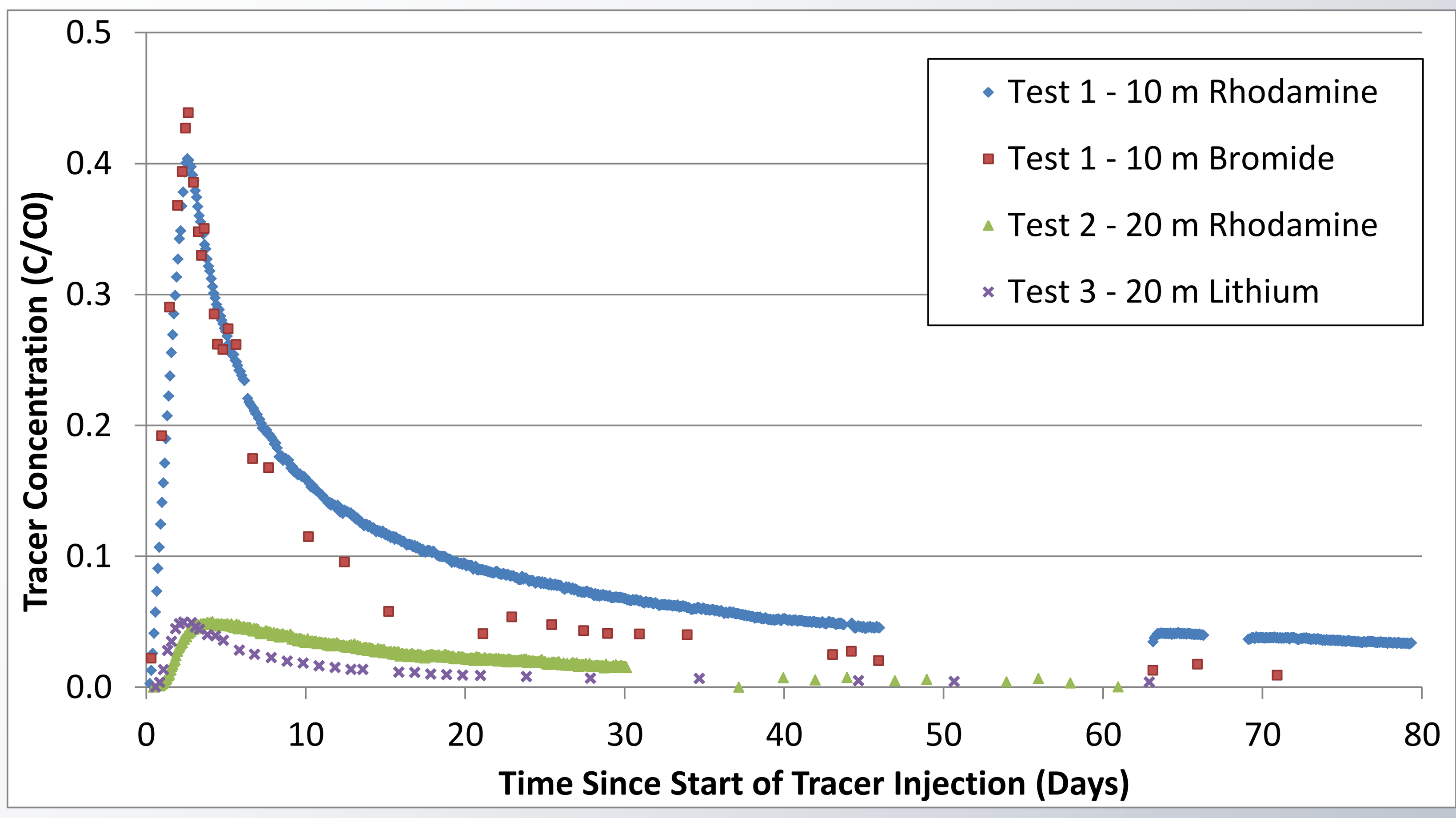


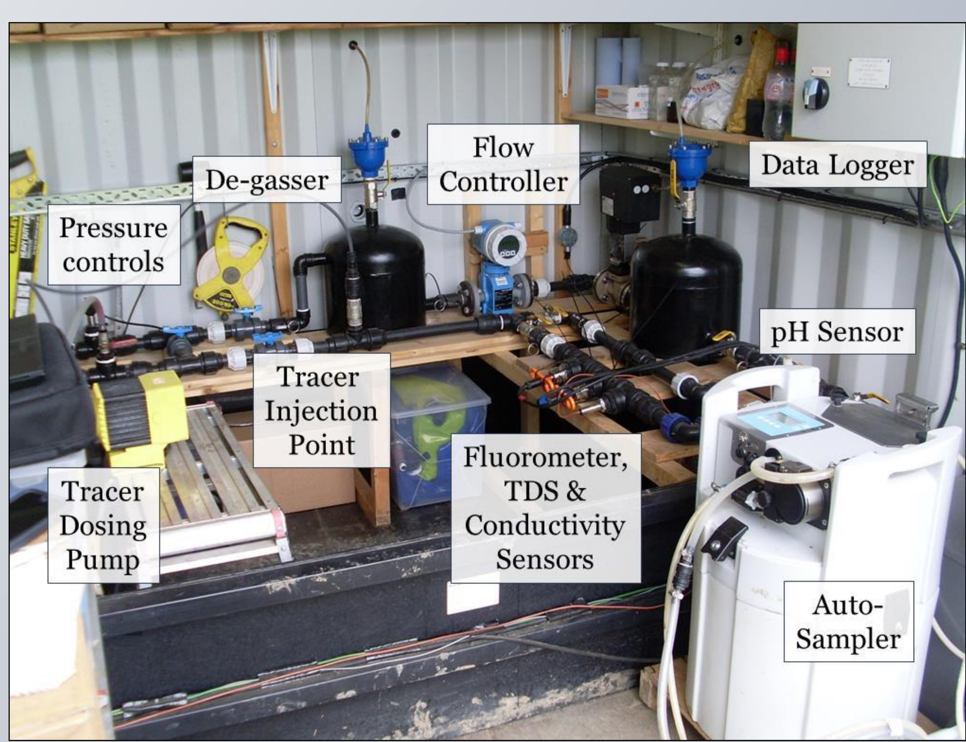

*Figure 3 – Tracer breakthrough curves*

## Conclusions

Modelling of the test data will be used to test our conceptual understanding of horizontal flow and transport at the field scale.

Ultimately, simulations will be used to estimate a number of useful transport parameters, not least dual-porosity parameters which have been used successfully under different field conditions and in the laboratory.

*Flow controls and tracer monitoring instrumentation*




EPSRC
Engineering and Physical Sciences Research Council