



The Certification Mark for Onsite
Sustainable Energy Technologies

MCS 022: GROUND HEAT EXCHANGER LOOK-UP TABLES

SUPPLEMENTARY MATERIAL TO MIS 3005

Issue 1.0

This standard has been approved by the Steering Group of the MCS.

This standard was prepared by the MCS Working Group 6 'Heat Pumps'.

REVISION OF MICROGENERATION INSTALLATION STANDARDS

Microgeneration Installation Standards will be revised by issue of revised editions or amendments. Details will be posted on the website at www.microgenerationcertification.org

Technical or other changes which affect the requirements for the approval or certification of the product or service will result in a new issue. Minor or administrative changes (e.g. corrections of spelling and typographical errors, changes to address and copyright details, the addition of notes for clarification etc.) may be made as amendments.

The issue number will be given in decimal format with the integer part giving the issue number and the fractional part giving the number of amendments (e.g. Issue 3.2 indicates that the document is at Issue 3 with 2 amendments).

Users of this Standard should ensure that they possess the latest issue and all amendments.

TABLE OF CONTENTS

1.	BOREHOLE HEAT EXCHANGERS	4
	1200 FLEQ run hours	5
	1800 FLEQ run hours	6
	2400 FLEQ run hours	7
	3000 FLEQ run hours	8
	3600 FLEQ run hours	9
2.	HORIZONTAL GROUND HEAT EXCHANGERS	10
	1200 FLEQ run hours	11
	1800 FLEQ run hours	12
	2400 FLEQ run hours	13
	3000 FLEQ run hours	14
	3600 FLEQ run hours	15
3.	SLINKY GROUND HEAT EXCHANGERS	16
	1200 FLEQ run hours	17
	1800 FLEQ run hours	18
	2400 FLEQ run hours	19
	3000 FLEQ run hours	20
	3600 FLEQ run hours	21
4.	AMENDMENTS ISSUED SINCE PUBLICATION	22

1. BOREHOLE HEAT EXCHANGERS

Maximum power to be extracted per unit length of borehole heat exchanger (W/m) with 1200 FLEQ run hours

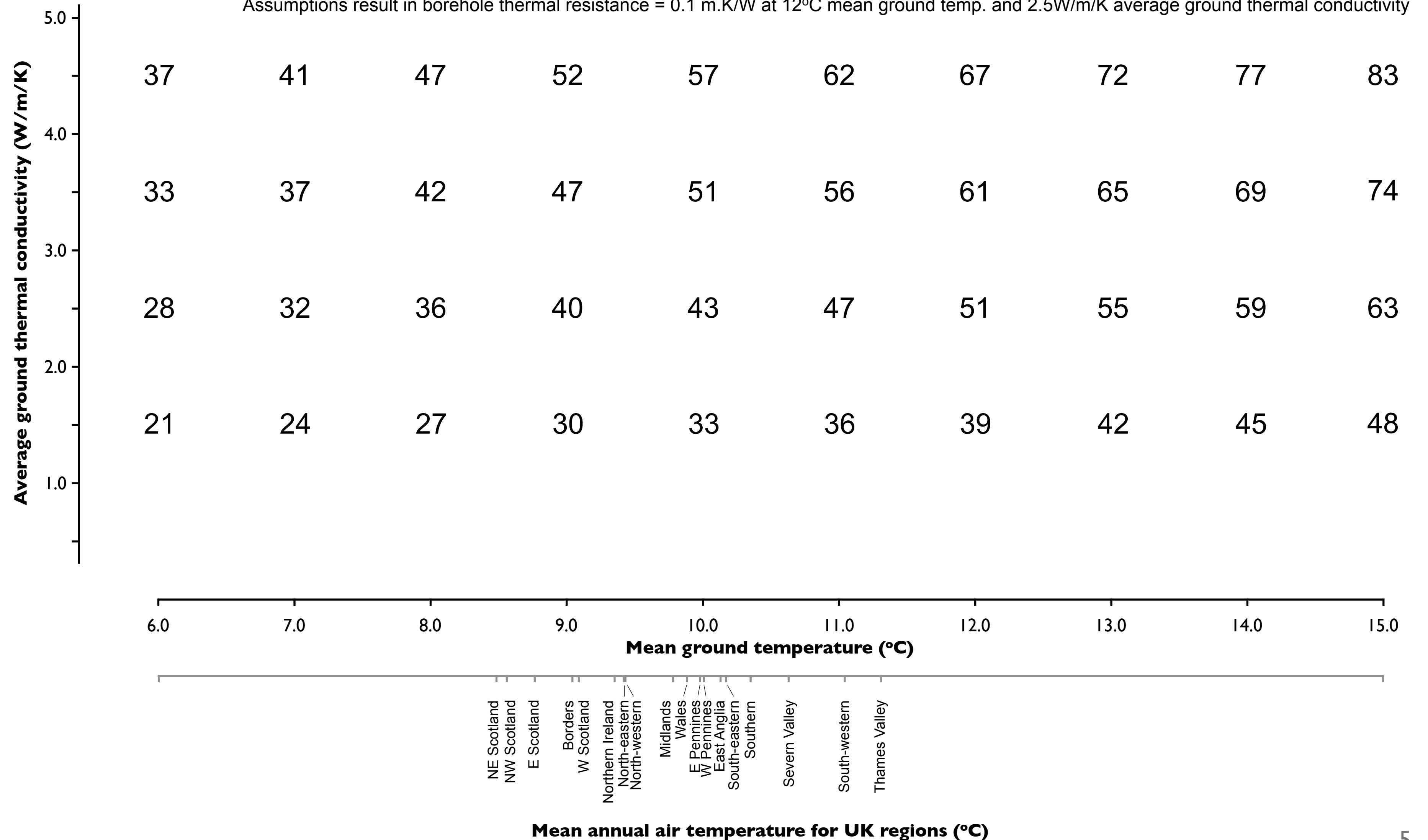
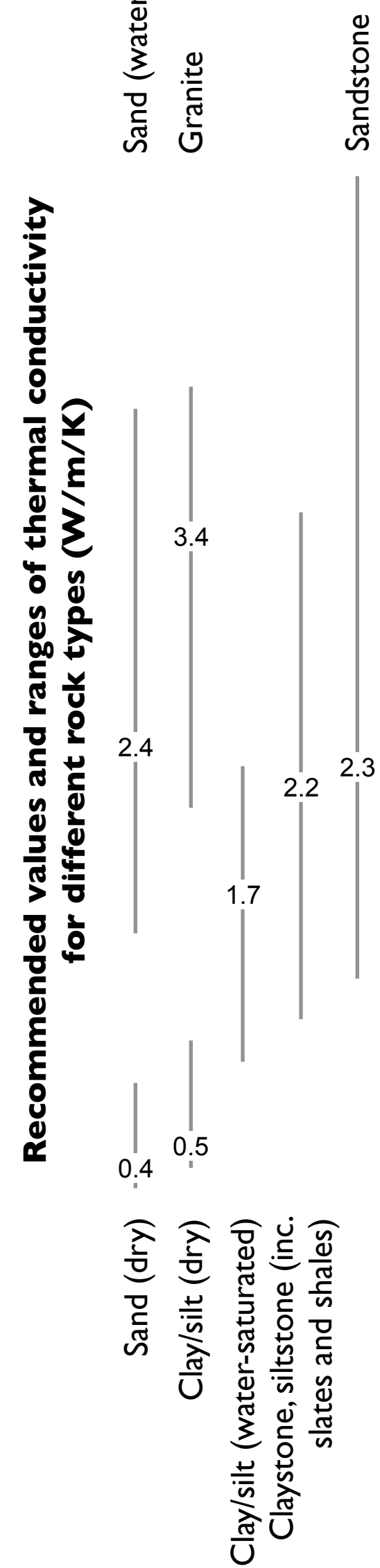
Conditions for use:

Heat extraction only (inc. hot water)

6m minimum borehole spacing. Only valid for boreholes arranged in a line; not applicable for a large number of systems in a small area

Table created assuming: 130mm borehole diameter; single U-tube; 32mm OD SDR-11, PE100 pipe with thermal conductivity = 0.420W/m/K; 52mm pipe centre-pipe centre shank spacing; 25% Mono Ethylene Glycol thermal transfer fluid; Re > 2500 in the borehole active elements; thermally enhanced grout with thermal conductivity = 2.4W/m/K

Assumptions result in borehole thermal resistance = 0.1 m.K/W at 12°C mean ground temp. and 2.5W/m/K average ground thermal conductivity



Maximum power to be extracted per unit length of borehole heat exchanger (W/m) with 1800 FLEQ run hours

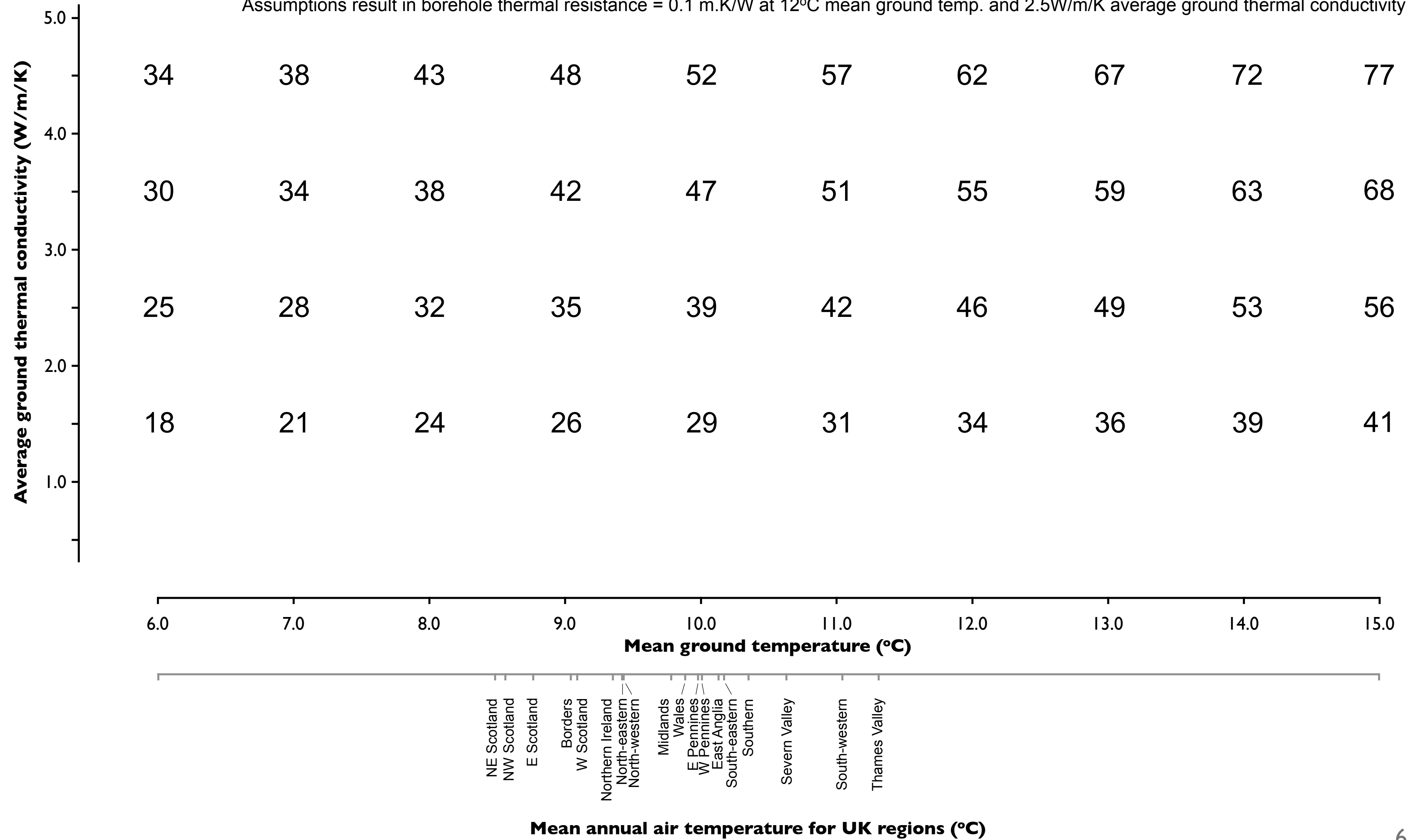
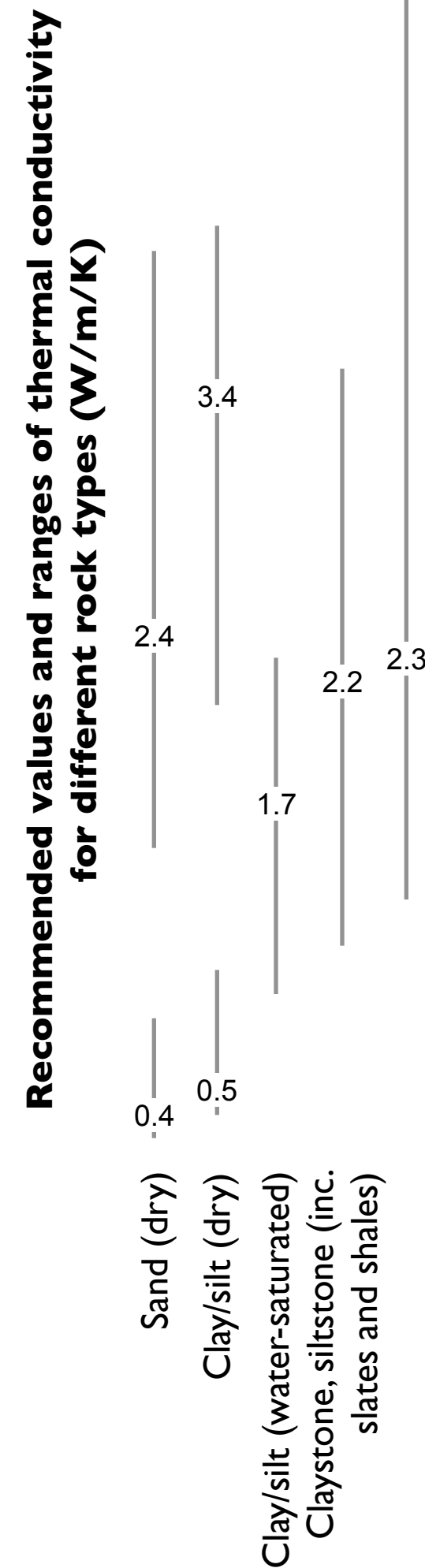
Conditions for use:

Heat extraction only (inc. hot water)

6m minimum borehole spacing. Only valid for boreholes arranged in a line; not applicable for a large number of systems in a small area

Table created assuming: 130mm borehole diameter; single U-tube; 32mm OD SDR-11, PE100 pipe with thermal conductivity = 0.420W/m/K; 52mm pipe centre-pipe centre shank spacing; 25% Mono Ethylene Glycol thermal transfer fluid; Re > 2500 in the borehole active elements; thermally enhanced grout with thermal conductivity = 2.4W/m/K

Assumptions result in borehole thermal resistance = 0.1 m.K/W at 12°C mean ground temp. and 2.5W/m/K average ground thermal conductivity



Maximum power to be extracted per unit length of borehole heat exchanger (W/m) with 2400 FLEQ run hours

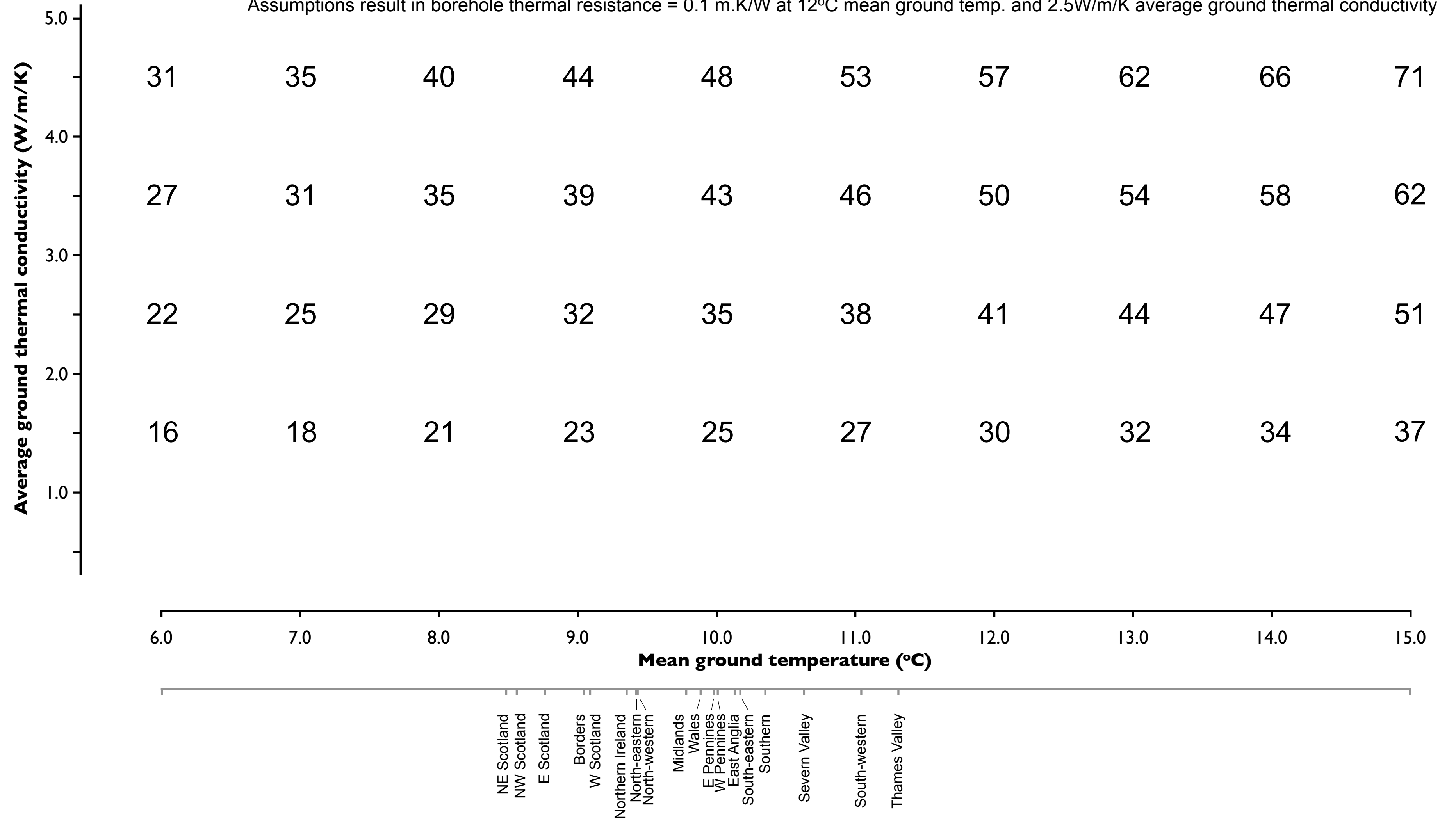
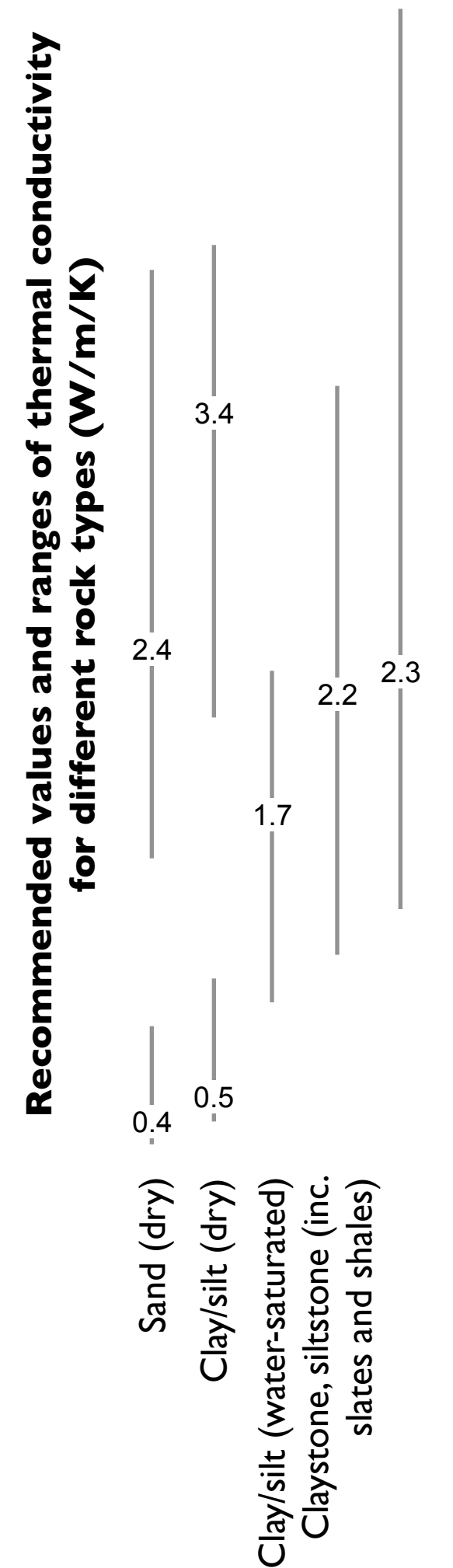
Conditions for use:

Heat extraction only (inc. hot water)

6m minimum borehole spacing. Only valid for boreholes arranged in a line; not applicable for a large number of systems in a small area

Table created assuming: 130mm borehole diameter; single U-tube; 32mm OD SDR-11, PE100 pipe with thermal conductivity = 0.420W/m/K; 52mm pipe centre-pipe centre shank spacing; 25% Mono Ethylene Glycol thermal transfer fluid; Re > 2500 in the borehole active elements; thermally enhanced grout with thermal conductivity = 2.4W/m/K

Assumptions result in borehole thermal resistance = 0.1 m.K/W at 12°C mean ground temp. and 2.5W/m/K average ground thermal conductivity



Mean annual air temperature for UK regions (°C)

Maximum power to be extracted per unit length of borehole heat exchanger (W/m) with 3000 FLEQ run hours

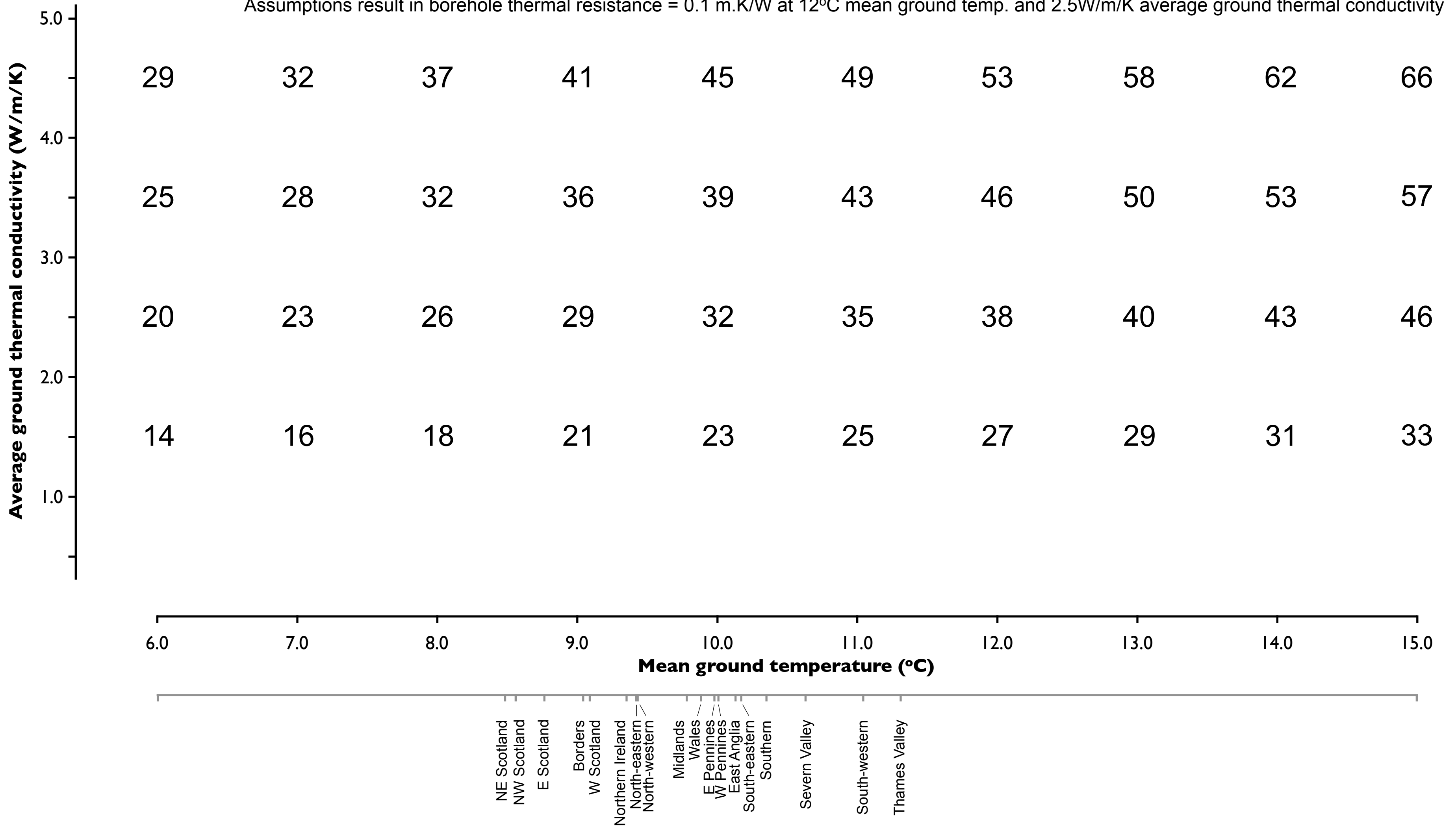
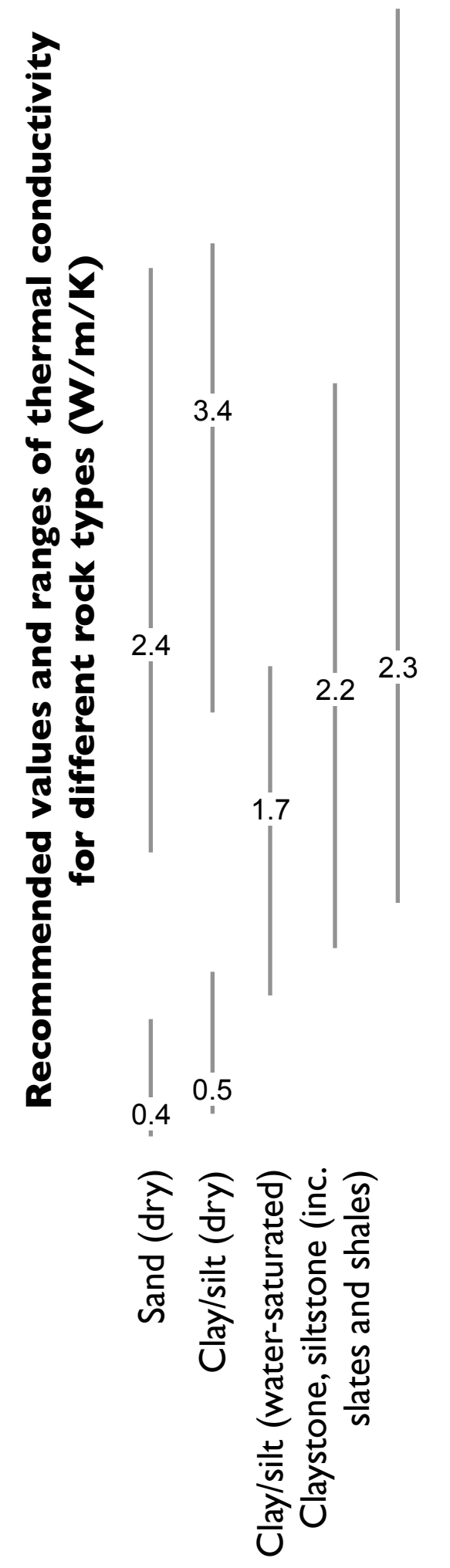
Conditions for use:

Heat extraction only (inc. hot water)

6m minimum borehole spacing. Only valid for boreholes arranged in a line; not applicable for a large number of systems in a small area

Table created assuming: 130mm borehole diameter; single U-tube; 32mm OD SDR-11, PE100 pipe with thermal conductivity = 0.420W/m/K; 52mm pipe centre-pipe centre shank spacing; 25% Mono Ethylene Glycol thermal transfer fluid; Re > 2500 in the borehole active elements; thermally enhanced grout with thermal conductivity = 2.4W/m/K

Assumptions result in borehole thermal resistance = 0.1 m.K/W at 12°C mean ground temp. and 2.5W/m/K average ground thermal conductivity



Mean annual air temperature for UK regions (°C)

Maximum power to be extracted per unit length of borehole heat exchanger (W/m) with 3600 FLEQ run hours

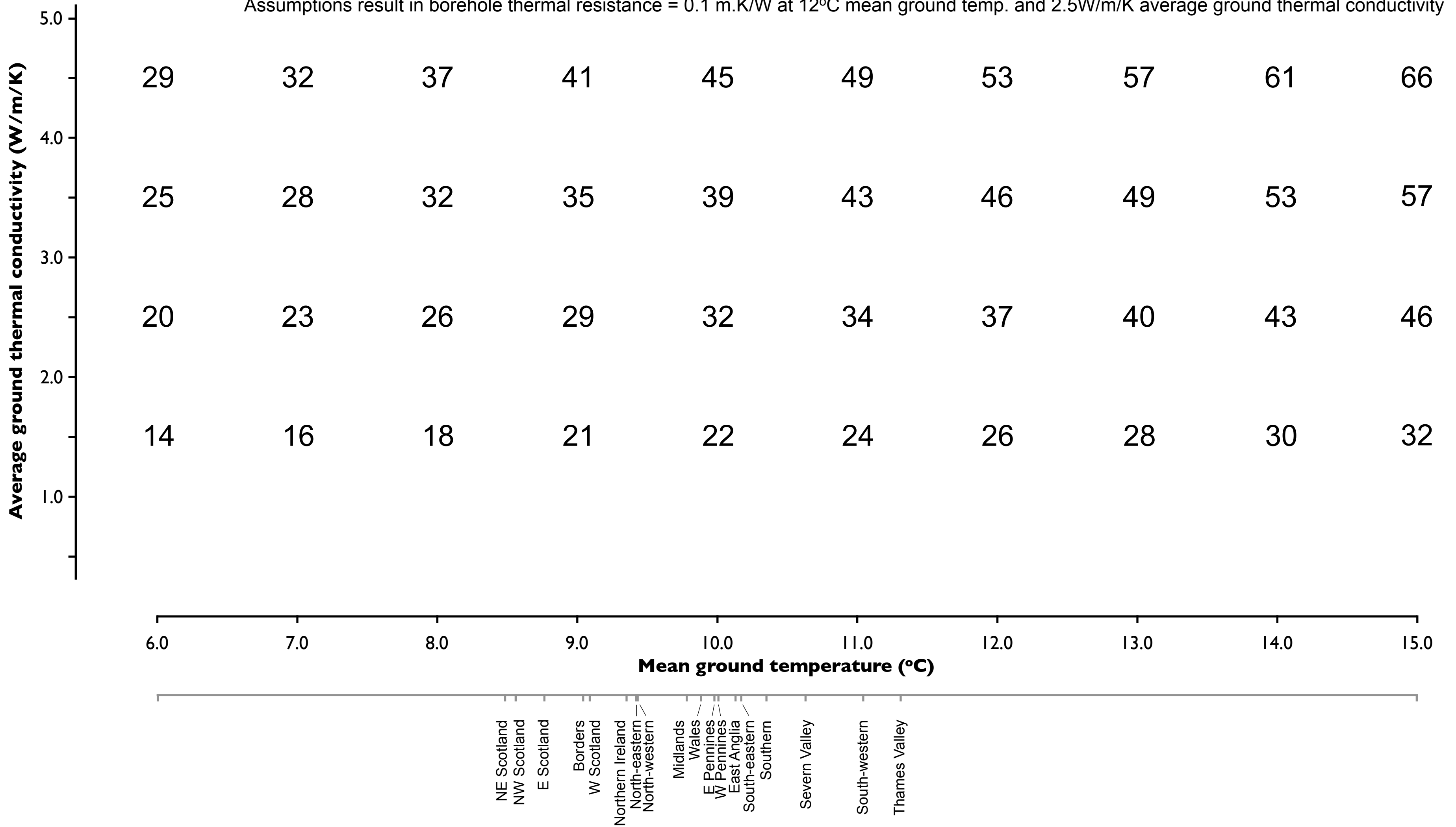
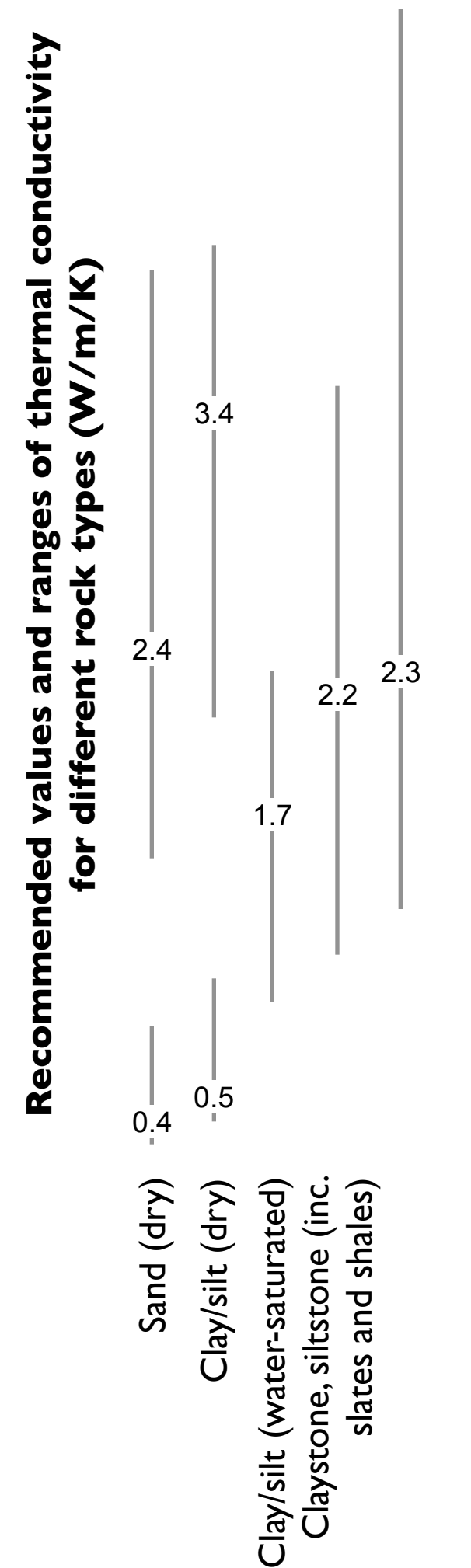
Conditions for use:

Heat extraction only (inc. hot water)

6m minimum borehole spacing. Only valid for boreholes arranged in a line; not applicable for a large number of systems in a small area

Table created assuming: 130mm borehole diameter; single U-tube; 32mm OD SDR-11, PE100 pipe with thermal conductivity = 0.420W/m/K; 52mm pipe centre-pipe centre shank spacing; 25% Mono Ethylene Glycol thermal transfer fluid; Re > 2500 in the borehole active elements; thermally enhanced grout with thermal conductivity = 2.4W/m/K

Assumptions result in borehole thermal resistance = 0.1 m.K/W at 12°C mean ground temp. and 2.5W/m/K average ground thermal conductivity



Mean annual air temperature for UK regions (°C)

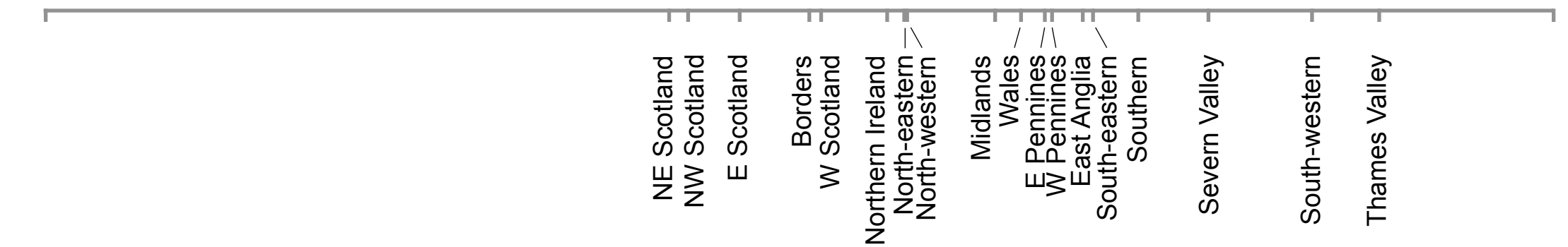
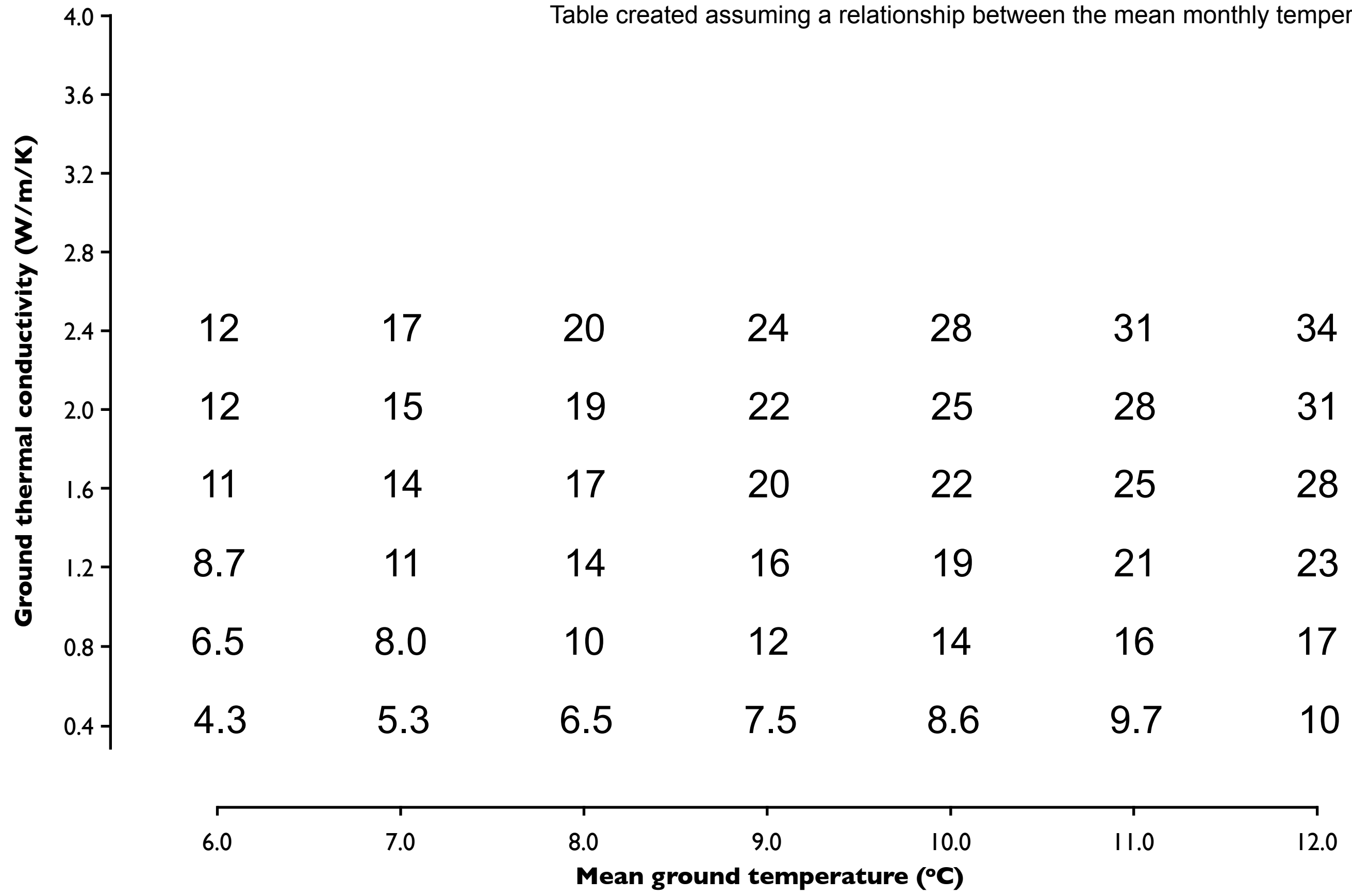
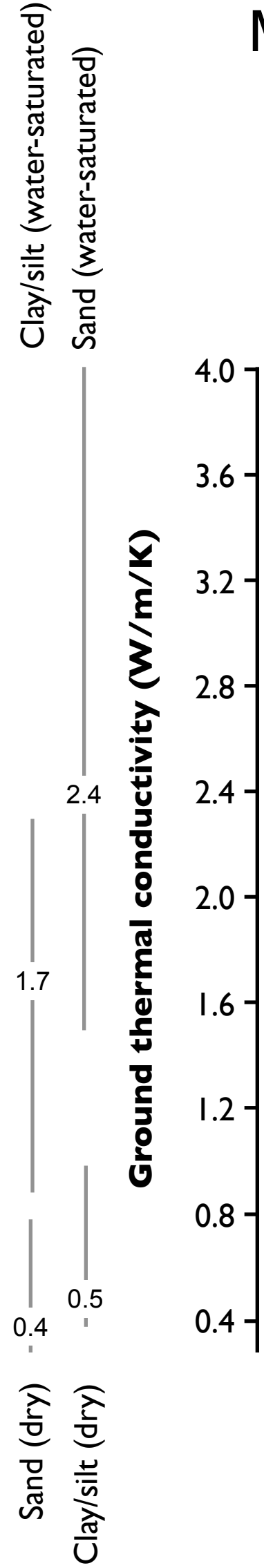
2. HORIZONTAL GROUND HEAT EXCHANGERS

Maximum power to be extracted per unit length of horizontal ground heat exchanger (W/m) with 1200 FLEQ run hours

Conditions for use:
 Heat extraction only (inc. hot water)
 0.75m minimum pipe spacing (d > 0.75m)
 Pipe depth between 0.8m and 1.2m
 Table created assuming 25mm OD SDR 11 pipe

Table created assuming a relationship between the mean monthly temperature swing and annual mean ground temperature

Recommended values and ranges of thermal conductivity for different rock types (W/m/K)



Mean annual air temperature for UK regions (°C)

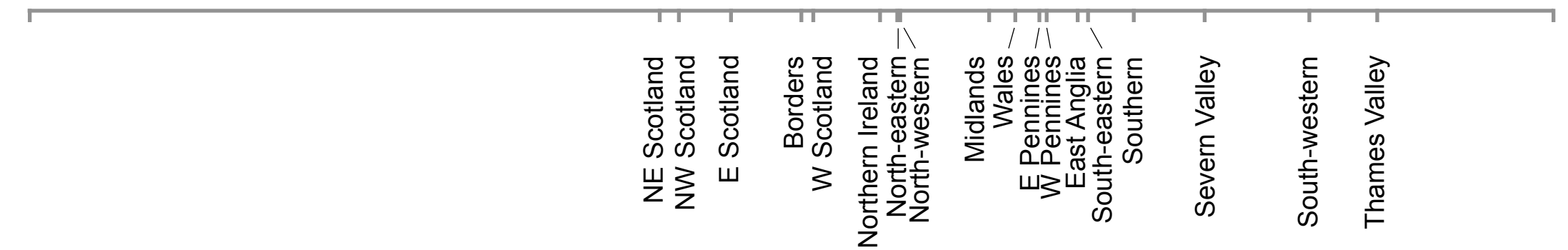
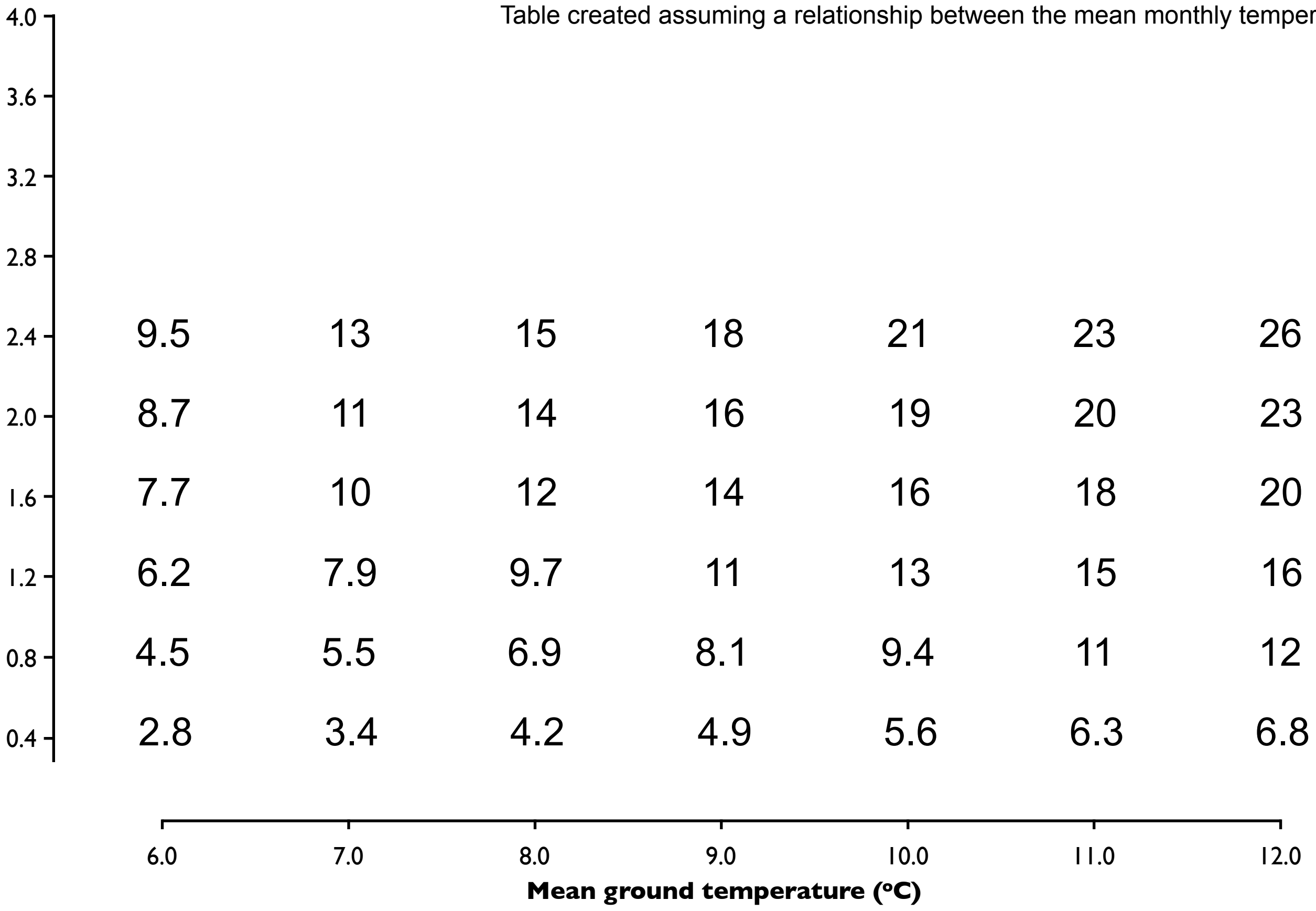
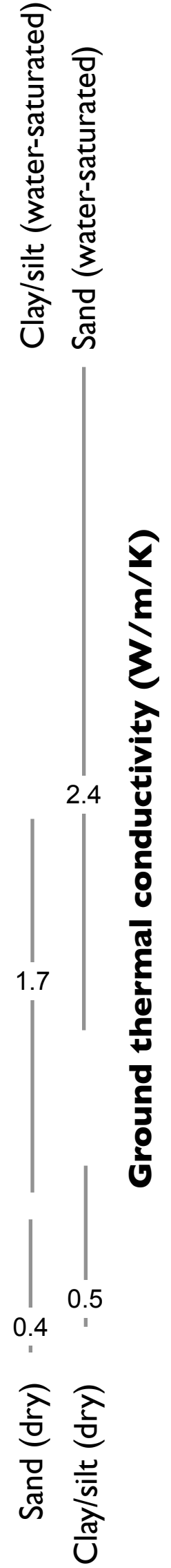
12	17	20	24	28	31	34
12	15	19	22	25	28	31
11	14	17	20	22	25	28
8.7	11	14	16	19	21	23
6.5	8.0	10	12	14	16	17
4.3	5.3	6.5	7.5	8.6	9.7	10

Maximum power to be extracted per unit length of horizontal ground heat exchanger (W/m) with 1800 FLEQ run hours

Conditions for use:
 Heat extraction only (inc. hot water)
 0.75m minimum pipe spacing ($d > 0.75m$)
 Pipe depth between 0.8m and 1.2m
 Table created assuming 25mm OD SDR 11 pipe

Table created assuming a relationship between the mean monthly temperature swing and annual mean ground temperature

Recommended values and ranges of thermal conductivity for different rock types (W/m/K)



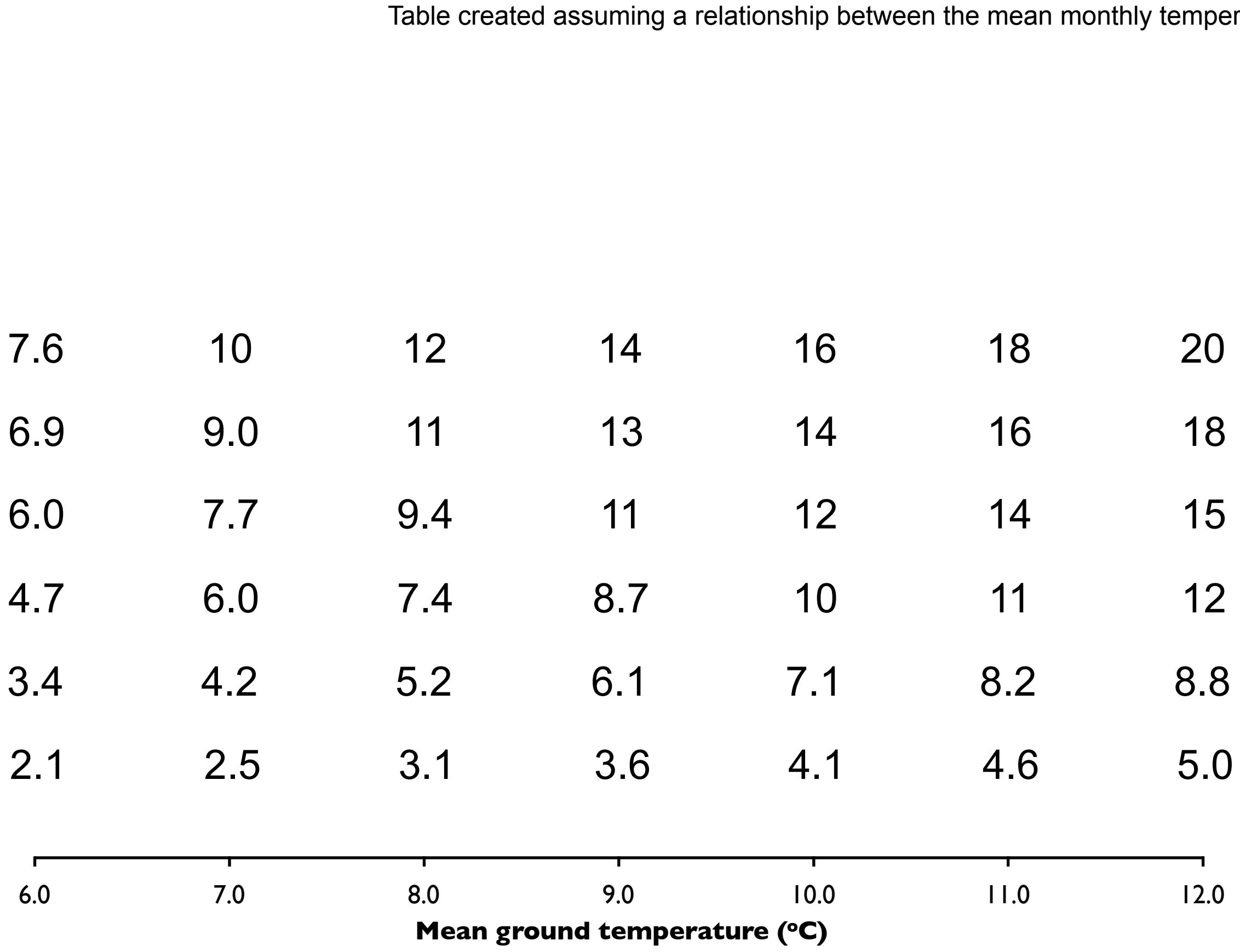
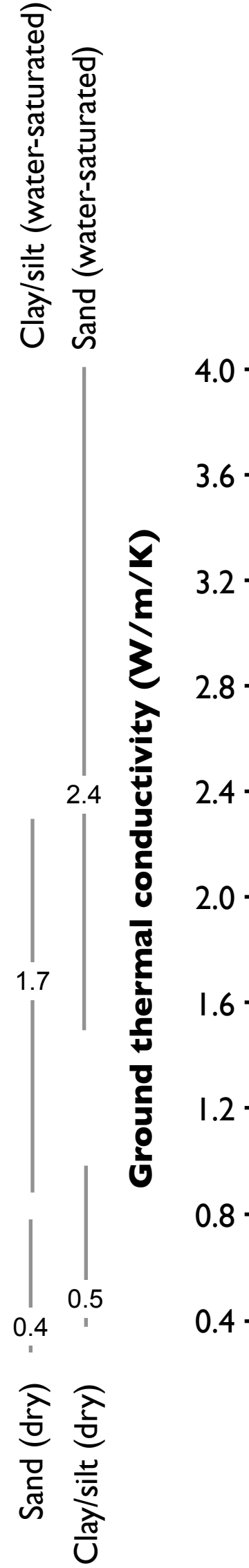
Mean annual air temperature for UK regions (°C)

Maximum power to be extracted per unit length of horizontal ground heat exchanger (W/m) with 2400 FLEQ run hours

Conditions for use:
 Heat extraction only (inc. hot water)
 0.75m minimum pipe spacing (d > 0.75m)
 Pipe depth between 0.8m and 1.2m
 Table created assuming 25mm OD SDR 11 pipe

Table created assuming a relationship between the mean monthly temperature swing and annual mean ground temperature

Recommended values and ranges of thermal conductivity for different rock types (W/m/K)



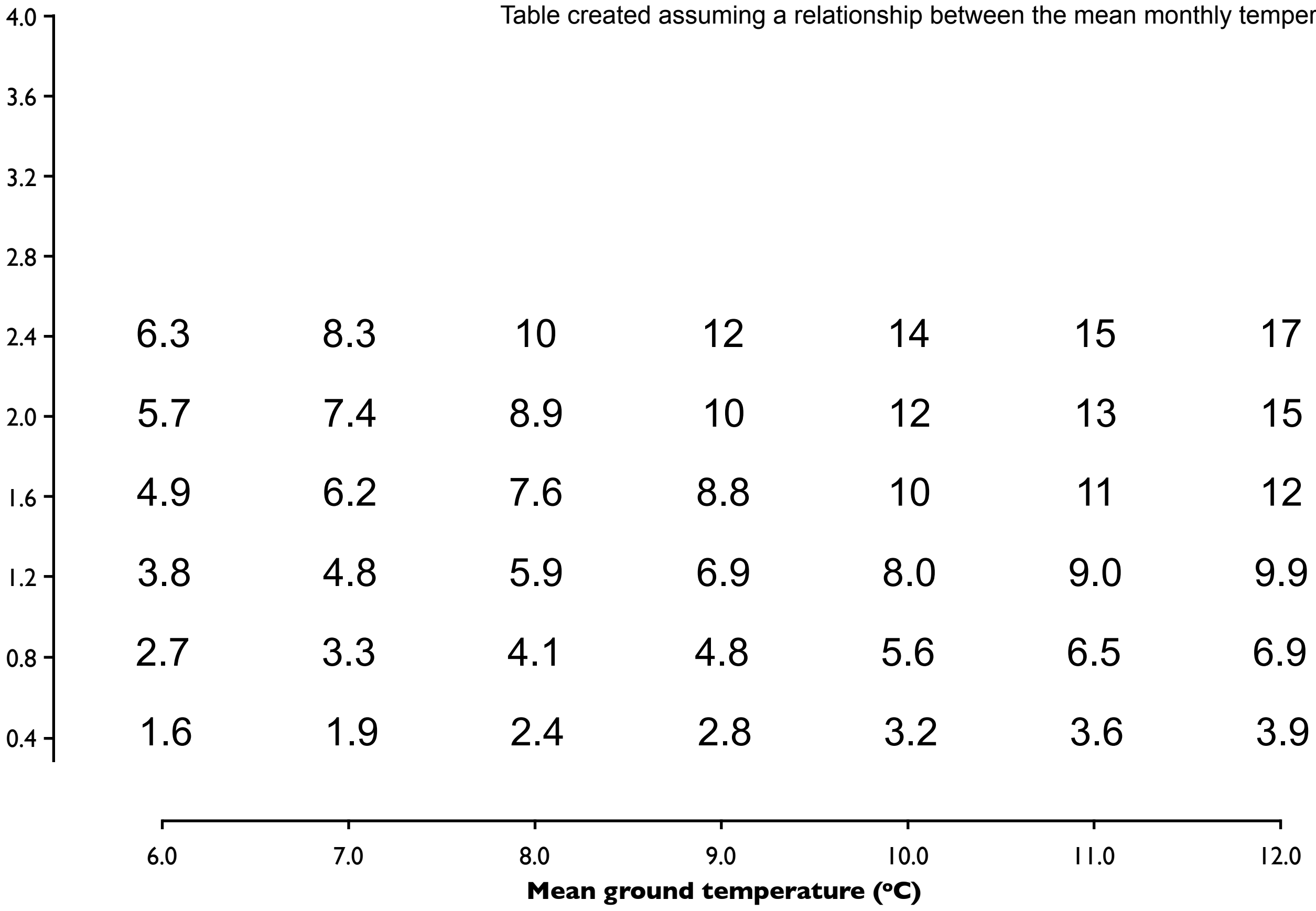
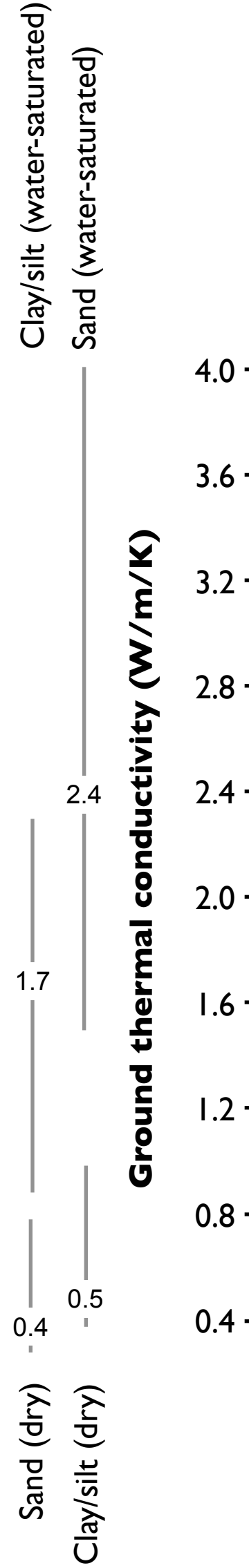
Mean annual air temperature for UK regions (°C)

Maximum power to be extracted per unit length of horizontal ground heat exchanger (W/m) with 3000 FLEQ run hours

Conditions for use:
 Heat extraction only (inc. hot water)
 0.75m minimum pipe spacing ($d > 0.75m$)
 Pipe depth between 0.8m and 1.2m
 Table created assuming 25mm OD SDR 11 pipe

Table created assuming a relationship between the mean monthly temperature swing and annual mean ground temperature

Recommended values and ranges of thermal conductivity for different rock types (W/m/K)



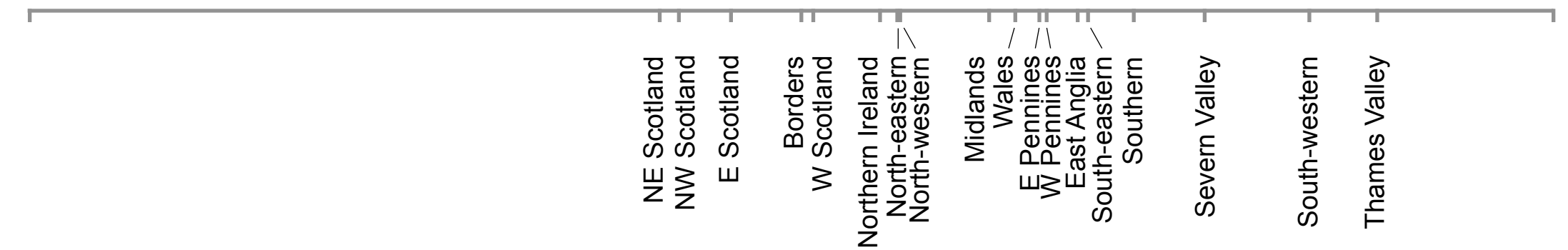
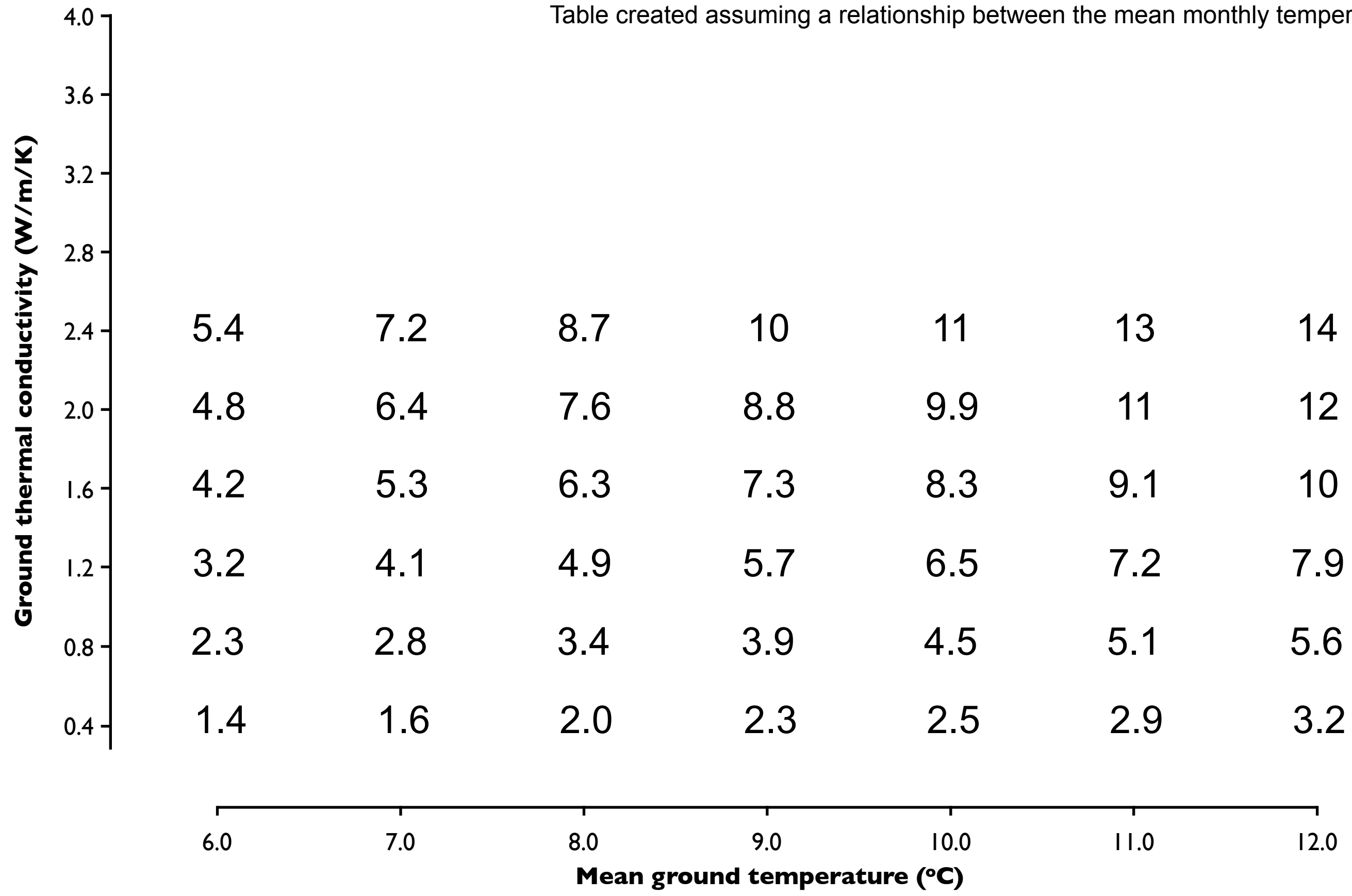
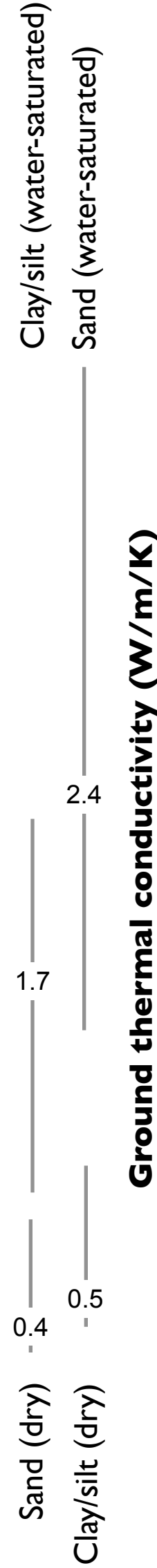
Mean annual air temperature for UK regions (°C)

Maximum power to be extracted per unit length of horizontal ground heat exchanger (W/m) with 3600 FLEQ run hours

Conditions for use:
 Heat extraction only (inc. hot water)
 0.75m minimum pipe spacing ($d > 0.75m$)
 Pipe depth between 0.8m and 1.2m
 Table created assuming 25mm OD SDR 11 pipe

Table created assuming a relationship between the mean monthly temperature swing and annual mean ground temperature

Recommended values and ranges of thermal conductivity for different rock types (W/m/K)



Mean annual air temperature for UK regions (°C)

3. SLINKY GROUND HEAT EXCHANGERS

Maximum power to be extracted per unit length of slinky ground heat exchanger trench (W/m) with 1200 FLEQ run hours

Conditions for use:

Heat extraction only (inc. hot water)

3m minimum trench spacing ($d \geq 3m$)

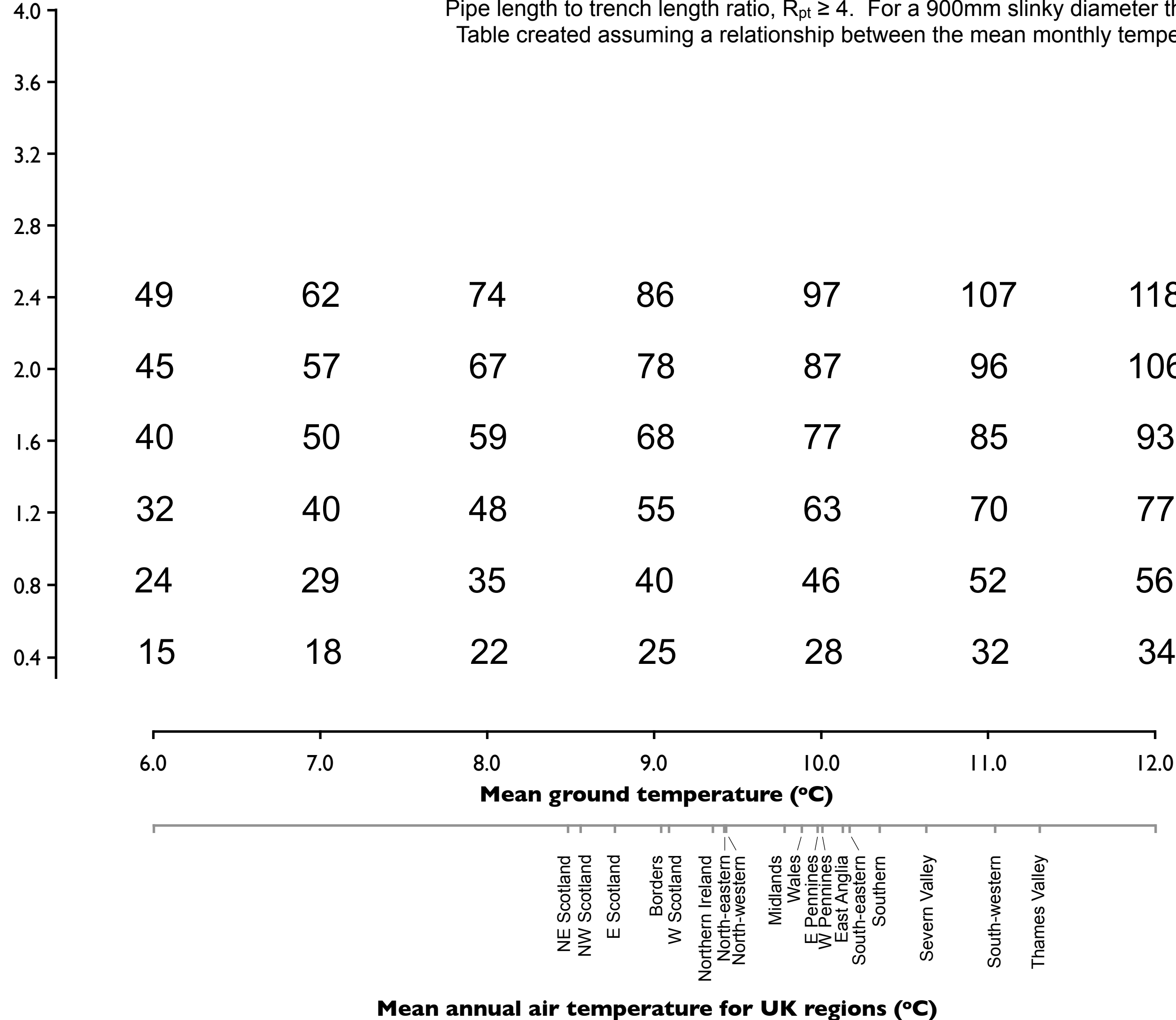
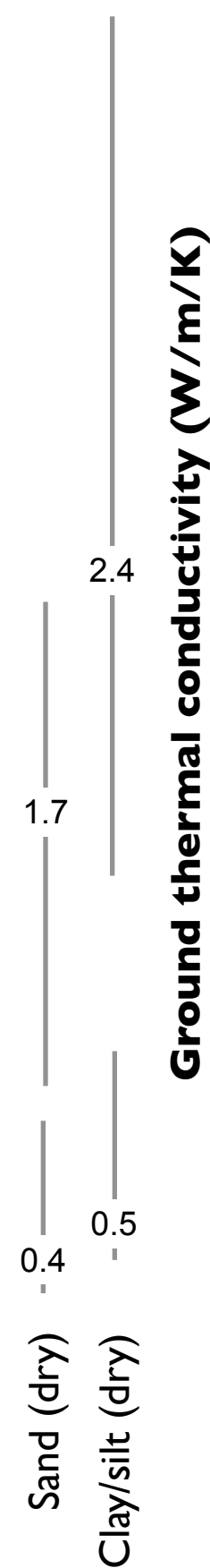
Mean slinky depth between 0.8m and 1.2m

Table created assuming 32mm OD SDR 11 pipe

Pipe length to trench length ratio, $R_{pt} \geq 4$. For a 900mm slinky diameter this corresponds to a maximum 1250mm slinky pitch

Table created assuming a relationship between the mean monthly temperature swing and annual mean ground temperature

Recommended values and ranges of thermal conductivity for different rock types (W/m/K)



Mean annual air temperature for UK regions (°C)

Maximum power to be extracted per unit length of slinky ground heat exchanger trench (W/m) with 1800 FLEQ run hours

Conditions for use:

Heat extraction only (inc. hot water)

3m minimum trench spacing ($d \geq 3m$)

Mean slinky depth between 0.8m and 1.2m

Table created assuming 32mm OD SDR 11 pipe

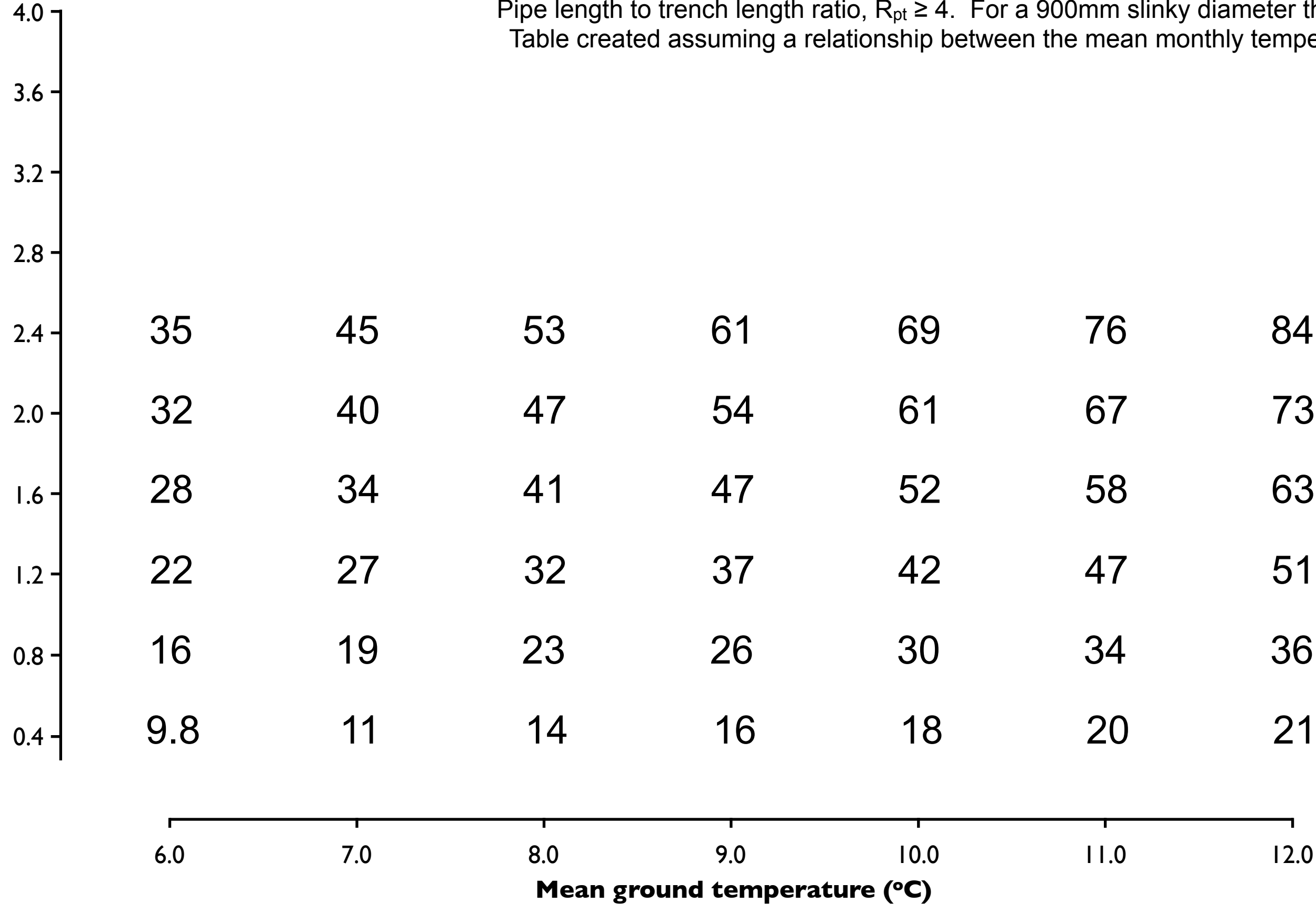
Pipe length to trench length ratio, $R_{pt} \geq 4$. For a 900mm slinky diameter this corresponds to a maximum 1250mm slinky pitch

Table created assuming a relationship between the mean monthly temperature swing and annual mean ground temperature

Recommended values and ranges of thermal conductivity for different rock types (W/m/K)

Clay/silt (water-saturated) 2.4
Sand (water-saturated)
1.7
0.4 0.5
Sand (dry)
Clay/silt (dry)

Ground thermal conductivity (W/m/K)



6.0 7.0 8.0 9.0 10.0 11.0 12.0

Mean ground temperature (°C)

NE Scotland
NW Scotland
E Scotland
Borders
W Scotland
Northern Ireland
North-eastern
North-western
Midlands
Wales
E Pennines
W Pennines
East Anglia
South-eastern
Southern
Severn Valley
South-western
Thames Valley

Mean annual air temperature for UK regions (°C)

Maximum power to be extracted per unit length of slinky ground heat exchanger trench (W/m) with 2400 FLEQ run hours

Conditions for use:

Heat extraction only (inc. hot water)

3m minimum trench spacing ($d \geq 3m$)

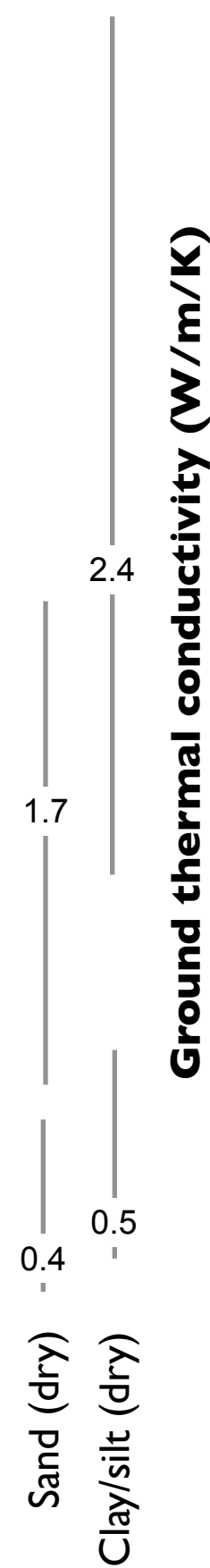
Mean slinky depth between 0.8m and 1.2m

Table created assuming 32mm OD SDR 11 pipe

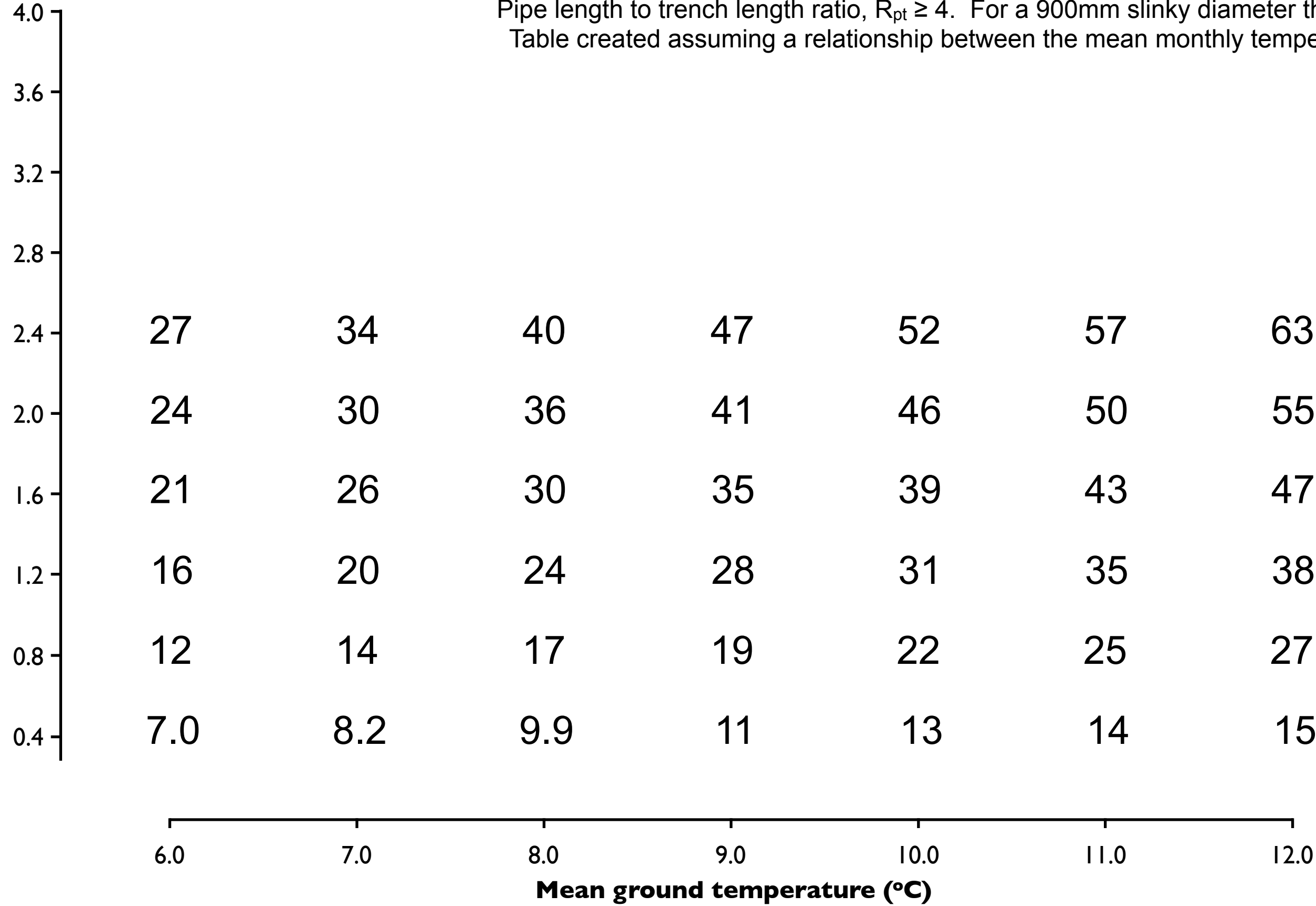
Pipe length to trench length ratio, $R_{pt} \geq 4$. For a 900mm slinky diameter this corresponds to a maximum 1250mm slinky pitch

Table created assuming a relationship between the mean monthly temperature swing and annual mean ground temperature

Recommended values and ranges of thermal conductivity for different rock types (W/m/K)



Ground thermal conductivity (W/m/K)



Mean annual air temperature for UK regions (°C)

Maximum power to be extracted per unit length of slinky ground heat exchanger trench (W/m) with 3000 FLEQ run hours

Conditions for use:

Heat extraction only (inc. hot water)

3m minimum trench spacing ($d \geq 3m$)

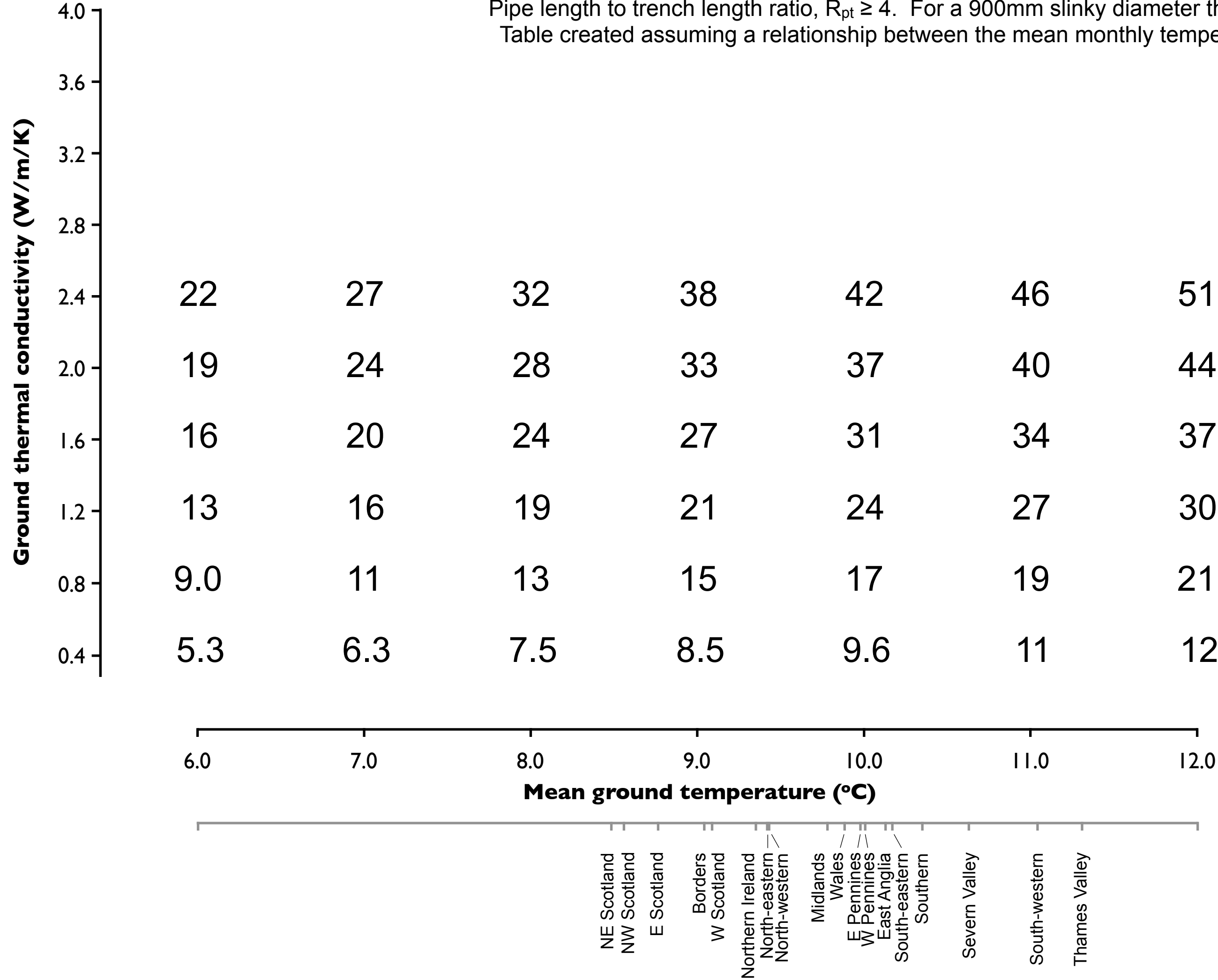
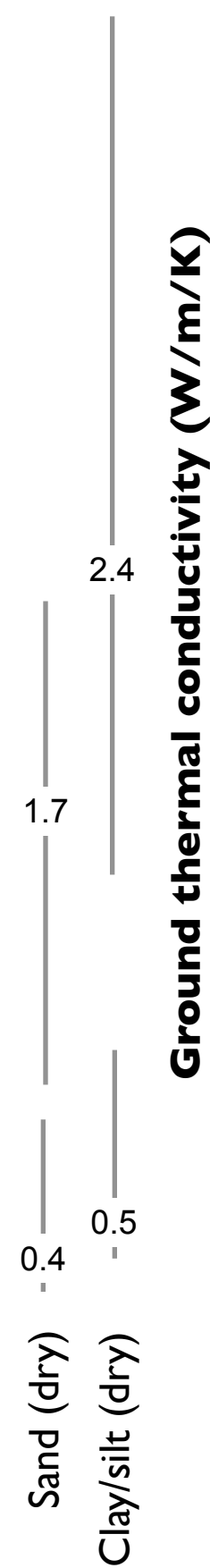
Mean slinky depth between 0.8m and 1.2m

Table created assuming 32mm OD SDR 11 pipe

Pipe length to trench length ratio, $R_{pt} \geq 4$. For a 900mm slinky diameter this corresponds to a maximum 1250mm slinky pitch

Table created assuming a relationship between the mean monthly temperature swing and annual mean ground temperature

Recommended values and ranges of thermal conductivity for different rock types (W/m/K)



Mean annual air temperature for UK regions (°C)

Maximum power to be extracted per unit length of slinky ground heat exchanger trench (W/m) with 3600 FLEQ run hours

Conditions for use:

Heat extraction only (inc. hot water)

3m minimum trench spacing ($d \geq 3m$)

Mean slinky depth between 0.8m and 1.2m

Table created assuming 32mm OD SDR 11 pipe

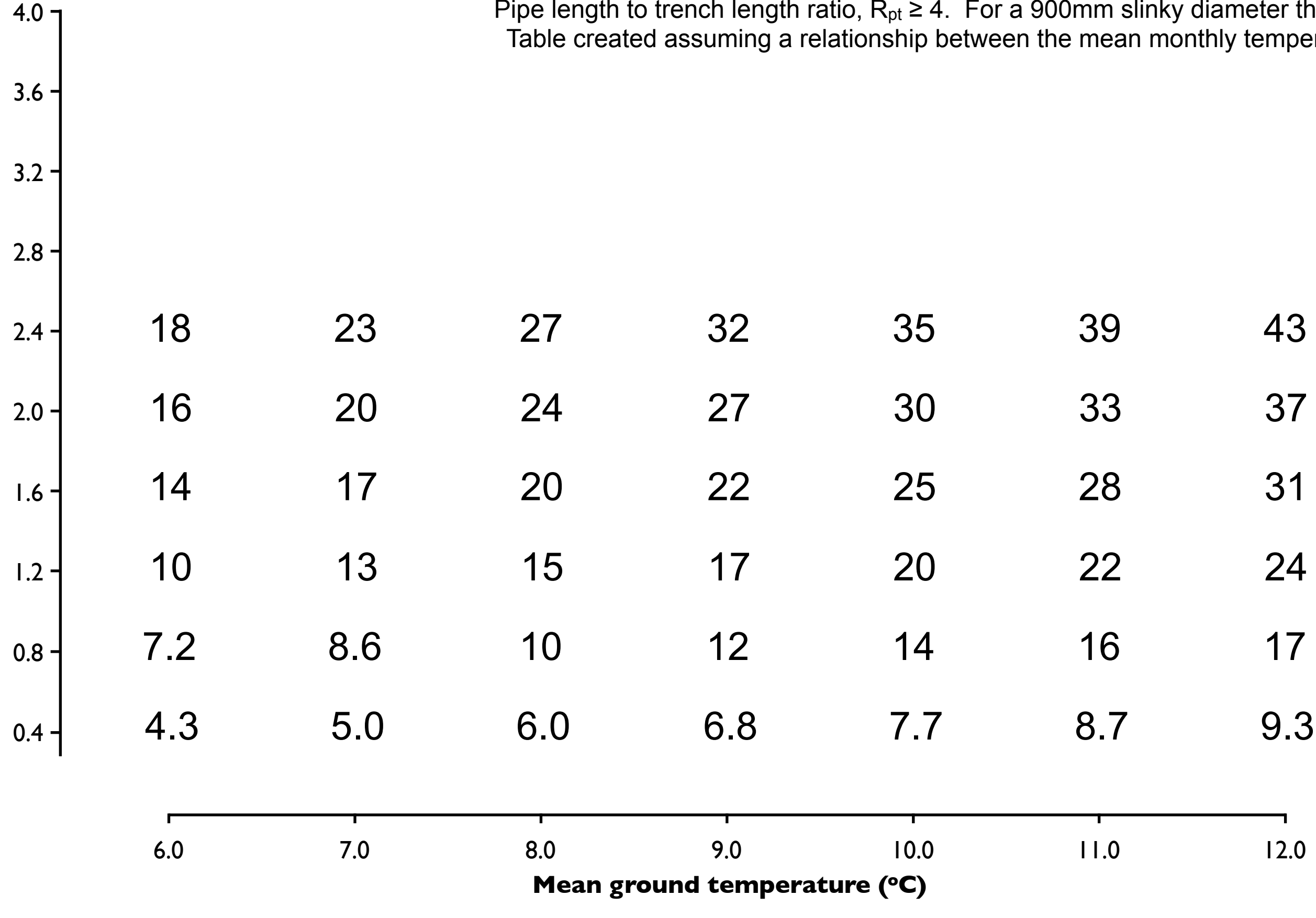
Pipe length to trench length ratio, $R_{pt} \geq 4$. For a 900mm slinky diameter this corresponds to a maximum 1250mm slinky pitch

Table created assuming a relationship between the mean monthly temperature swing and annual mean ground temperature

Recommended values and ranges of thermal conductivity for different rock types (W/m/K)

Clay/silt (water-saturated)
Sand (water-saturated)
1.7
2.4
0.4
0.5
Sand (dry)
Clay/silt (dry)

Ground thermal conductivity (W/m/K)



6.0 7.0 8.0 9.0 10.0 11.0 12.0

Mean ground temperature (°C)

NE Scotland
NW Scotland
E Scotland
Borders
W Scotland
Northern Ireland
North-eastern
North-western
Midlands
Wales
E Pennines
W Pennines
East Anglia
South-eastern
Southern
Severn Valley
South-western
Thames Valley

Mean annual air temperature for UK regions (°C)

4. AMENDMENTS ISSUED SINCE PUBLICATION

Issue Number:	Amendment Details:	Date:
1.0	First issue	02/09/2011