

# **Dawdon Mine Water Heat Pump Trial**

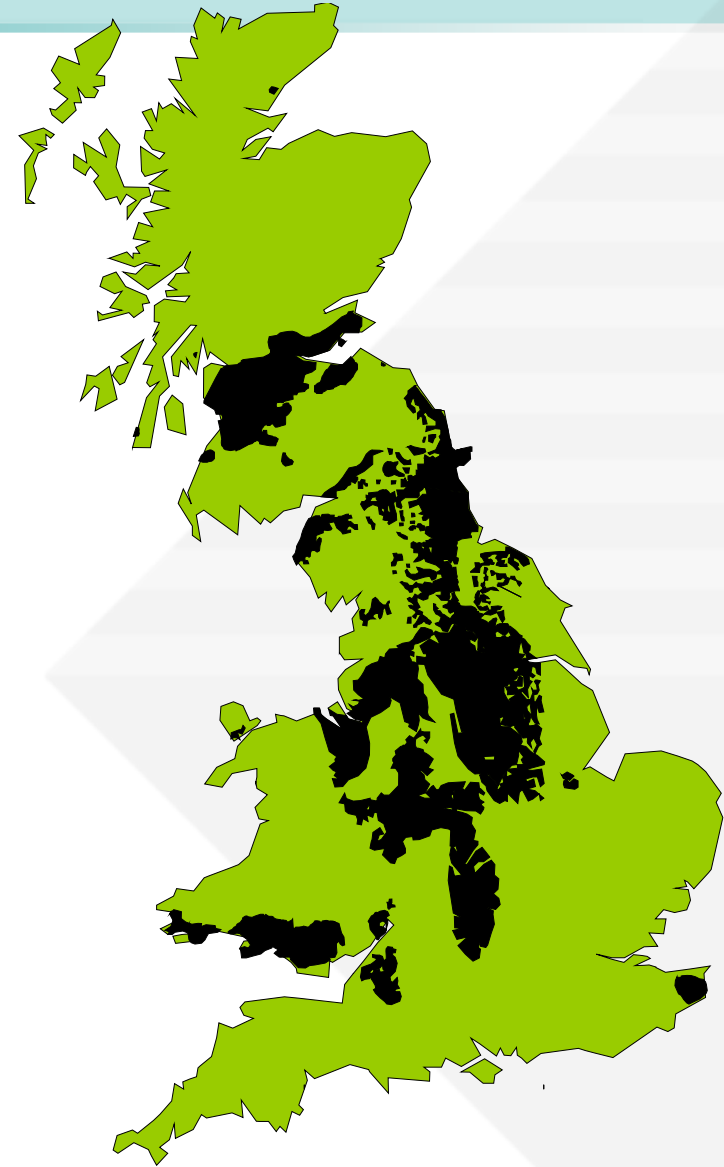
**14-Dec-12**

**This presentation was produced by  
The Coal Authority**

- ◆ **Potential for Mine Water sourced heating**
- ◆ **Dawdon heat pump trial**
  - ◆ **A demonstration project**



- ◆ 7.7 million properties on UK Coalfield
- ◆ 2 million sit on the shallow coal workings
- ◆ Many areas have flooded mine workings in the near sub-surface
- ◆ Potentially a large resource



# Treatment of coal mine waters 60 schemes in UK



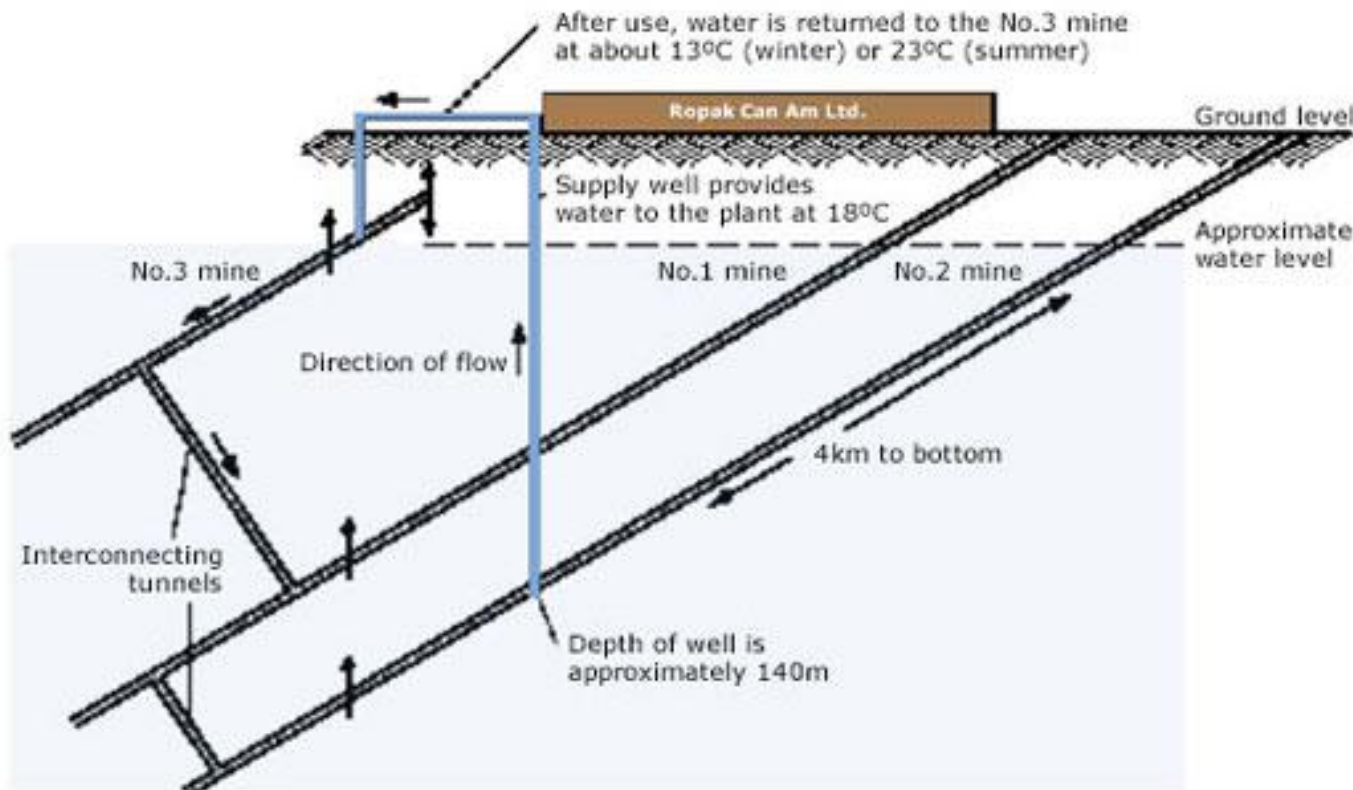
# Mine water sourced heating?

- ◆ Only a handful of examples worldwide, including:
  - ◆ Nova Scotia, Canada (1986)
  - ◆ Scotland (2001)
  - ◆ Heerlen, the Netherlands (2008)
    - ◆ Plus a few others
- ◆ Substantial UK potential
  - ◆ Gravity discharges 17 – 2877 Kw<sub>thermal</sub>\* (*out of 11 coal mine water discharges*)
  - ◆ Pumped flows 69 – 1205 Kw<sub>thermal</sub>\* (*out of 7 pumped flows – Moira to Horden*)
  - ◆ Many more potential sites >100MW

\* $\Delta T$  5K



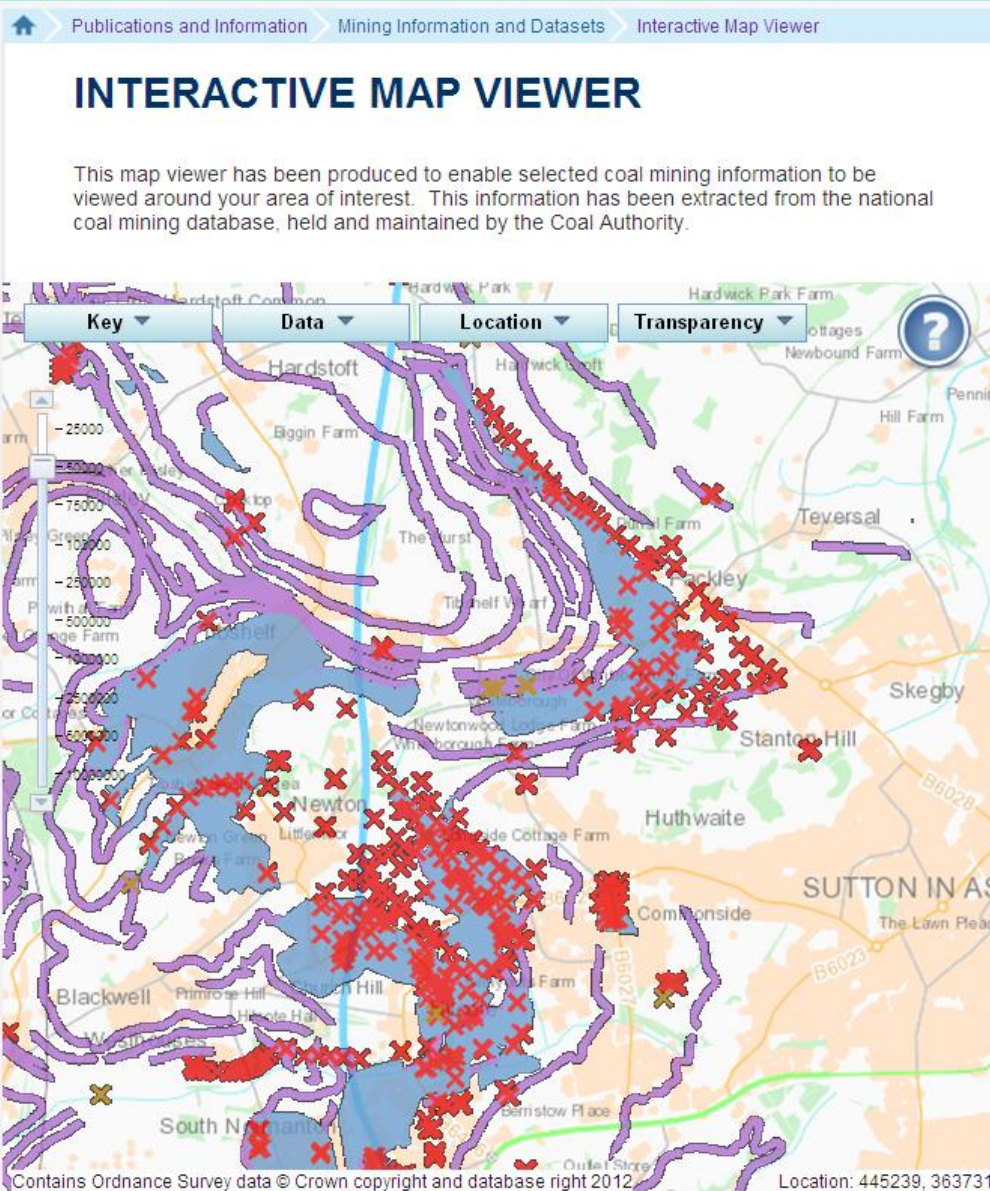
- ◆ Vast amounts of water in mine void
- ◆ Relatively stable temperature year round
- ◆ Access via open shafts at some former mines



Schematic of system at Springhill, Nova Scotia

Source: Canada Centre for Energy:  
<http://www.centreflow.ca/2011/03/31/coal-as-renewable-energy/>

- ◆ Permission required from CA to enter mine workings or coal seams
  - ◆ ~20 / year issued relating to GSH, mainly closed loop
- ◆ Specific Mine Water Heat Access Agreements available for exclusivity rights over geographical areas
  - ◆ 7 Access Agreements issued to date
    - ◆ Abstract water, extract heat, and return to mine workings
- ◆ Provision of Information
  - ◆ Mining information
  - ◆ Hydrogeological information



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# Mine water sourced heating

- ◆ Why has mine water not been used for heating schemes more widely?

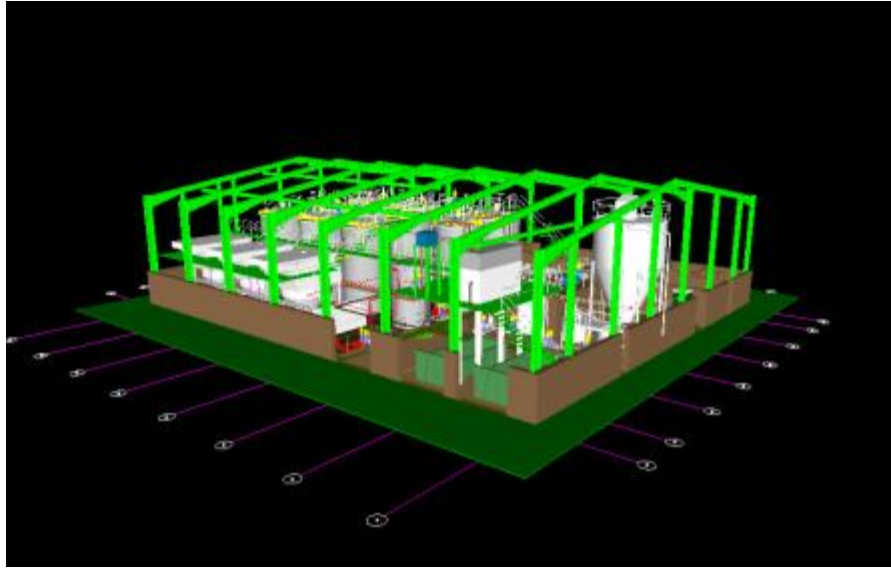


- ◆ Perhaps due to fears over potential clogging of pipes and mechanisms...

- ◆ CA considered benefits of a trial
- ◆ Decided to proceed to:
  - ◆ Demonstrate technology to interested parties
  - ◆ Explore performance optimisation



# Dawdon mine water treatment scheme



**Dawdon, Seaham, Co. Durham  
pumps 100 l/s mine water  
to protect aquifer from pollution  
High salinity  
High Iron (removed by lime  
treatment)  
Offices , 8 rooms**

- ◆ Warm mine water that is treated reliably and fully within consent limits
- ◆ Potential to trial a heat pump unit within facility, usefully heating offices
  - ◆ Utilising 1.5 l/s mine water @ 20C
- ◆ Assess reliability and performance (COP) of system – up to 5 anticipated (typical ground source heat systems achieve 3.5).



# Treated mine water



- ◆ Mine water loop: ~1.5l/s, 20degC, <1mg/l Fe
- ◆ Heat exchanger units, interchangeable:
  - ◆ Bowman Heat Exchanger (Tube in Shell);
  - ◆ SWEP Gasket Plate Heat Exchanger
- ◆ Heat pump unit:
  - ◆ Danfos DHP - L Opti Pro 3 Ph. 12KW
- ◆ Radiators:
  - ◆ 21 standard domestic type units,
  - ◆ low temperature to simulate underfloor heating,
  - ◆ total surface area approx 60m<sup>2</sup>
- ◆ DHW also provided to offices











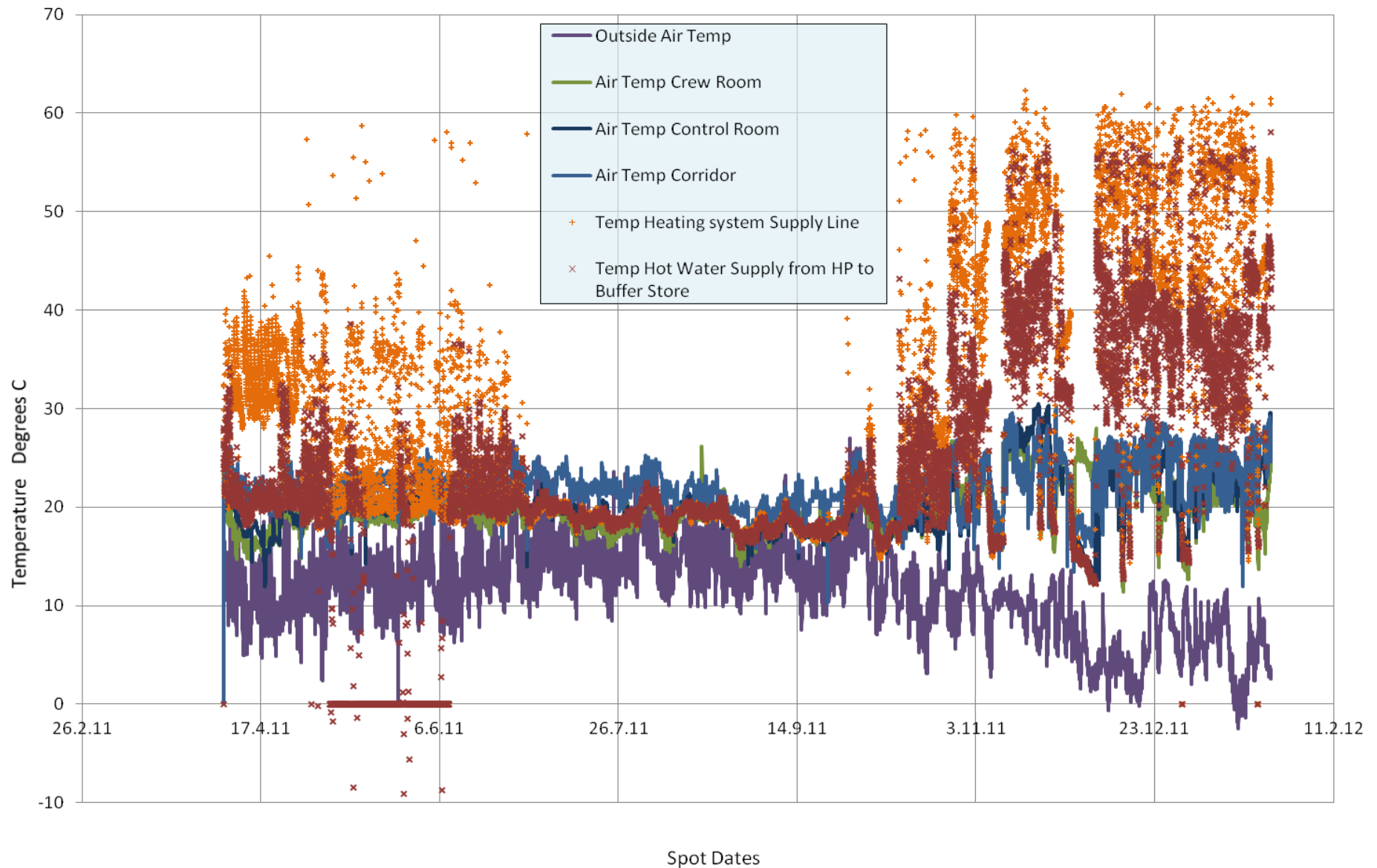
- ◆ System commissioned April 2011
- ◆ Successful heating of offices and provision of hot water
- ◆ COP 3.5 – 4 (including immersion heater used to boost hot water supply)
- ◆ Various issues with temperature probes, leaks and electrical problems
- ◆ Rapid clogging of tube in shell heat exchanger, resulting in failure of system (June 2011)

- ◆ Replacement heat exchanger
- ◆ Y-strainer filter installed
- ◆ Flow meter installed in mine water circuit to identify any clogging early
- ◆ System re-started in October 2011
  - ◆ Heating season resumed

- ◆ Heating resumed - COP typically 3.5 - 4
  - ◆ Ideal COP of 5 – 6 not observed
- ◆ Y – strainer filter had to be cleared every couple of days (see photo)
- ◆ System finally failed again in April 2012 due to clogging of tube in shell heat exchanger

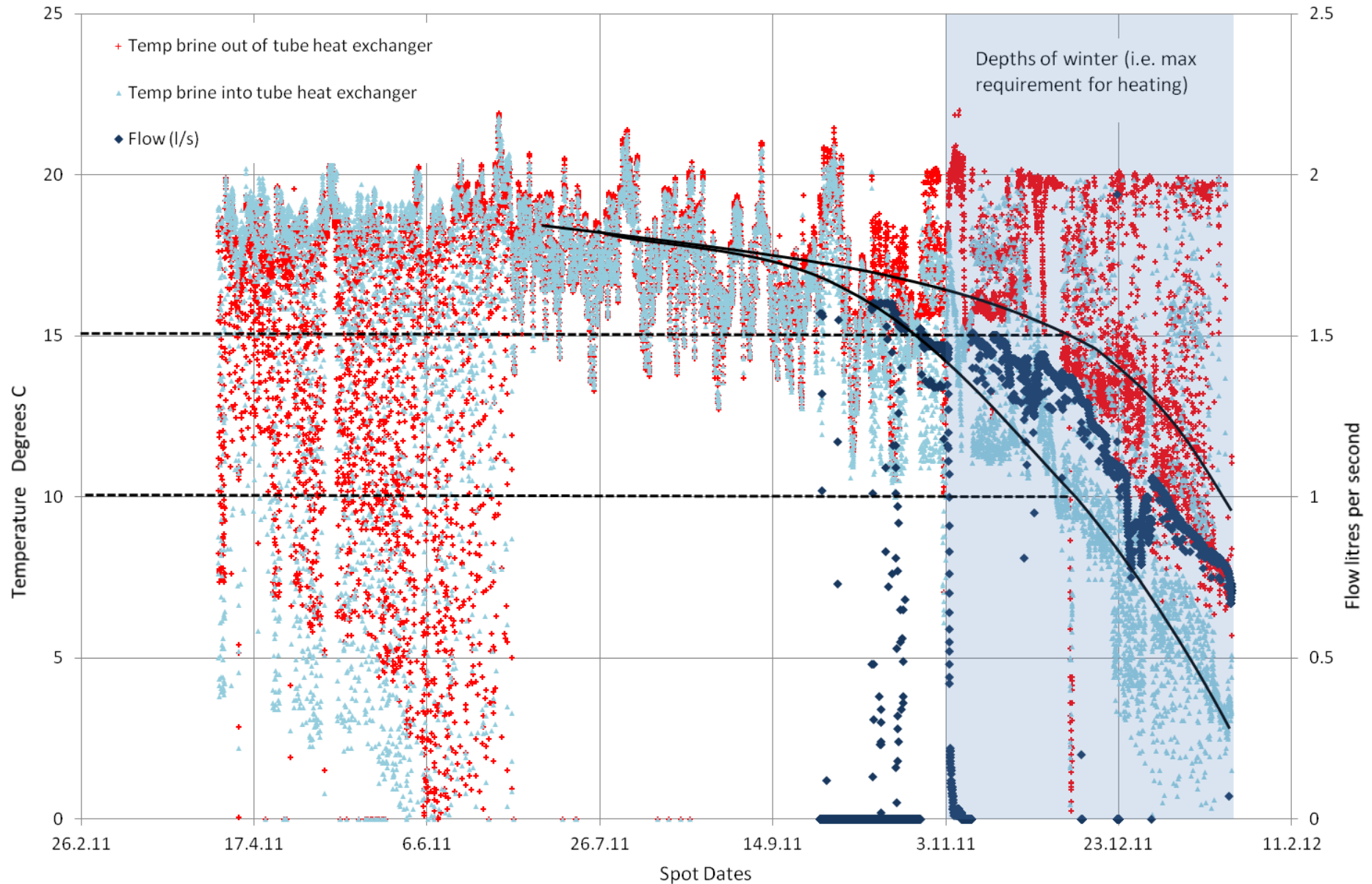


# Heating circuit temp. plots





# Brine T, tube heat exchanger



# Why treated water caused clogging

- ◆ Clogging clearly an issue for sustained operation: ochre?
  - ◆ Mineralogical analysis undertaken of material blocking heat exchanger
    - ◆ Largely amorphous hydrous ferric oxide = ochre
- ◆ Treated water still contains ~1 mg/l total Iron – mainly as particles of iron
  - ◆ Hence high tendency for clogging.

- ◆ Raw mine water feed?
  - ◆ Scheme in Lumphinnans, Scotland has been operating for 10+ years, with no reports of clogging issues, despite [Fe] ~80mg/l
  - ◆ Sealed systems prevent dissolved species precipitating from solution
  - ◆ Keep the oxygen out !
- ◆ Dawdon System reconfigured to take feed off raw untreated mine water
- ◆ Trial started at Dawdon in 2012-13 heating season





**Untreated mine water feed**

14 December 2012

- ◆ In operation since September 2012
- ◆ Heating effectively provided to offices
- ◆ Flow has remained steady at 0.8 – 1.3 litres per second (depending upon plant flow)
- ◆ No clogging observed yet
- ◆ Data collection underway



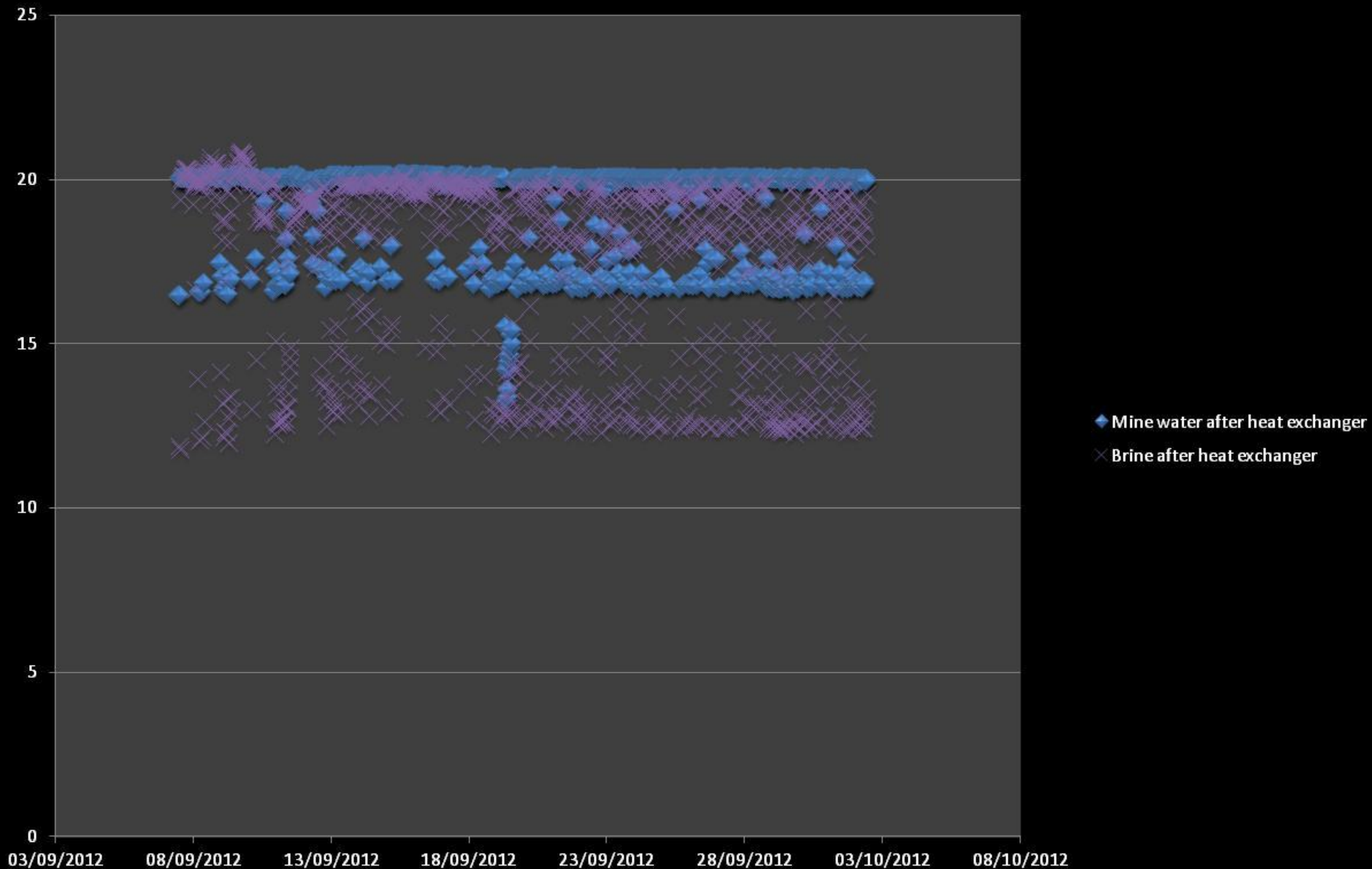


# $\Delta T$ mine water (3°C)





# Heat exchanger efficiency (°C)



- ◆ Demonstrate successful application of raw mine water use in heat pump system at Dawdon
- ◆ Continue:
  - ◆ Providing information across coalfields
    - ◆ Industry, developers, planners, etc
  - ◆ Issue Permits and Heat Access Agreements
    - ◆ Statutory requirement
- ◆ Facilitate the use of the resource by others