Ground Source Heat Pump Association Webinar Series 2020

OPEN-LOOP BOREHOLE GSHPs

Lessons learned from 20 years of open-loop systems in the UK

John Findlay, Carbon Zero Consulting Ltd
Iain Howley, Howley Energy & Water Ltd

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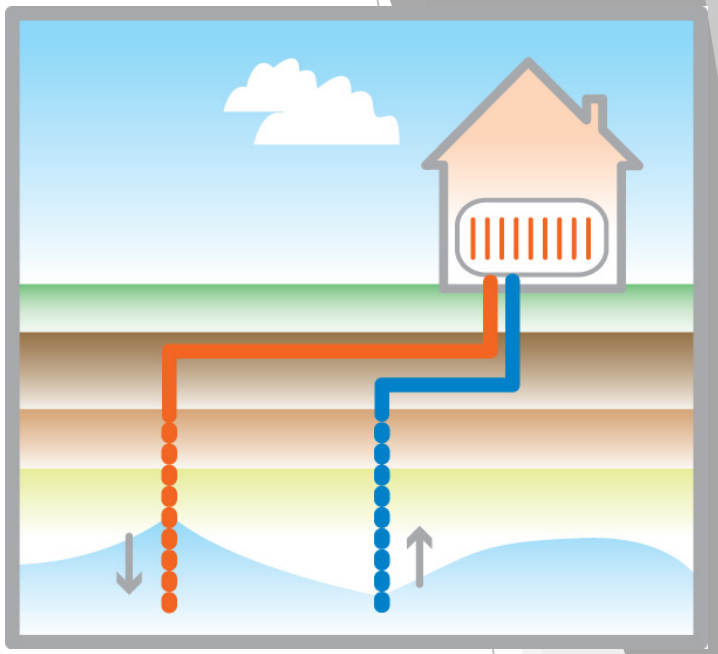
Subjects, to include:



John:

- Regulation
- Basics of open loop boreholes
- Energy; heating & cooling
- Drilling & testing
- A few Open-loop system considerations

Iain:

- The Importance of ongoing monitoring of system performance
- The growing enquiries for Open Loop fed district heating networks

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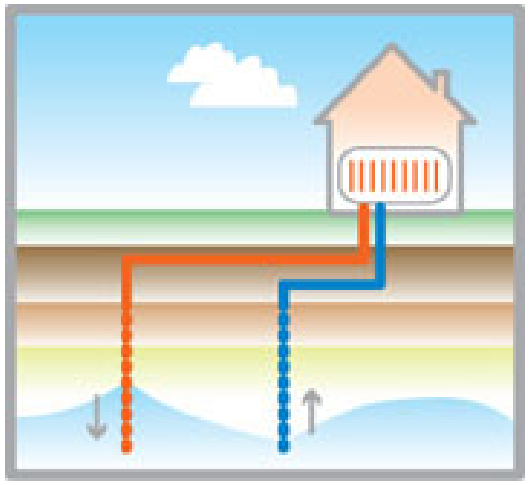
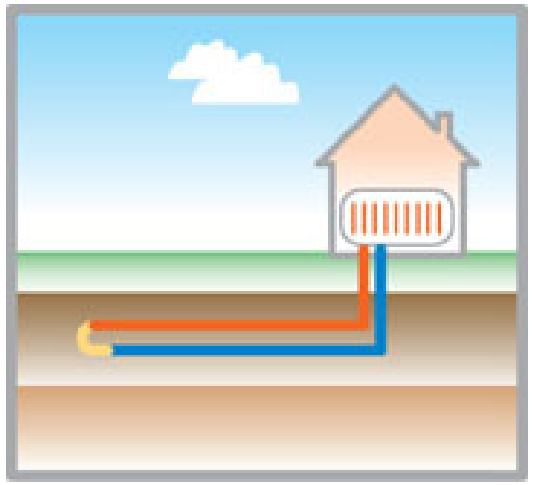
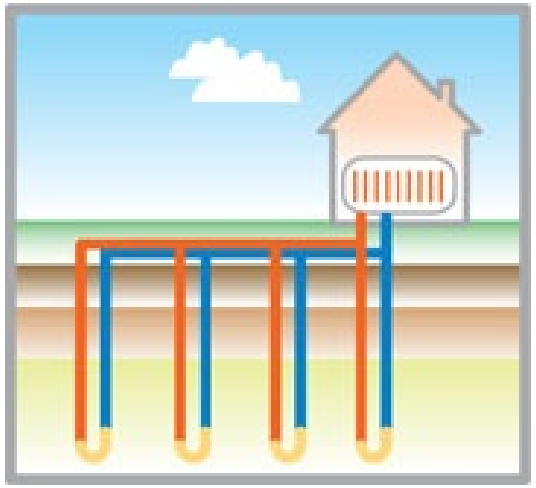
Environment Agency Regulation



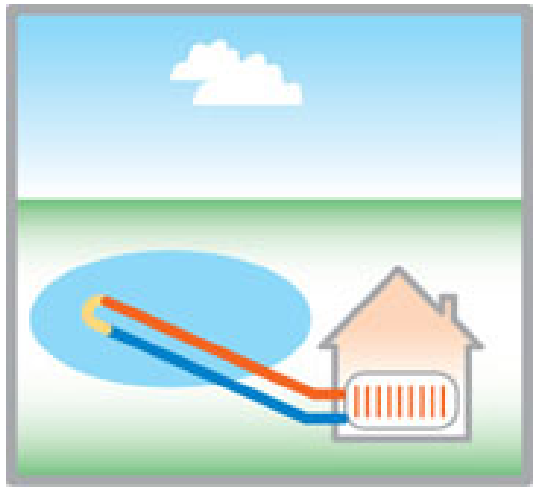
Open-loop.
EA regulates all schemes >20m^3/day (Water Resource regulations)



EA not involved, (too many and low or no impact)



EA not involved. (Some involvement with large schemes via planning)



EA involved with river, lake, estuary and sea-based schemes

Note also: Coal Authority – permit to drill required

Typical Regulatory works and timeframe

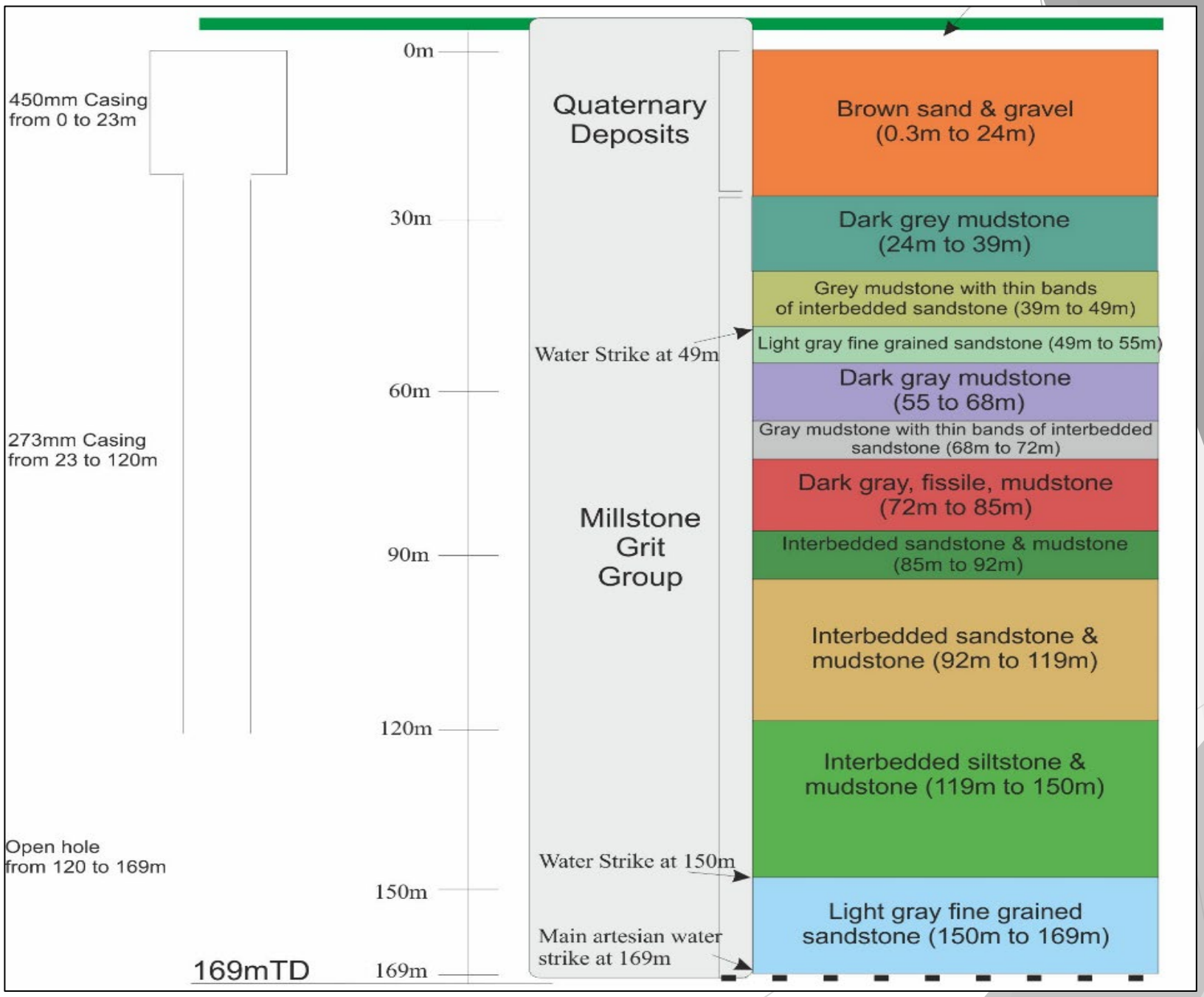
- From receipt of order, the open-loop design, construction and regulatory process >9 months
- Pre-application (for all >20m^3/day systems)
- Water-features survey
- Drilling and formal test-pumping
- Data analysis, hydrogeology, reporting
- Abstraction and environmental (discharge) permit applications
- *Smaller and/or balanced systems now have environmental permit exemption (simplifies the process – and saves £5k!)*

Open Loop. A different beast!

- Open loop design; fundamentally different to closed loop
- UK Geology is well known, 1.5 million BGS Logs. BUT - MUST involve the right expertise at an early stage
- GSHPA/CIBSE CP3 and GSHPA Good Practice Guidelines
- Geology, Hydrogeology, Thermogeology, Geochemistry, Hydraulics, Borehole engineering, Abstraction, Injection, Casing design, Drilling, Testing, Regulation, Wellheads & chambers…
  - …as well as all the building physics and heat/cool design requirements in common with closed loop

Borehole design.

Abstraction borehole design may differ from injection



Borehole photos

Energy available

Consistent source temperature (≈10°C in Scotland to 13°C in south of England. London can be higher)

Heat available = Sc x ΔT x Q

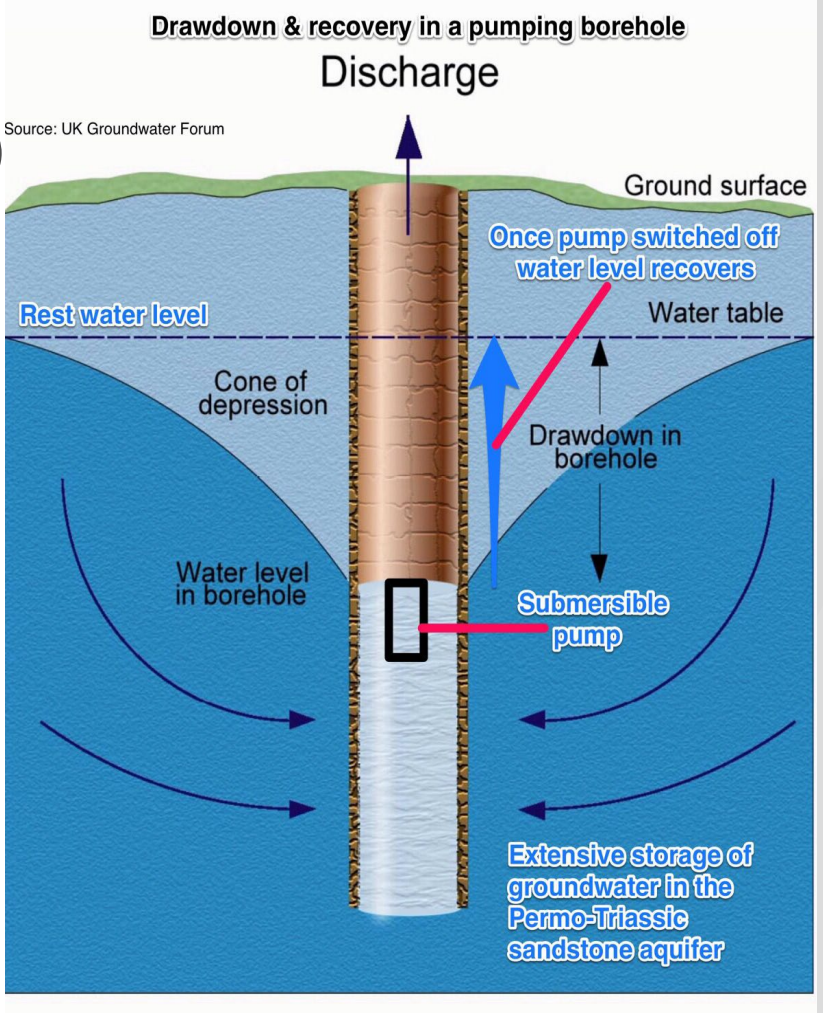
Sc = Specific heat capacity of water 4200J/l/°C

ΔT = temp change across heat exchanger, say 5°C

Q = groundwater flow rate

So for a 10l/second flow rate there is about 300kW of heat available, assuming COP = 3.5.

OPEN LOOP CAN SUPPORT SYSTEMS OF ≈20kW to many mega-Watts heating and/or cooling



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DRILLING RIGS.....and drilling rigs

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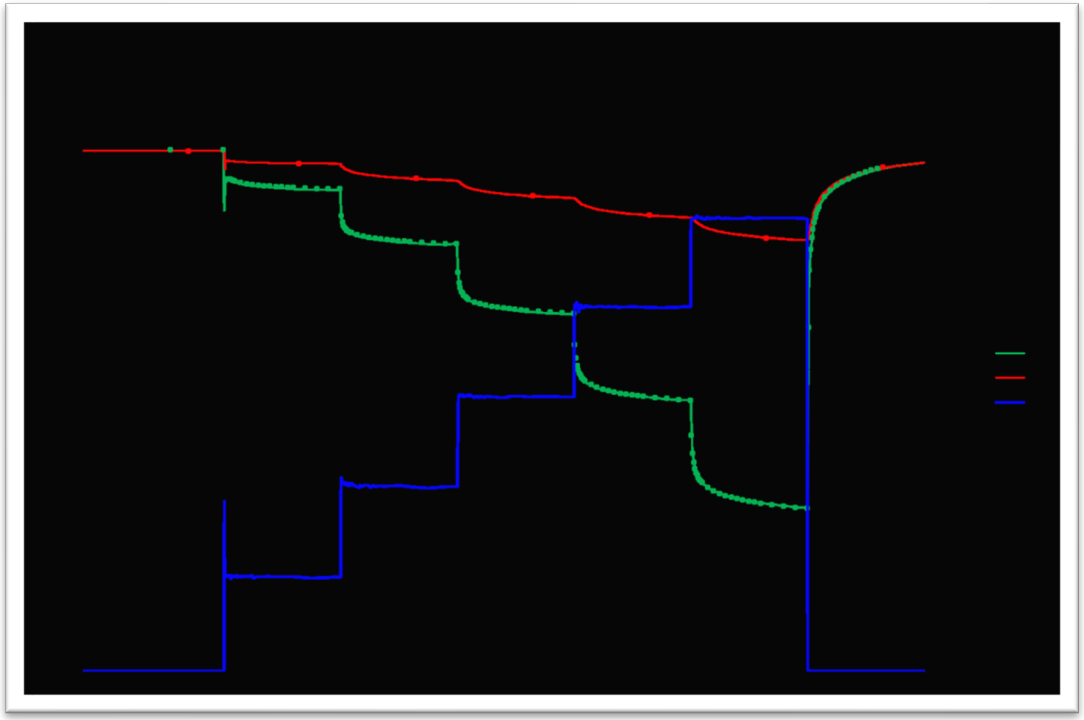
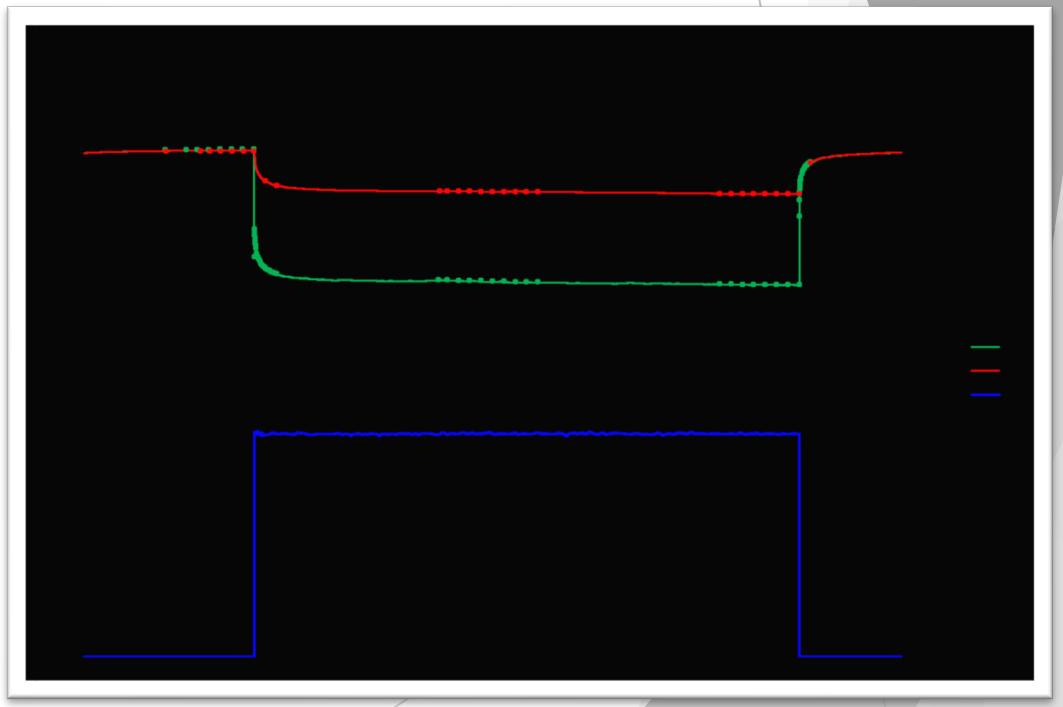
Test pumping

Testing; Usually specified by Environment Agency
Abstraction & re-injection tests
Monitor flow rate, drawdown, draw-up, water quality….
Only after ‘operational’ tests can permanent pump be specified





Cooling

- PASSIVE COOLING: Temperature from a borehole of 10 - 12°C excellent for passive (no compressor) cooling. Very high COPc
- ACTIVE COOLING as required, with lower COPc
- A well balanced open loop system is *the most efficient means of heating/cooling any building*:
  - Little or no net heat extraction/discharge
  - Additional efficiencies from cooled or warmed water for the following season (ATES systems in the right conditions)

Other considerations

- Borehole location and separation.
  - Multiple borehole pairs can be used. BUT, assessment, modelling of interaction (thermal and hydraulic) needed
- Groundwater chemistry. Iron, Manganese at elevated concentration can be a serious constraint
  - Maintain flow and pressure through the system and no exposure of water to atmosphere
- Microbiology. Good disinfection of equipment during drilling and testing. Further disinfection of borehole after completion
  - Microbiology growth in borehole, pipeline, PHXs can cause clogging and loss of efficiency

There are many lessons learnt….

- The Importance of ongoing monitoring of system performance
- Many FM teams adopt ‘out of sight, out of mind’ policy
- It is critically important to be able to interrogate operational trends
- To be able to do this, we need to log…

  - Borehole operational characteristics
  - Abstraction & recharge temperatures
  - Flow rates / volumes (against water levels)
  - Pump performance is checked through maintenance programme
  - Pressure before & after plate heat exchanger are monitored

  - All operational data to be compared to original benchmark test data

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Lincolnshire Herbs Ltd - 3,400kW Heating Only Scheme

Two abstraction wells – 1 recharge well installed in 2014/15

Peak flow is 130 l/sec

Full monitoring suite so performance trends can be understood & interpreted

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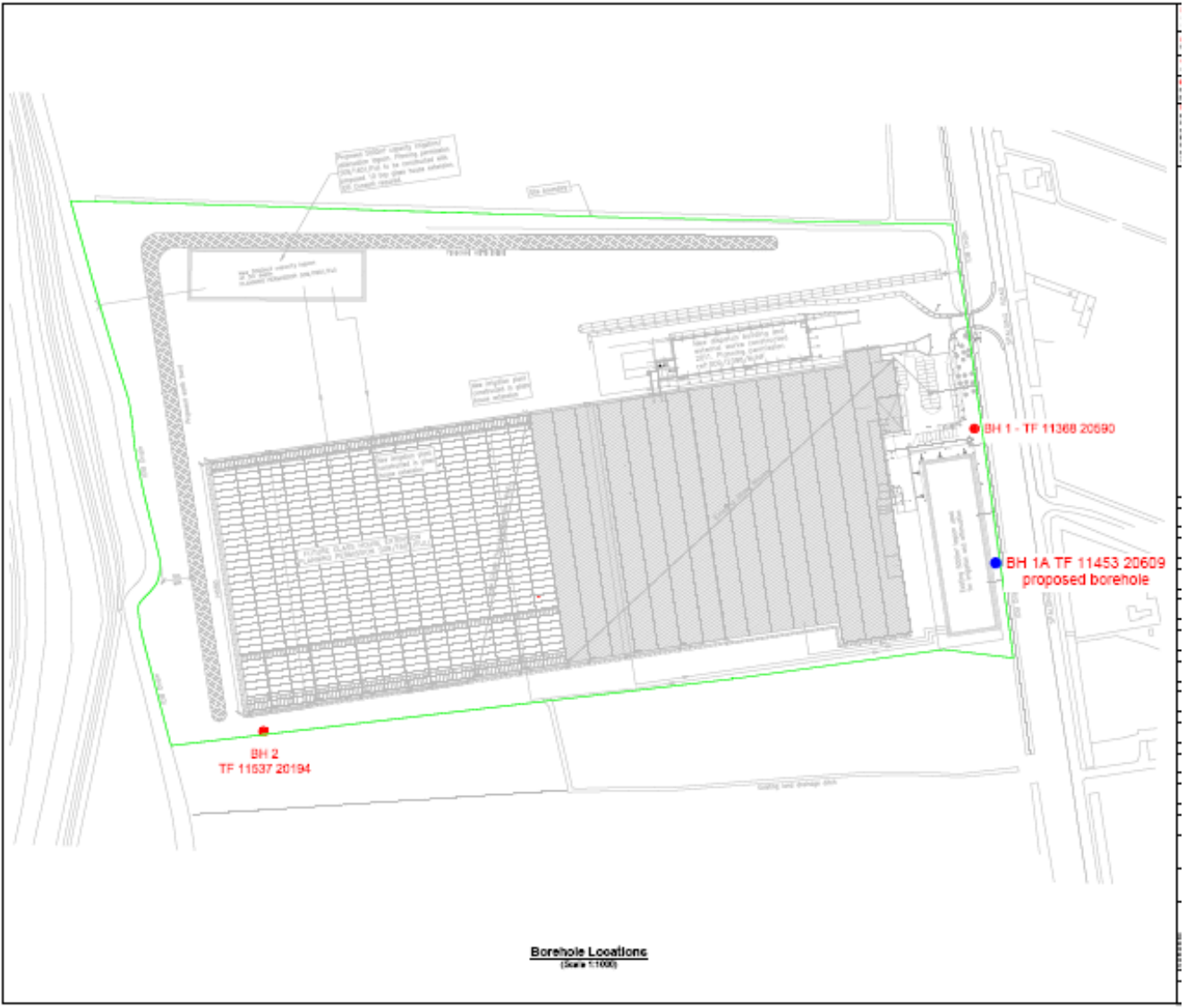

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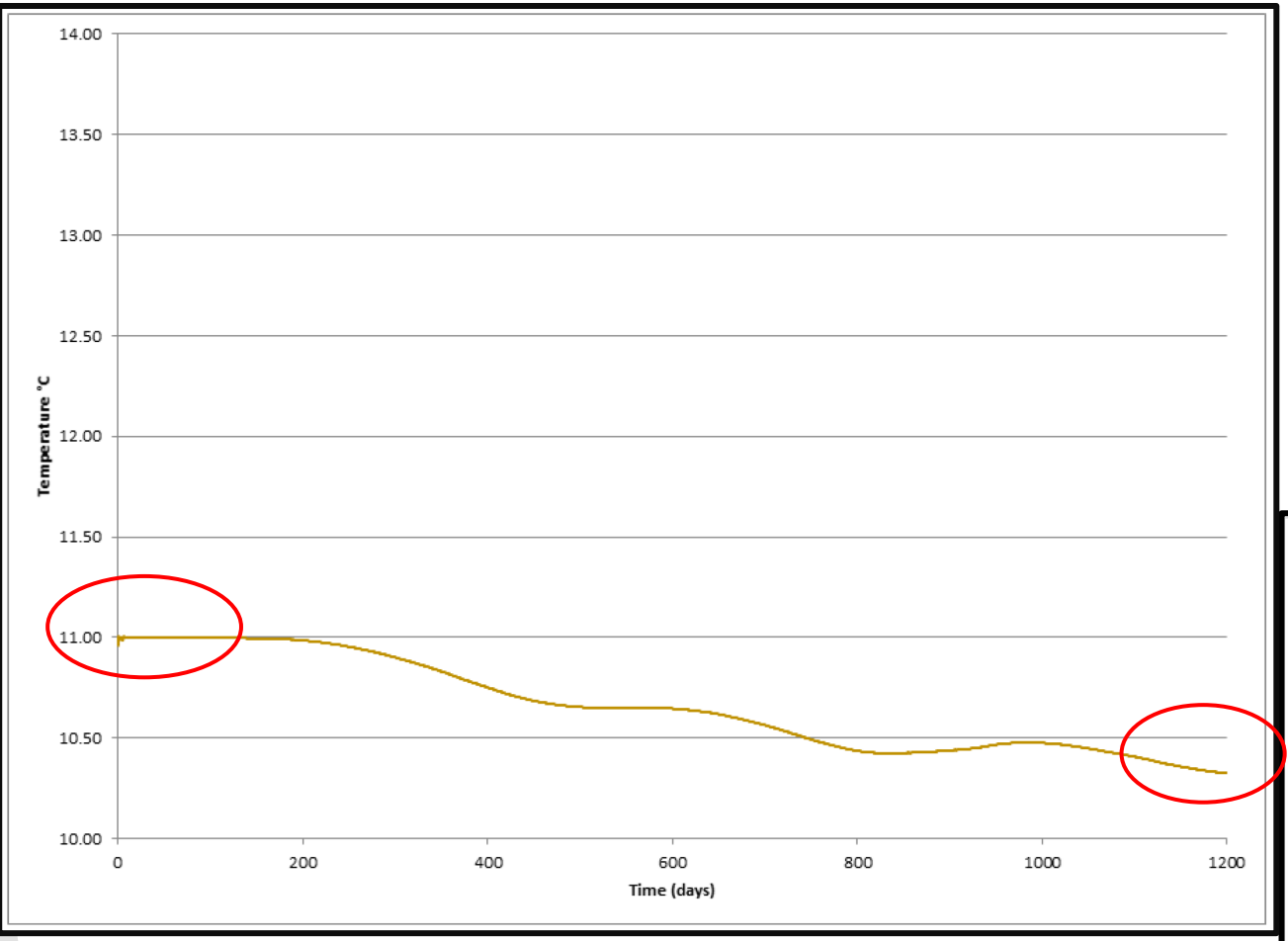
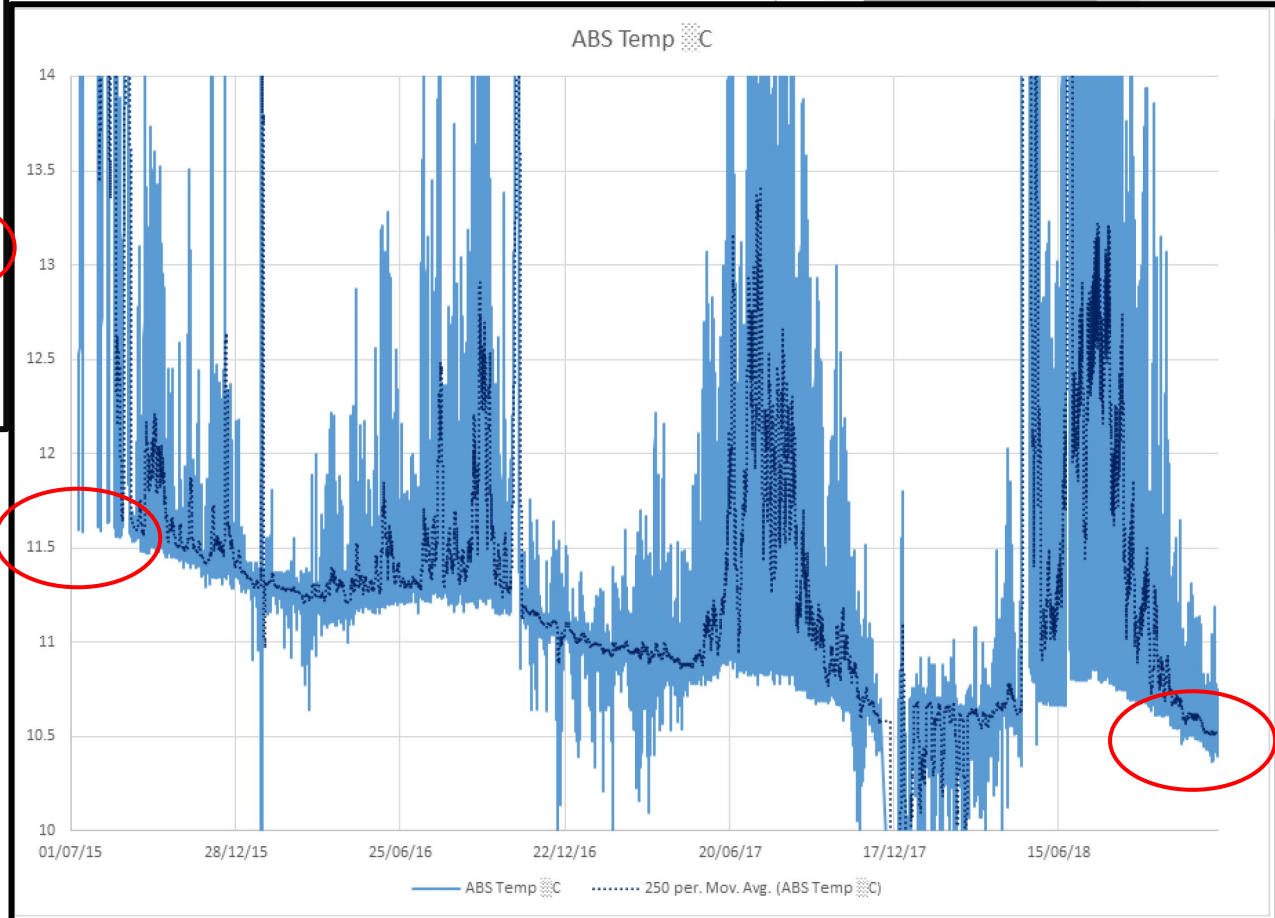


Predictive model results 3.5 years

Actual ongoing data results 3.5 years



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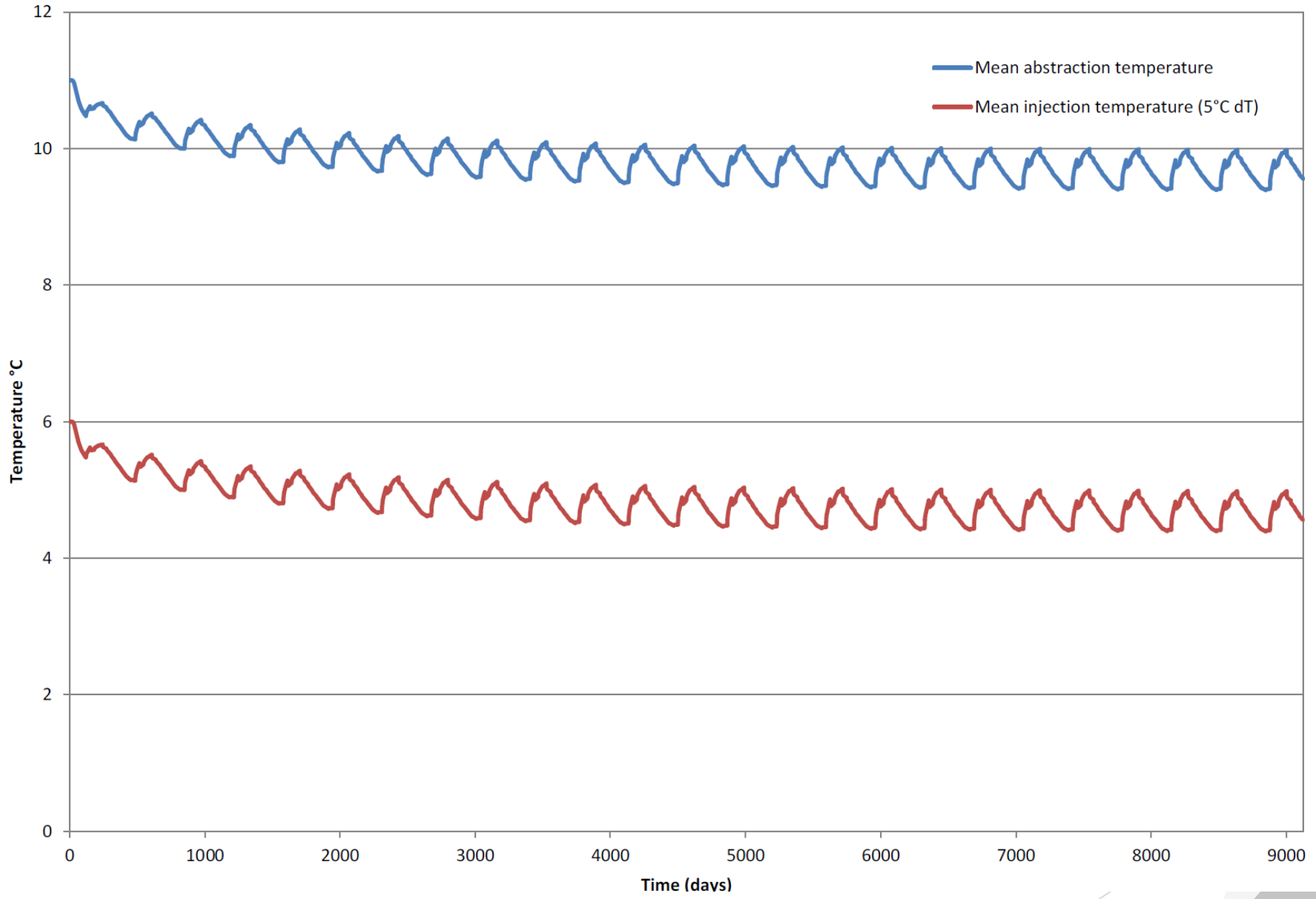

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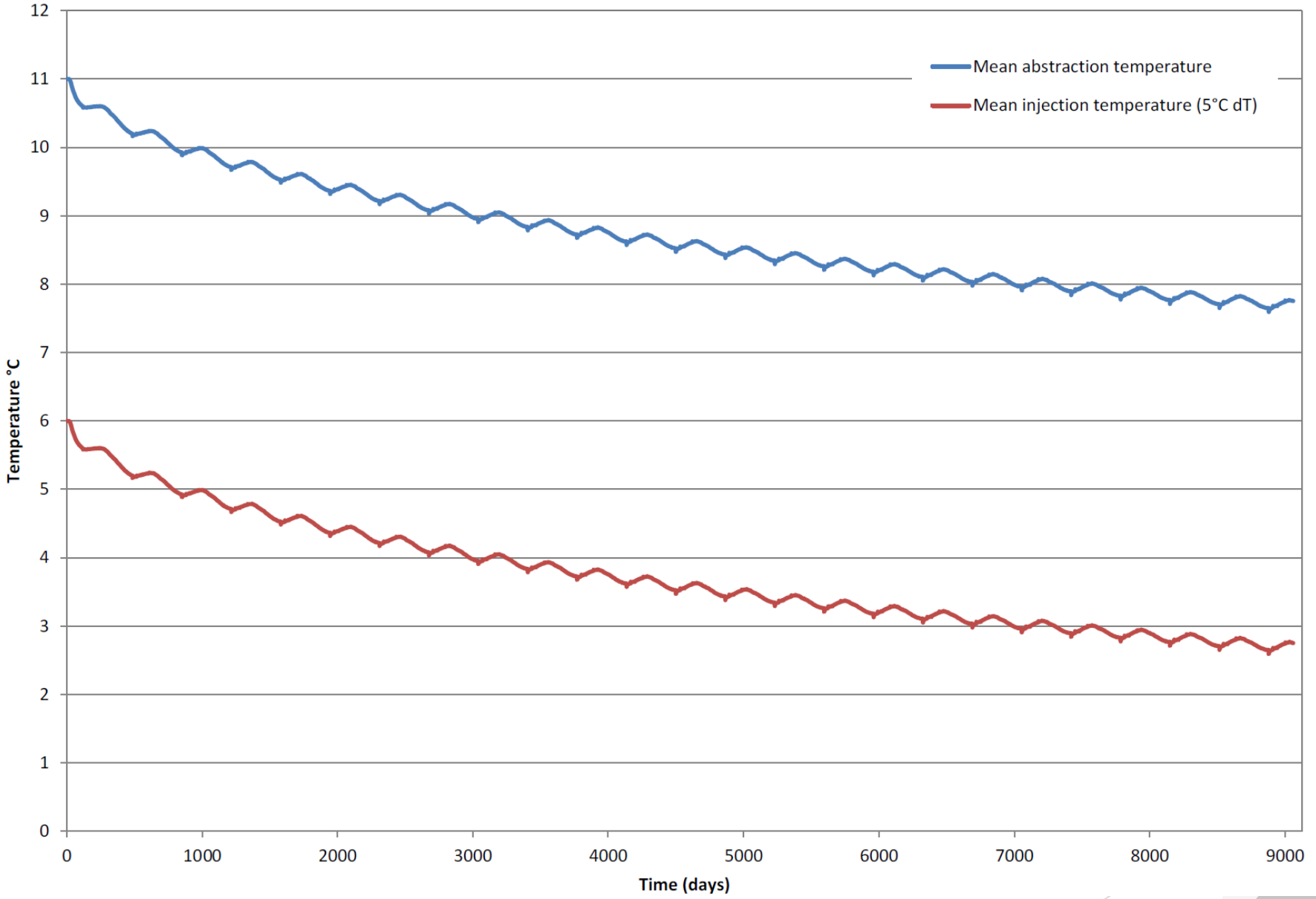
Predictive model results 25 years



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Predictive model results 25 years reduced BH distances

District Heating Networks….

- Open Loop Boreholes now being considered….Why ?

- Lower temperature DHN's can now use high temp heat pumps

  - They are usually massive heating only loads 4 – 40MW !
  - Ground source system not likely to realistically provide the higher loads but can provide good contribution with a bivalent / hybrid system
  - Would be able to offer greater load capability if serving cooling load too
  - Incredibly important to model the ground to identify level of sustainable use
  - Ongoing monitoring remains of critical importance to see trends

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Questions…..

and thank you

www.gshp.org.uk info@gshp.org.uk

John Findlay

carbonzero CONSULTING

Iain Howley

Howley Energy & Water Limited

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