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GeoReports

Example Report
BGS Keyworth

Ground Source Heat Pump (Basic):

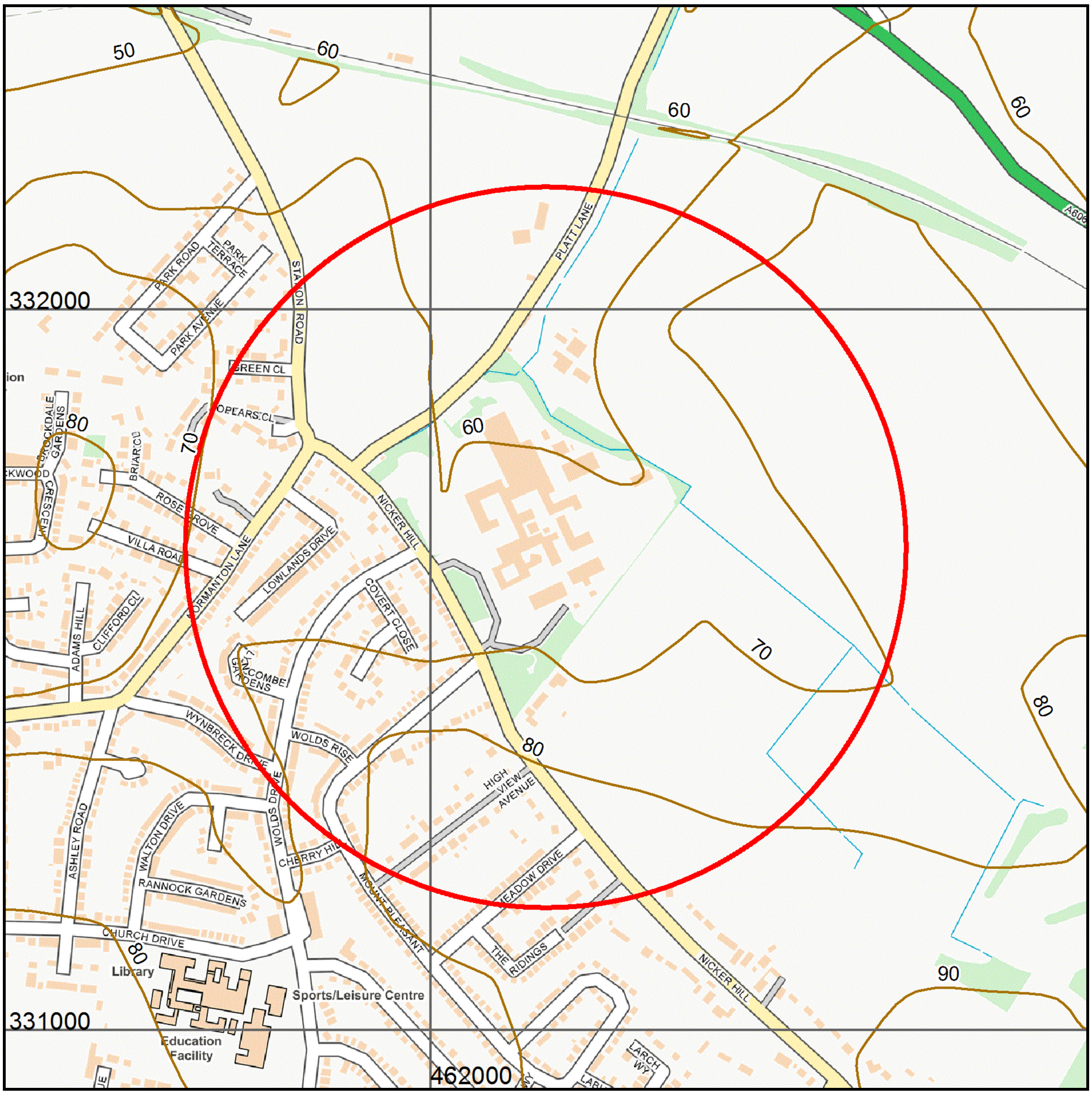
This report is for closed loop systems and contains a geological map with descriptions of rock types, estimates of mean annual ground temperatures and thermal conductivities.

Ground source heat pumps (GSHP) can provide low carbon solutions for space heating and cooling of residential and commercial buildings. GSHP systems have relatively low running costs but relatively high installation costs. Much of the cost is associated with installation of the external loop and is strongly affected by the geological and environmental conditions at the site. The site factors can affect both the heating and cooling performance of the heat pump and the drilling-trenching methods and costs.

Report Id: ***GR_999999/1***

Client reference:

Search location



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Site Address:
British Geological Survey,
Keyworth

Area centred at: 462160,331670
Radius of site area: 500 metres

Temperature and Thermal Properties (Basic)

This module is computer-generated and describes the thermal properties of formations occurring at the ground surface.

Temperature

The temperature of the ground determines the temperature gradient within the collector loops of the ground source heat pump. Surface ground temperatures are determined by the air temperature and are influenced by daily and seasonal variations. These variations diminish rapidly with depth so that at a depth of 10 to 15 m the ground temperature is equal to the mean annual air temperature. Mean site temperature has been estimated using a model based on the 30-year station averages published on the UK Meteorological Office (UKMO) web site www.metoffice.gov.uk. For mainland UK at sea level it varies from about 8 to 12 °C with the highest values in the south-west and lower values to the east and north and at sites of greater elevation.

The annual temperature variation is transmitted into the soil layer, but rapidly reduces in amplitude. It lags behind that of the surface cycle such that at a depth of 3.5 m the minimum soil temperature is likely to be in the first two weeks of April and the maximum temperature about the end of October. The annual temperature variation at 3.5 m depth will be about one quarter that at the surface. Soil temperatures at depth have been estimated using a soil diffusivity of 0.05 m^2 day^{-1}.

At depths below about 15 m temperatures are affected by the small amount of heat conducted upwards from the sub-surface. In the UK this creates an increase of temperature with depth that has an average value of 2.6 °C per 100 m. This geothermal gradient will vary depending upon the nature of the rocks and their thermal properties. In addition moving groundwater can create warmer regions by transporting heat from depth; or cooler regions when cold water flows down from near the ground surface. Estimates of the temperatures at 100 and 200 m depths have been made from an estimate of the local heat flow and the thermal conductivity of the bedrock geology shown on the 1:250 000 scale geological map. It should be noted that anomalies caused by flowing groundwater are not included here.

Estimated temperature parameters of the site (in °C)

Mean annual air temperature	9.6 °C
Mean annual temperature swing	8.2 °C
Estimated mean soil temperature	10.6 °C
Minimum annual soil temperature at 1 m	5.2 °C
Maximum annual soil temperature at 1 m	16 °C
Estimated temperature at 50 m depth	12.3 °C
Estimated temperature at 100 m depth	14 °C
Estimated temperature at 150 m depth	15.6 °C
Estimated temperature at 200 m depth	17.3 °C

Soil temperatures at 1 m depth estimated using a soil diffusivity of 0.05 m^2 day^{-1}.
Annual temperature variation based on mean January and July air temperatures.

Thermal properties

The rate at which heat is exchanged between the collector loop of the ground source heat pump and the ground is determined mainly by the thermal properties of the Earth. Thermal conductivity is the capacity of a material to conduct or transmit heat, whilst thermal diffusivity describes the rate at which heat is conducted through a medium. For a horizontal loop system in a shallow (1 to 2 m) trench then the properties of the superficial deposits are important, whilst for a vertical loop system it is the properties of the bedrock geology that are important.

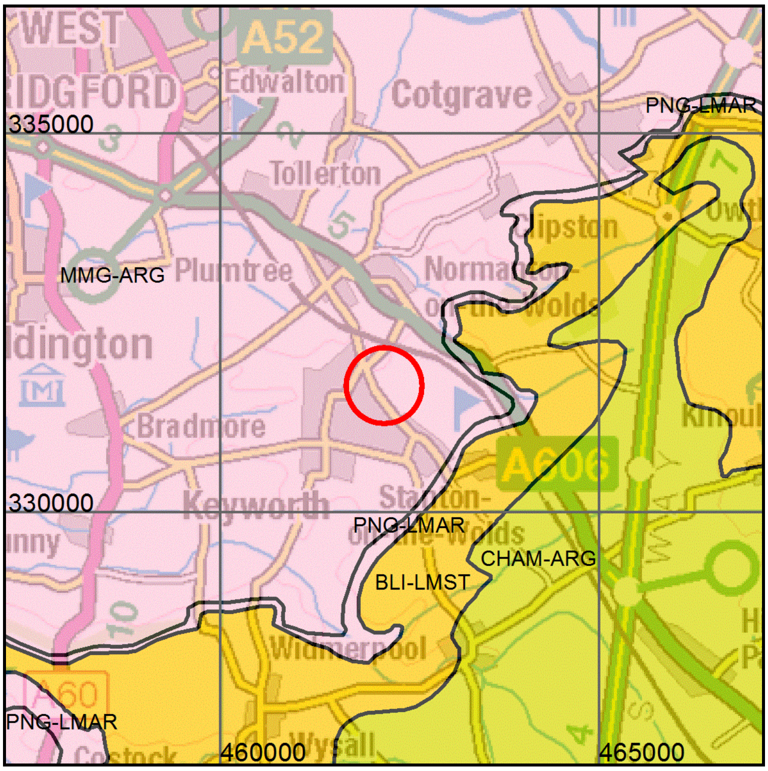
Thermal conductivity varies by a factor of more than two (1.5 to 3.5 W m^{-1} K^{-1}) for the range of common rocks encountered at the surface and can vary significantly for many superficial deposits. The thermal conductivity of superficial deposits and soils will depend on the nature of the deposit, the bulk porosity of the soil and the degree of saturation. An approximate guide to the thermal conductivity of a superficial deposit can be made using a simple classification based on soil particle size and composition. Deposits containing silt or clay portions will have higher thermal conductivities than those of unsaturated clean granular sand. Clean sands have a low thermal conductivity when dry but a higher value when saturated.

Typical rock thermal diffusivities range from about 0.065 m^2 day^{-1} for clays to about 0.17 m^2 day^{-1} for high conductivity rocks such quartzites. Many rocks have thermal diffusivities in the range 0.077 to 0.103 m^2 day^{-1}.

Typical values of thermal conductivity and diffusivity for superficial deposits

Class	Thermal Conductivity W m^{-1} K^{-1}	Thermal diffusivity m^2 day^{-1}
Sand (gravel)	0.77	0.039
Silt	1.67	0.050
Clay	1.11	0.046
Loam	0.91	0.042
Saturated sand	2.50	0.079
Saturated silt or clay	1.67	0.056

Thermal conductivity-diffusivity (based on 1:250 000 Bedrock Geology map)
The linework and formation names displayed on the following map is based on the BGS Digital Map of Great Britain at the 1:250 000 scale and may differ from those shown in other modules that are based on 1:50 000 scale mapping.



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Key to Thermal conductivity-diffusivity:

Map colour	Computer Code	Geological unit	Composition	Thermal conductivity W m^{-1} K^{-1}	Thermal diffusivity m^2 day^{-1}
	BLI-LMST	BLUE LIAS FORMATION	LIMESTONE	2.54	0.1019
	CHAM-ARG	CHARMOUTH MUDSTONE FORMATION	ARGILLACEOUS ROCKS, UNDIFFERENTIATED	1.3	0.0509
	MMG-ARG	MERCIA MUDSTONE GROUP	ARGILLACEOUS ROCKS, UNDIFFERENTIATED	1.87	0.0697
	PNG-LMAR	PENARTH GROUP	LIMESTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED	2.2	0.089

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