Scottish Environment Protection Agency
Buidheann Dìon Àrainneachd na h-Alba

SEPA's Requirements for Activities Related to Geothermal Energy v1.3

October 2022

1. Purpose and scope

This guidance is directed at anybody planning to install a geothermal energy system. It is designed to help developers understand what authorisation is required by SEPA for controlled activities[1] associated with geothermal energy systems.

This document:

- describes the types of geothermal energy systems commonly in use in Scotland;
- describes the potential risk to the water environment from them;
- sets out the authorisation required under The Water Environment (Controlled Activities) (Scotland) Regulations (CAR), which is administrated by SEPA.

Other permissions may also apply e.g. from the Coal Authority, Planning Authority or NatureScot[2]. However, this aspect is not covered in this document.

This guidance does not cover activities associated with the extraction of thermal energy from other water sources e.g. water in lochs or the sea.

2. Types of geothermal systems

Geothermal energy is broadly defined as energy from the interior of the earth used for heating or cooling.

Many schemes that involve the extraction of heat from the ground involve drilling a borehole(s). Most of these boreholes are to depths of less than 200m. Some involve drilling deep boreholes (greater than or equal to 200m in depth). Other schemes don't require borehole construction and instead involve laying pipework at depths of a few metres.

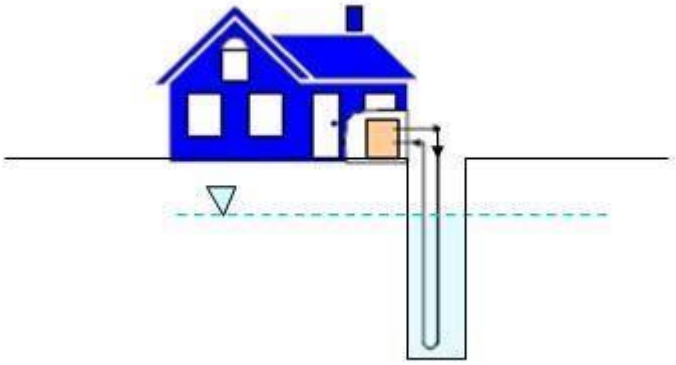
Some systems do not involve abstractions or discharges to the water environment. These are termed 'closed loop groundwater geothermal systems'. They work by circulating a fluid around a closed system with one part of the circuit in groundwater and one part connected

[1] Under the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR)

[2] For example, on a geological SSSIs where the interest features may be damaged by the installation, and activities associated with, the installation of a borehole.

to a heat pump in the building(s) to be heated or cooled (Figure 1). The fluid in the system uses groundwater as a heat source or a heat sink.

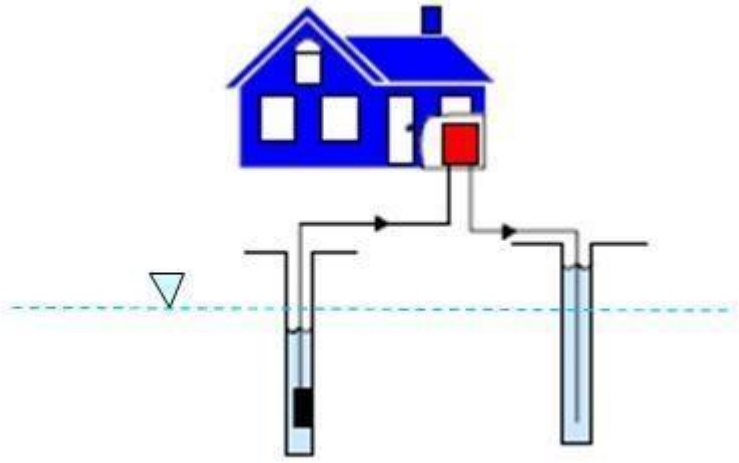
Figure 1 Example of a closed loop geothermal system



Taken from Geothermal (Ground-Source) Heat Pumps A World Overview, J. Lund, B. Sanner, L. Rybach, R. Curtis, G. Hellström, GHC Bulletin, September 2004

Other systems involve abstracting groundwater, which is used as a heat source or sink in a heat pump, and then the water is returned to the water environment. These are termed 'open loop geothermal systems' (Figure 2).

Figure 2 Example of an open loop geothermal system



Geothermal (Ground-Source) Heat Pumps A World Overview, J. Lund, B. Sanner, L. Rybach, R. Curtis, G. Hellström, GHC Bulletin, September 2004

3. Potential impacts on the water environment from geothermal systems

Geothermal energy schemes can involve the following key activities:

1. Construction and operation of a borehole or boreholes;
2. Abstraction of groundwater;
3. Subsequent return of the abstracted groundwater to the water environment.

The risks posed by geothermal activities will depend on the activities involved and are described below.

3.1 Borehole construction and operation

Borehole construction can pose a risk to the water environment by:

- the introduction into groundwater of drilling fluids or other potentially polluting construction materials;
- the connection of groundwaters with differing water qualities;
- creating a pathway to allow deep poor-quality groundwater, or any methane present within the strata, to reach surface receptors such as rivers or water supplies;
- the creation of a pathway to allow surface pollutants to enter groundwater; and
- the loss of groundwater via uncontrolled artesian flow.

3.2 The abstraction of groundwater

The abstraction of groundwater can pose a risk to the water environment and other water users by:

- reduction in flow to surface waters and other surface ecosystems;
- intrusion of saltwater or other intrusion;
- reducing the amount of water available for other water users.

3.3 The discharge of abstracted groundwater

The discharge of the abstracted groundwater can pose a risk to the water environment by the introduction of pollutants to the water environment either by their addition or by

discharging the abstracted water into groundwater or surface ecosystems with a differing natural water quality.

4. Regulatory control

Depending on the type of geothermal energy scheme this can involve the following activities which may require control under the Water Environment (Controlled Activities)(Scotland) Regulations 2011 (CAR).

1. Construction and operation of a borehole or boreholes;
2. Abstraction of groundwater;
3. Subsequent return of the abstracted groundwater to the water environment;

The level of authorisation under CAR is described further in the Controlled Activities Regulations: A Practical Guide.

If you are removing and managing radioactive scales and precipitates from equipment associated with boreholes then you may encounter naturally occurring radioactive material (NORM). Guidance on SEPA's regulation of this material can be found in SEPA's Authorisation guide for radioactive substances activities.

4.1 Borehole construction and operation

Boreholes <200m deep

The construction of boreholes < 200m in depth are normally authorised via CAR General Binding Rule 3 (GBR). The borehole should be designed to prevent:

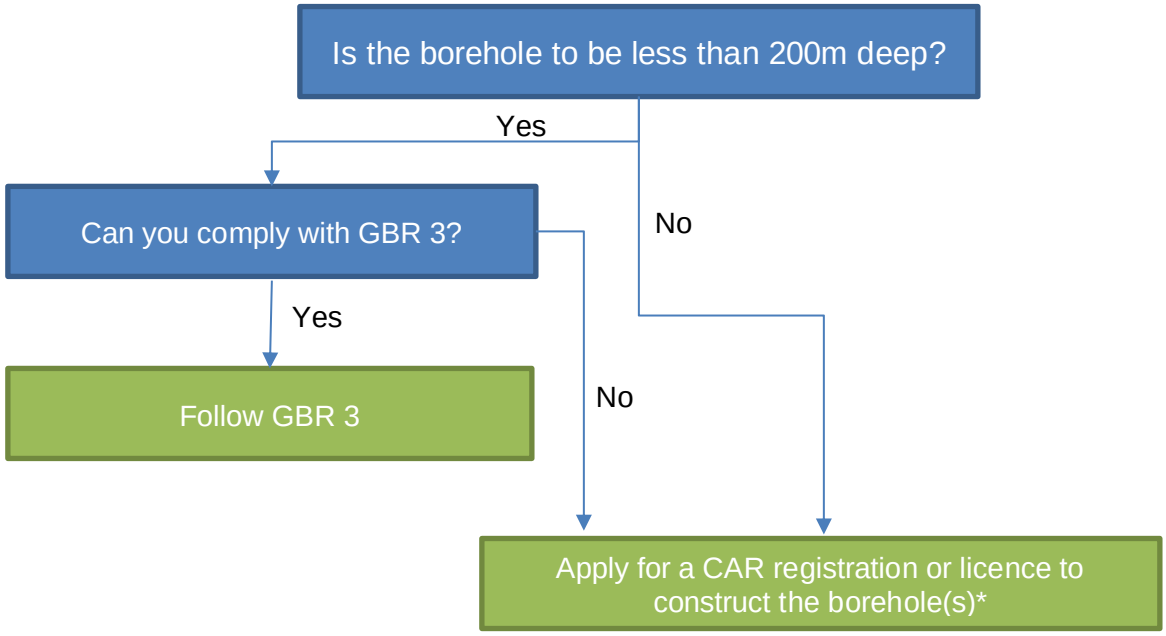
- pollution;
- unacceptable mixing of water between layered aquifer systems; or
- loss of water from artesian aquifers

Efficient heat exchange can be achieved by the use of thermally transmissive grout.
To comply with the GBR, closed loop geothermal boreholes should be grouted throughout their length following construction. This will greatly reduce the risks to the water environment from the borehole or any leaks of circulating fluids. For closed loop systems it is also best practice to put in place measures to detect any leaks in the pipework and carry out repairs if necessary.

Boreholes ≥200m deep

The construction and operation of boreholes to depths of greater than or equal to 200m require a CAR licence[3].

Figure 3 Borehole Construction and Operation.



*There is a lower charge for boreholes that are drilled for the purposes of closed loop geothermal systems and the pipework involved is fully cemented in place within 14 days of being drilled.

4.2 Abstractions and return of the abstracted water

Closed loop systems

There are no abstractions or discharges to the water environment from a closed loop geothermal system and therefore no authorisation for the abstraction or discharge from SEPA will be required[4].

[3] See the CAR Practical Guide

[4] Note that an authorisation will be required for the borehole construction.

Open loop systems – where GBR 17 applies

Open loop systems abstract groundwater and discharge the water back into the water environment. If:

- the volume of water abstracted and not returned does not exceed 10m^3 per day; and
- an open loop system returns water to same geological formation from which it was abstracted; and
- the chemical composition of the abstracted water has not been altered, by for example, addition of chemicals from a cooling process,

then the abstraction and discharge can be authorised by GBR 17.

Open loop systems – where GBR 17 does not apply

GBR 17 cannot be used if the GBR conditions can't be complied with. For example, if the abstracted water is returned to another part of the water environment such as a surface water body.

In these cases, where GBR 17 does not apply, the abstraction may be authorised by:

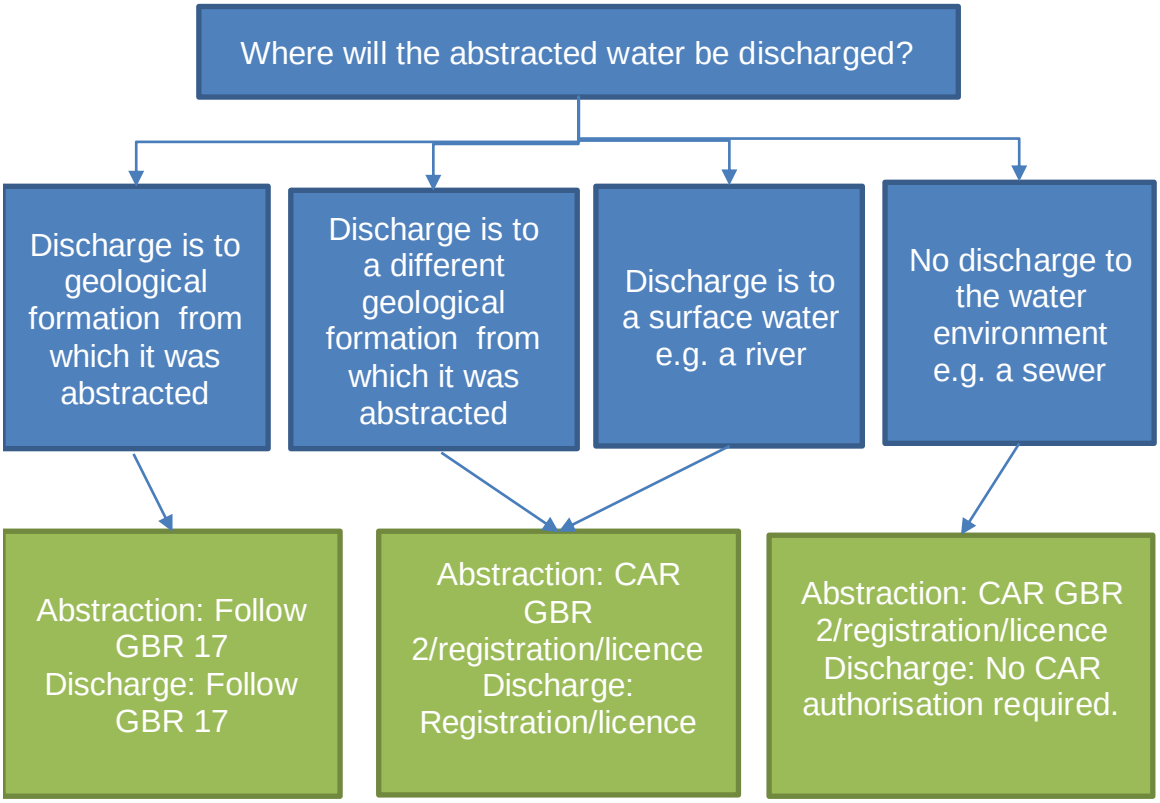
- GBR 2 if it is less than <10 m^3/day;
- either registration or licence for abstractions of ≥10 m^3/day.

An application to SEPA for a CAR authorisation for the discharge (registration or licence) will also be needed. This will take account of the impact on the water environment including surface water receptors and abstractions. Best practice would be to avoid the addition of any substances (including chemicals) to the abstracted water. If there is no chemical addition to the effluent and there are no thermal compliance implications the discharge should be authorised via a CAR registration as a "thermal effluent". You should consider the quality and temperature of the abstracted water and the impact of discharging this to the receiving water. Information on thermal surface water status boundaries is set out in the Standards Directions 2014. WAT-SG-85: Application of Standards to Thermal Discharges also provides further details.

The impact on other receptors such as wetlands and abstractions also needs to be taken into account. In relation to impacts on an abstraction the change in temperature or chemical quality that would be acceptable depends on the use of the abstracted water.

Note that whilst SEPA would consider the impact of changes in heat on the water environment in relation to whether this is causing pollution, it does not regulate the availability of heat as a resource.

Figure 4: Abstraction and discharge of abstracted water



GBR 17

The rules relating to GBR 17 can be found in the CAR Practical Guide. GBR 17 allows for the 'abstraction and subsequent return of groundwater for the purpose of extracting geothermal energy from the abstracted water'. SEPA considers that:

- A map showing the location of the abstraction and discharge and borehole logs should be kept by the owner/operator to demonstrate compliance with Rule (a).

- any volume of water may be abstracted but the volume of water abstracted and not returned must not exceed 10m^3 per day. For example, an abstraction of 200m^3/d could take place provided 190m^3/d is returned;
- Rule (c) means that the chemical composition of the abstracted water should not be altered including adding or removing any chemicals. If abstractions from mine workings takes place care should be taken to prevent oxidation of the water prior to its re-injection;
- There should be a means of demonstrating that the volume of water abstracted and not returned does not exceed 103m/d;
- Pipe work and other equipment should be maintained so there is no leakage or water.

Drilling of the borehole is covered by GBR3 provided the rules are complied with and the borehole is <200m deep.

5. Lithium Extraction

Geothermal brines have the potential to be a possible source of lithium. The higher temperature groundwater results in increased lithium concentrations due to enhanced leaching from rocks. If lithium extraction is undertaken together with geothermal energy production, then the regulatory approach for the borehole construction, abstraction and discharge would be the same as that for geothermal. It should be noted that if radioactive scales and precipitates need to be removed or managed then a Radioactive Substances authorisation may also be required. Depending on the method of lithium extraction a PPC permit may also be required.

6. References

WAT-SG-85: Application of Standards to Thermal Discharges

Controlled Activities Regulations: A Practical Guide

Geothermal (Ground-Source) Heat Pumps A World Overview, J. Lund, B. Sanner, L. Rybach, R. Curtis, G. Hellström, GHC Bulletin, September 2004

Water Environment (Controlled Activities)(Scotland) Regulations 2011

Regulatory Guidance: Geothermal heat in Scotland , Scottish Government, January 2016

For information on accessing this document in an alternative format or language please either contact SEPA by emailing to equalities@sepa.org.uk

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http://contactscotland-bsl.org/

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