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UK COLLABORATORIUM FOR RESEARCH ON INFRASTRUCTURE & CITIES

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Harvesting Energy from Buried Infrastructure: Current UKCRIC research

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The Challenge & Potential Solution

- The UK Government has a commitment to reach net-zero emissions by 2050.
- This needs to include heating, 70% of which comes from direct burning of natural gas.
- Ground thermal energy storage coupled with ground source heat pump systems is an energy efficient solution, but retains high investment costs.
- Use of buried infrastructure for simultaneous structural function and ground heat exchange can reduce these capital costs.
- Our vision is to use sub-surface infrastructure for heat transfer and storage, including waste and drinking water distribution networks, and green infrastructure such as sustainable urban drainage and swales.

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About UKCRIC

The UK Collabatorium for Research in Infrastructure and Cities (UKCRIC) is integrated research capability with a mission to underpin the renewal, sustainment and improvement of infrastructure and cities in the UK and elsewhere.

- 13 funded cross-disciplinary lab and urban observatory test facilities
- 13 founding partner Universities across the UK

PLEXUS is a UKCRIC laboratories pump priming project: https://www.ukcric.com/news/introducing-plexus-ukcric-s-lab-pump-priming-project/

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Overview of PLEXUS Research

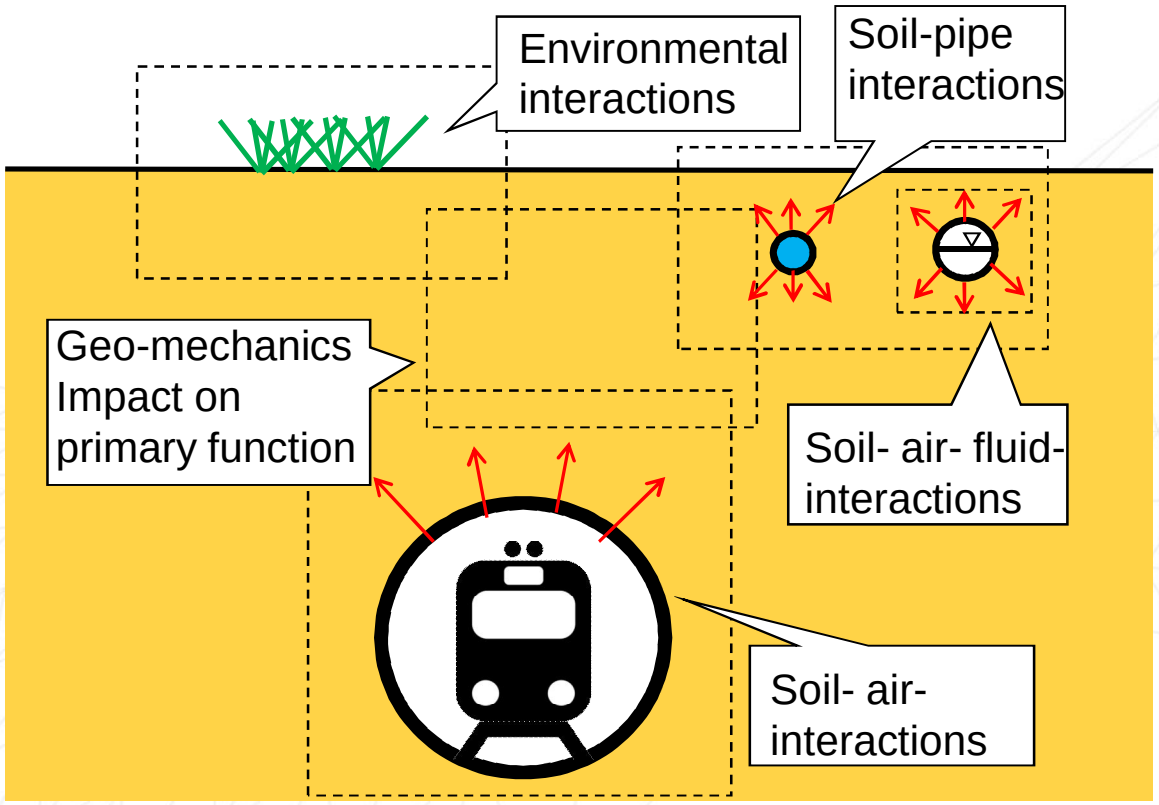
One of three research challenges looks at harvesting thermal energy from buried infrastructure:

- Sustainable urban drainage systems
- Buried pipe networks for water and waste water distribution
- Waste water treatment infrastructure
- Larger scale tunnels

Considering thermal energy capacity and potential impacts on primary structural function for different boundary conditions.

Overview of Key Interactions

Ground
Structure
Underground Space
Surface Environment



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Buried Pipe Distribution Networks

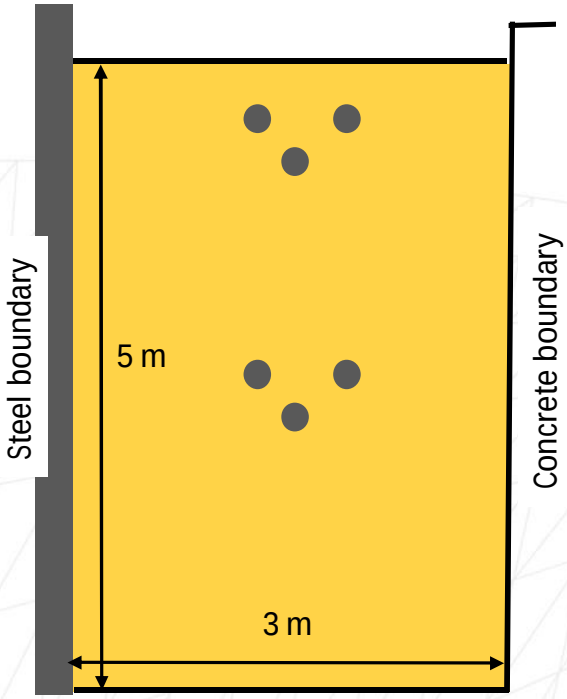
Large scale experiment (30m pipe length) built at the Integrated Civil and Infrastructure Research Centre (ICAIR, Sheffield)

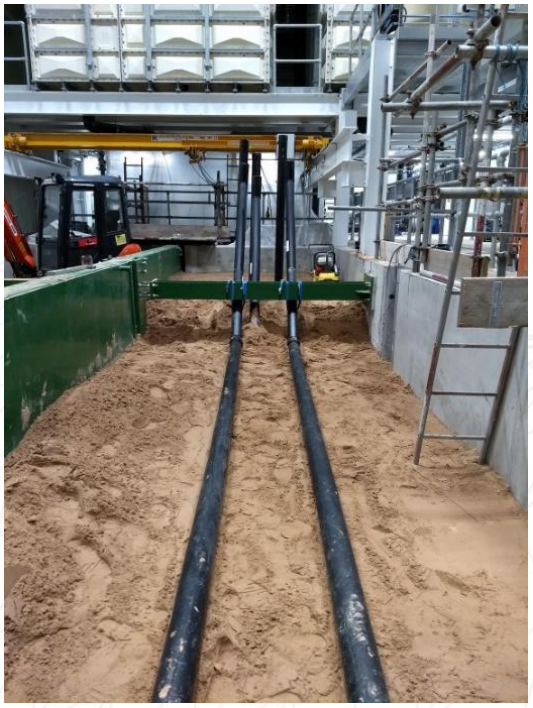
- 125mm OD pipe at 0.5 m and 2 m depth in unsaturated sand
- Water circulation without and with heat injection

Heat transfer from ambient air is dominant thermal process in absence of substantial other heat input

Consideration of both natural and forced thermal processes important for potential transfer and storage of energy

ICAIR Experiment Set Up





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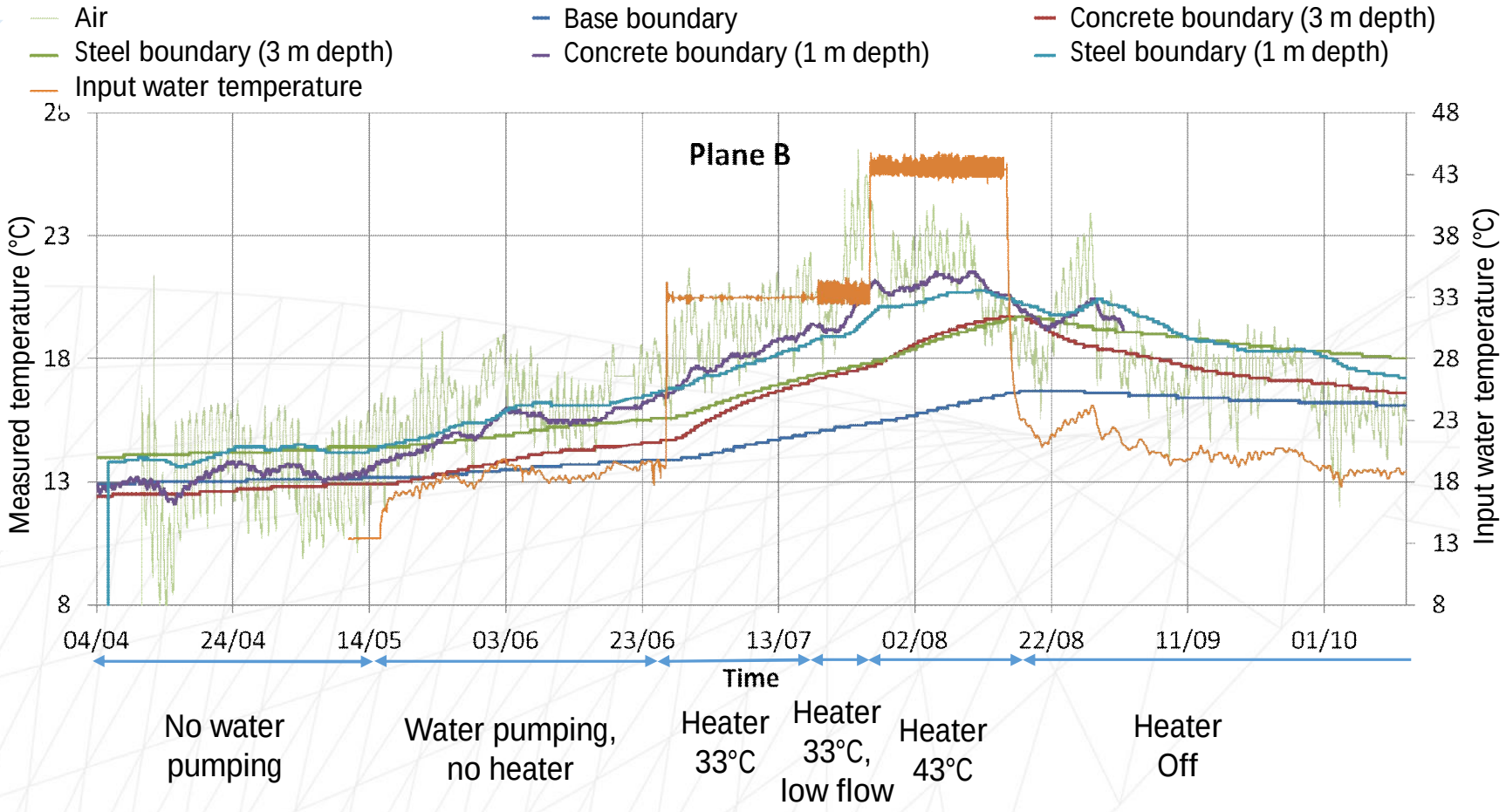

Sustainable Urban Drainage

A pilot scale experiment of a SuDS set up at the National Green Infrastructure Facility (NGIF, Newcastle)

- 1.8 m diameter, 1.0 m deep lysimeter with heating cable at base
- Record of thermal and hydrological parameters under background and heat injection conditions

Temperatures fluctuate naturally due to ambient air and rainfall conditions.

Heat injection causes additional changes to temperatures, but these are moderated by further rainfall events.

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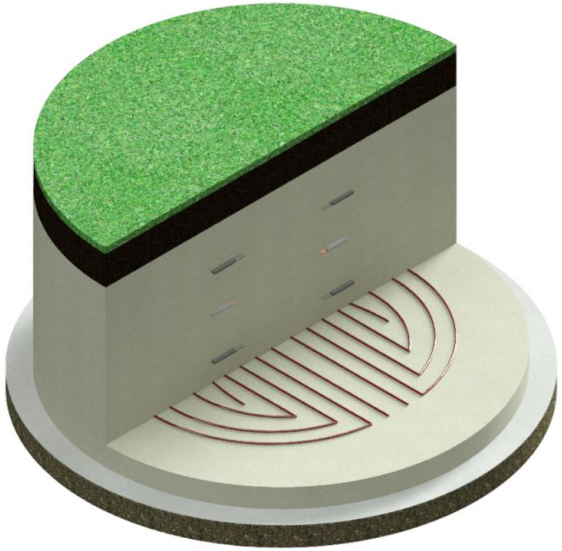
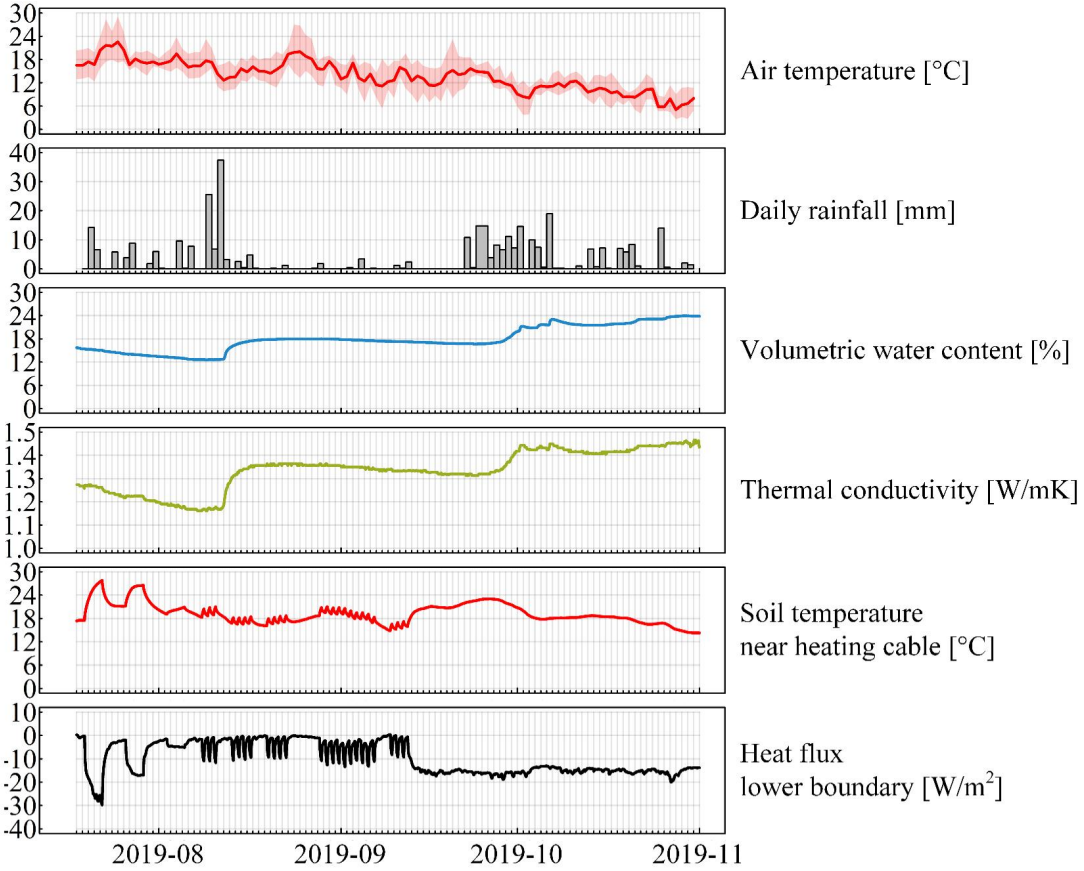
Principle Interactions





Overall Conclusions to date

1. Dual use infrastructure will have minimal impact on primary function of drainage, water and waste water infrastructure.
2. Understanding and accounting for surface environmental interactions will be important for thermal energy assessment of shallow buried infrastructure.
3. Further physical experiments, simulation and upscaling for energy potential continues.

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