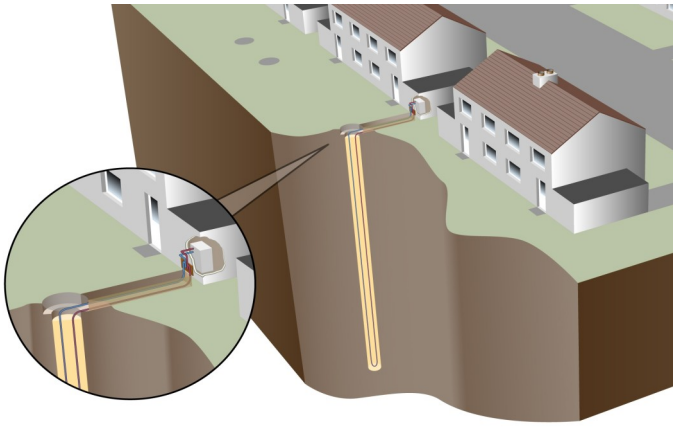
Closed loop boreholes V4

Energy for ground source heat pumps, as the name implies, is provided via low-grade solar energy stored in the ground. This energy can be extracted in a number of ways, generally involving the circulation of a water and antifreeze mix within the ground. This can be via horizontal ground arrays, such as slinkies or vertical ground arrays.

Vertical ground arrays (often referred to as boreholes) are generally used for large commercial projects or smaller sites where there is insufficient area for horizontal arrays. Drilling is a specialist discipline and the advice of a geothermal drilling company should always be sought.



The ground

A geological survey by the driller should provide an indication of the type of material that the borehole is to be drilled into. This material can determine the design of the borefield particularly in large commercial projects. For example a borehole in loose stones has an extraction rate of approx. 20 W/m and granite of 55-70 W/m. The survey should also indicate whether there are any mine workings or aquifers present.

Sizing of boreholes

The design of boreholes for **small, individual applications** can be done with tables, empirical values and guidelines. A popular parameter to calculate the required length of borehole heat ex-changers is the specific heat extraction, expressed in Watt per meter borehole length. Typical values range between 40-70 W/m, dependent upon geology (thermal conductivity), annual hours of heat pump operation, number of neighbouring boreholes, location, etc. Typically a 75-100m

Facts at a glance:

Borehole performance—This is dependant on the geology, heating distribution system, building heating profile, location, etc. As a guide a 75—100m borehole will provide 3—5 kW of extractable heat.

Borehole design—Borehole design for **small, individual applications** can be done with tables, empirical values and guidelines. For **larger commercial projects** (>100kW) then a thermal response test is required.

Borehole make up—Boreholes generally consist of a 60 to 100m deep hole, with a loop of PE100 pipe encased in a bentonite thermal grout

Borehole spacing—Boreholes should be spaced at 5 to 6 metres between centres to avoid interference

For **larger commercial projects**, (nominally over 100kW) guidelines tend to overestimate the number of required boreholes and it is advisable that a thermal response test or TRT is carried out on a test and representative borehole. A thermal geologist can combine the results from a TRT, with the heating and cooling profile of the building, to calculate the type, depth, number and spacing of boreholes. The cost of completing a TRT is generally recovered in the reduction in the number of boreholes required.

Borehole drilling

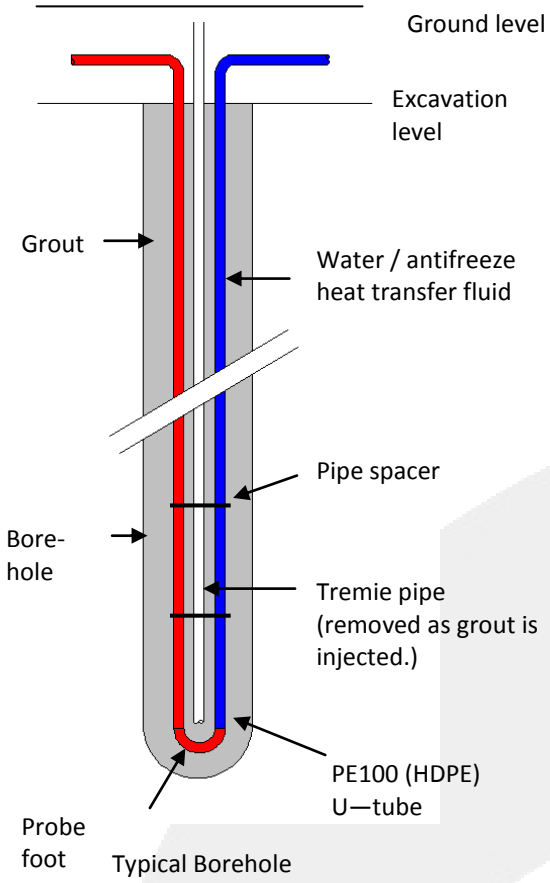
This element of the project is quite distinct from the installation of the heat pump, underfloor heating and DHW cylinder. It should be considered as contractually equivalent to the installation of the gas main, which is handled separately from the fitting of any boiler. Care must be taken to ensure the borehole 'tails' are left in a suitable configuration for the M & E contractor.

A borehole basically consists of a hole drilled between 60 and 100m deep vertically down. Generally the borehole diameter is around 110 - 145mm, but this diameter depends on the type of machine being used to drill the borehole and the diameter of the borehole pipe (usually 32-40mm). The drilling rigs used by drillers come in many shapes and sizes some small enough to operate and gain access to small gardens others designed for larger commercial projects.

The first few meters of a borehole is generally sleeved with a casing to avoid the sides collapsing. The depth of this casing is dependent on the material that the borehole is sunk into and the depth of soil.

Boreholes are generally placed at 5-6m centres however for large commercial projects the interference from one borehole to another may well need to be calculated to ensure that adequate spacing or sufficient depth is provided. A loop of pipe (usually PE100 HDPE or Pex pipe) is inserted within the hole. Normally in the UK a single loop is used. It is possible to use a twin loop or duplex system, to try and extract more energy.

However, for a twin loop system a larger diameter hole is required and the energy yield from the borehole only increases by an approximate factor of 1.25. (This is dependant on the hole and pipe diameter, distance from the next borehole, how the pipe is inserted, grouting, etc). The pipe is generally either filled with water or weighted at the end to aid with the insertion.



Along with the borehole pipe a small tremie pipe (25–40mm) is also inserted attached to the borehole pipe. The tremie pipe is used to fill the borehole completely with thermal grout and is withdrawn as the grout is injected. The thermal grout provides an enhanced thermal path to allow the energy within the ground to be absorbed by the fluid circulating around the borehole pipe. The driller will take responsibility for grouting the hole using specialist pumping equipment.

The drilling contractor will perform a pressure test, cap the plastic ground array pipe and issue a certificate before leaving site.

Connection of boreholes

If more than one borehole is required, the pipes should be connected in such a way that equal distribution of flow in the different channels is secured. Manifolds can be at the building, or the pipes can be connected in trenches in the field.

To avoid any joints, and to eliminate the need for any electro-fusion welding (which requires specialist equipment and attracts a significant cost), it is sensible to use a specially extended borehole probes. This eliminates the need for any electrofusion joints, which are generally beyond the scope of most heating contractors. This pipe is simply laid in a trench, which is required between the top of the borehole, and the manifold on the side of the building. The groundworking crew can provide the trenching since their prices will generally be more competitive than any drilling contractor.

The design of boreholes is a complicated issue and the above is simply meant as an overview. Expert advice should be taken regarding sizing and placement and consideration of the buildings heating profile should be taken into account. Any figures quoted within this document are for an initial guide only and Kensa cannot be held responsible for any sizing based on this data.