Ground Source Heat Pump Association Webinar Series 2020

CLOSED LOOP BOREHOLES

Geology & Soil

Tim Baker
Principal Hydro-Thermogeologist
B. A. Hydro Solutions
GSHPA Council Member

2nd July 2020

GSHPA
GROUND SOURCE HEAT PUMP ASSOCIATION

Re-Cap…..

GSHPA Thursday talks as a response to lockdown, all available on YouTube. The three previous Webinars:

1. Closed Loop Borehole Design – General
2. Closed Loop Borehole Design – Hydraulic
3. Closed Loop Borehole Design – Construction and Finishing

Today – Geology, hydrogeology, thermogeology, soils….

GSHPA
GROUND SOURCE HEAT PUMP ASSOCIATION

Today: Geology and Soil Conditions

- Why do you NEED to seriously consider the geology and soil?
- Who should consider the geology and soil?
- How can you consider the geology and soil?
- What to do with the information?
- When should you consider the geology and soil?

GSHPA
GROUND SOURCE HEAT PUMP ASSOCIATION

Why Consider Geology and Soil?

Understanding the geology/soil is a critical part of the Feasibility Study, Risk Assessment and/or Impact Assessment.

An understanding of the geology/soil should inform whether a project progresses, its architecture, its design, its cost, how it operates, management and maintenance and the success of a scheme!

The geology/soils is one third of the critical design trilogy!

Geology / Soil Conditions

The Heat Pump / Scheme

The Load(s)

If one or more of the three are not correctly dealt with in the design, the scheme will fail.

GSHPA
GROUND SOURCE HEAT PUMP ASSOCIATION

Who Should Consider Geology and Soil?

The geology and soil beneath the site can be considered in different ways and by different parties involved with the design. Fundamentally:

The person/company responsible for designing the system must also take responsibility for the geology/soil

The person /company responsible for the design should be confident and competent at interpreting the geology

Or

They should engage someone who is and/or commission a desk study to correctly characterise what is there.

There should be evidence of how the geology/soil was assessed to validate the design.

GSHPA
GROUND SOURCE HEAT PUMP ASSOCIATION

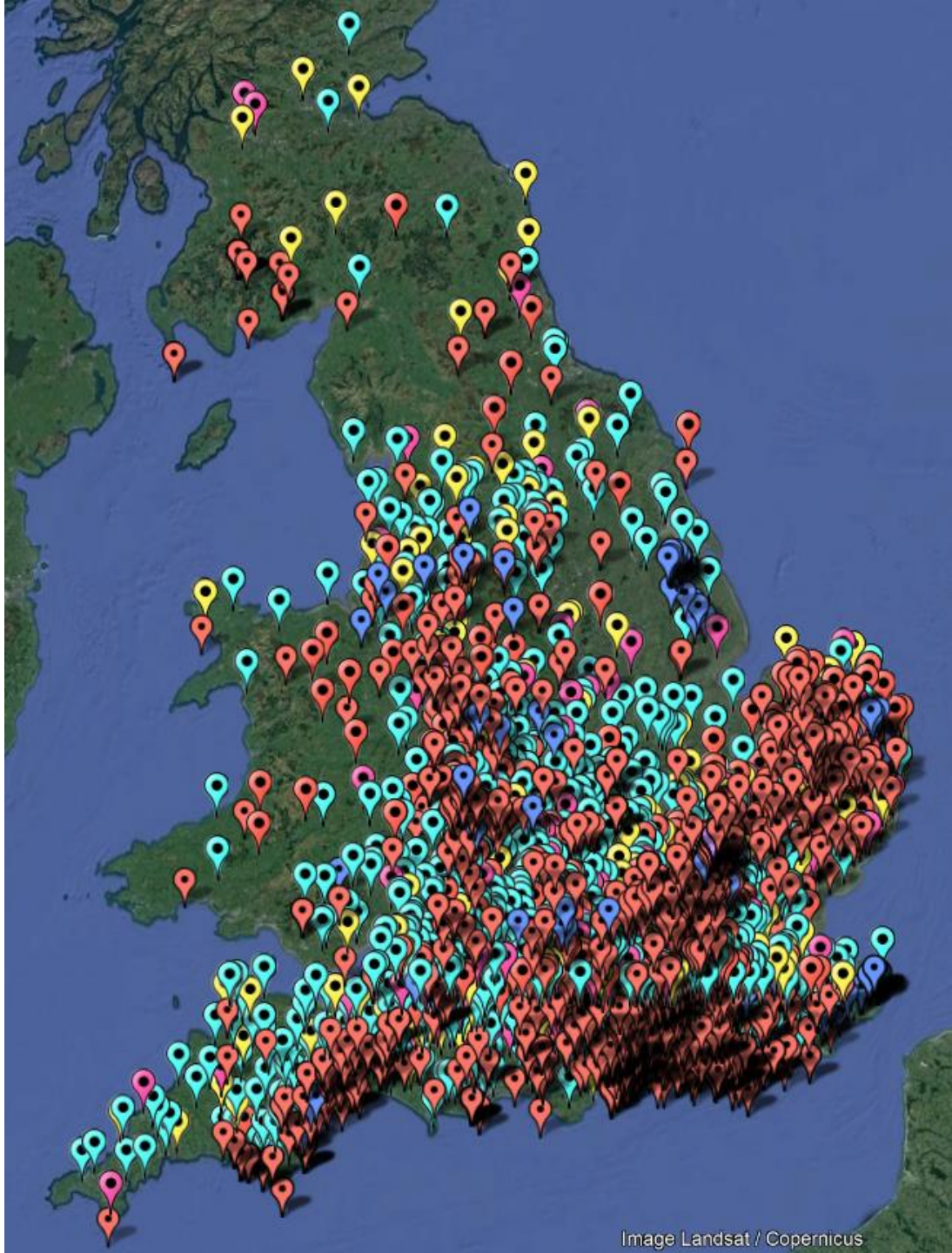
How To Consider Geology/Soil?

The 3 types of GSH&C systems require 3 different approaches

Vertical Closed Loop Collectors
- Boreholes
- Piles

Horizontal Closed Loop Collectors
- Shallow pipes beneath lawns/parks/gardens/carparks
- Multiple layers of horizontal pipes

Open Loop Systems
- Abstraction/Injection Boreholes
- Wells & adits
- Mine workings (direct & indirect)
- Surface water



GSHPA
GROUND SOURCE HEAT PUMP ASSOCIATION

Vertical Closed Loop Ground Collectors

For these systems the following summarises the typical ways of starting to characterise the ground conditions in the order they would normally occur:

Initial postcode/NGR check – normally free

Thermogeological Assessment (desk study)

Trial drilling

In-situ testing – Thermal Response Testing (TRT)

Laboratory testing – from cores and/or samples from fresh exposures

Geophysical surveying*

GSHPA
GROUND SOURCE HEAT PUMP ASSOCIATION

Horizontal Closed Loop Ground Collectors

For these systems the following summarises the typical ways of starting to characterise the ground conditions in the order they would normally occur:

Initial postcode/NGR assessment using soil maps

Occasionally a desk study can help, but ONLY where there is good data

Trial pits to visually assess the conditions present

In-situ thermal measurements of the ground

Laboratory testing of representative samples

Thermal Response Testing (TRT) on installed loops

Remote sensing*

GSHPA
GROUND SOURCE HEAT PUMP ASSOCIATION

Boreholes - Open Loop

For these systems the following summarises the typical ways of starting to characterise the ground conditions in the order they would normally occur:

Initial postcode/NGR check for viability and issues

Hydrogeological Assessment (desk study)

Trial boreholes

Pump testing of boreholes, wells, etc….

Tracer tests

GSHPA
GROUND SOURCE HEAT PUMP ASSOCIATION

What do I do with it?

- Make critical decisions on the direction the project should take
- Use the site specific geology/hydro/soil characterisation to develop the design
- Develop models to simulate the ground's response to heat extraction and rejection
- Model fluid and heat movement through the ground to refine the model
- Refine the design each time new hydro-thermo-geological data becomes available
- Prepare impact assessments to assure the client, the regulator, stakeholders
- Select contractor based on the conditions anticipated
- Prepare before starting the ground works
- Avoid disasters
- Plan how to overcome issues that cannot be avoided
- Best understand how to manage the project, who needs to be involved/present

GSHPA
GROUND SOURCE HEAT PUMP ASSOCIATION

When To Consider the Geology/Soil Conditions?

When should a project start to consider the ground conditions present?

- As soon as possible!
- Before major decisions have to be made
- Throughout the project

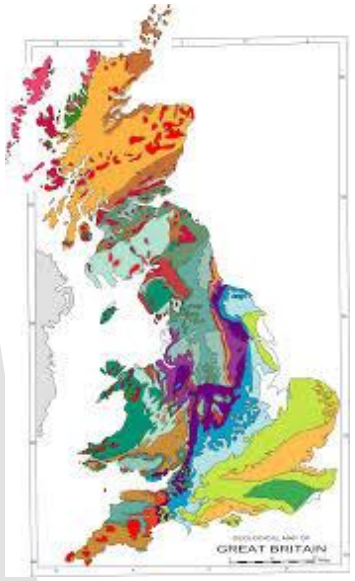
Start by ‘assessing’ what might be there in design iterations;
End, knowing what is there has been accounted for in the final design.

- Collect and interpret the drill cuttings
- Review the driller’s logs
- Measure the ground temperature
- Complete tests and incorporate the findings
  - Photograph
  - Sample
  - Measure

GSHPA
GROUND SOURCE HEAT PUMP ASSOCIATION

Typical Process

Postcode check



Preliminary Design

Desk Study & / or Field Testing

Develop & Refine Design

Excavate, Record, Measure, & Test

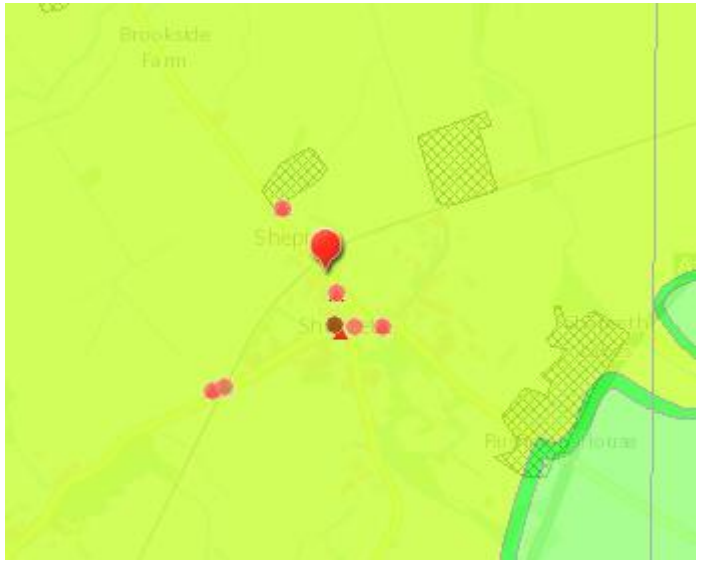
Revise Design Based on Ground

Final Design Installed

GSHPA
GROUND SOURCE HEAT PUMP ASSOCIATION

Example -

Check the postcode: SG8 6PZ….



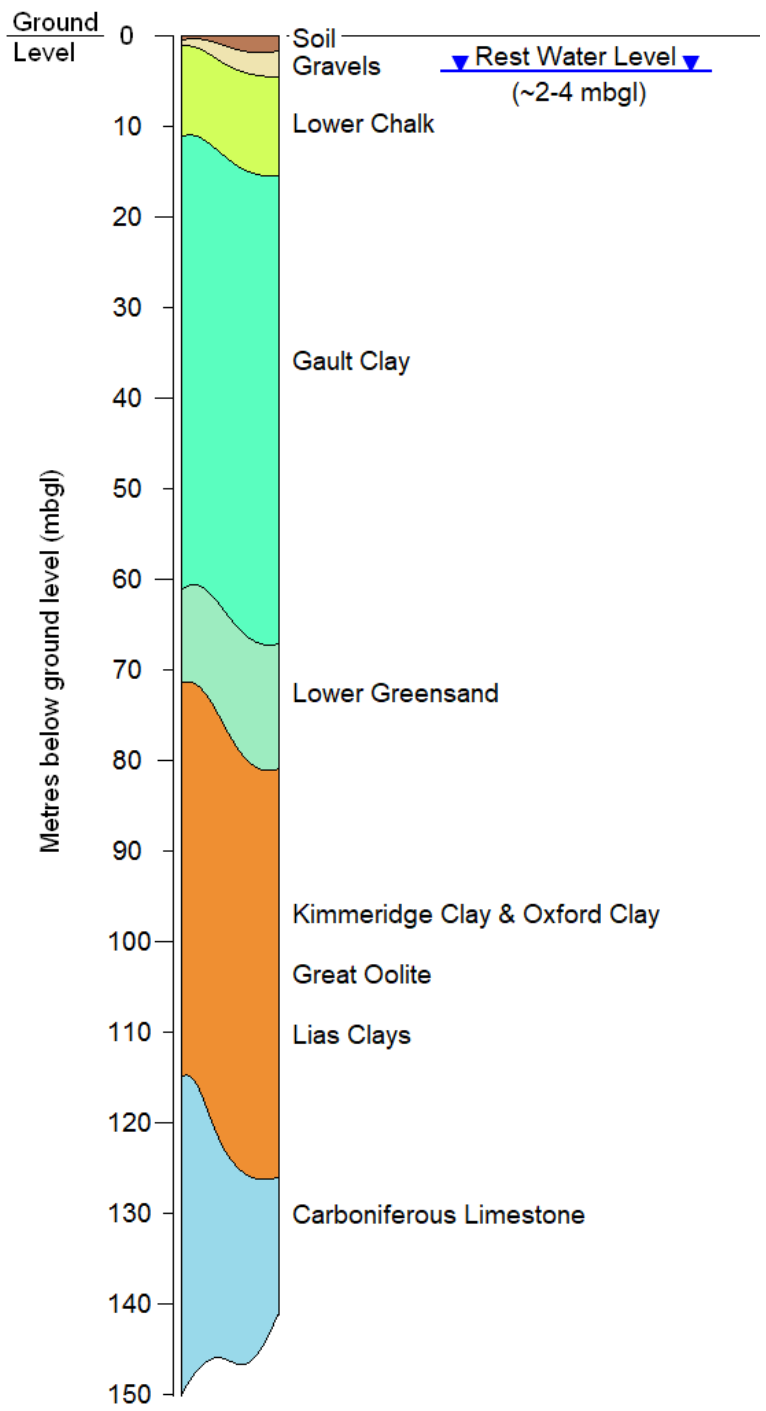
…. On [lower] Chalk which could have a thermal conductivity of up to 2.5 W/mK.

For a 40 kW system [COP4], using the look up tables, it indicates ~790 metres,
so 5 holes to ~158 metres.

However, the geology is actually more complicated…..

……the Chalk is only ~10metres thick over multiple layers

GSHPA
GROUND SOURCE HEAT PUMP ASSOCIATION



When the thermal properties for the different strata are assessed the thermal property range for different drill depths can be assessed:

Drill Depth (Metres)	Thermal Conductivity (W/mK)			Volumetric Heat Capacity (MJ m-3K-1)		
50	1.54	-	1.76	2.28	-	2.38
75	1.70	-	1.95	2.23	-	2.33
100	1.63	-	1.87	2.24	-	2.35
125	1.63	-	1.86	2.25	-	2.36
150	1.82	-	2.09	2.22	-	2.34
175	1.96	-	2.25	2.19	-	2.33
200	2.07	-	2.38	2.18	-	2.32

The look up tables now suggest ~1,000 metres of borehole

Modelling = 4no holes to 158 = 617 metres

Saving in drilling cost of >£5k for ~£1k design cost

Questions…..

and thank you

www.gshp.org.uk

Tim Baker

B. A. Hydro Solutions Limited

info@gshp.org.uk

GSHPA

GROUND SOURCE HEAT PUMP ASSOCIATION