

Hydrogeological aspects of boreholes for heat pumps

In recent years, there have been significant legislative and methodological changes in the construction and use of geothermal heat pumps (GHP), also known as ground-source heat pumps (GSHPs). The use of GHP has become a widespread solution for heating buildings of all kinds, from family homes to industrial buildings. This article concerns GHP (ground-to-water and water-to-water types) that use shallow geothermal energy, obtained mainly through boreholes.

A GHP removes heat from the geological environment (rocks or groundwater) and converts it to a higher temperature usable for central heating and hot water. The primary GHP circuit of the ground-to-water type most often consists of a borehole, but it can also be surface collectors placed a short distance under the surface (or other solutions); in the case of water-to-water GHP, it is a system of collection and injection wells (one or more).

Methodological instruction of the Ministry for Regional Development

In 2023, the Energy Act No. 458/2000 Coll. was amended by Act No. 19/2023 Coll. The result of these changes is, among other things, a significant simplification and acceleration of the process of permitting ground-to-water GHPs. In July 2023, a methodological instruction was published by the Ministry for Regional Development entitled *Location, permission, and use of heat pumps* [1].

According to this instruction, a borehole for the ground-to-water system does not meet the definition of a structure according to the Building Act No. 283/2021 Coll.; therefore, according to this Act, boreholes do not require any permit. The GHP itself is considered a product, and its installation is not subject to planning or building regulations.

Drilling these boreholes (with an average depth of 100–200 m) means a considerable risk of affecting the natural conditions of groundwater in the area (such a deep borehole usually passes through several aquifers) and a large number of these boreholes are drilled every year throughout the Czech Republic. Therefore, from a hydrogeological point of view, it is very problematic that these boreholes are not subject to any approval and documentation process.

However, drilling these (mostly deep) boreholes still requires a permit according to the Water Act, i.e. obtaining consent from the relevant water authority according to Section 17, paragraph 1, letter g, of the Water Act No. 254/2001 Coll. The main basis for them is the expert statement from the holder of the certificate of professional competence for hydrogeology (Act No. 62/1988 Coll.) [2] and the opinion of the basin manager. Currently, the Water Authority is the only body that comments on the plan of a borehole for a ground-to-water GHP. Its role in the protection of natural water conditions in an area is therefore absolutely crucial.

New handbook of the Ministry of the Environment and the Czech Association of Hydrogeologists

In response to this new situation, the Ministry of the Environment (MoE) and the Czech Association of Hydrogeologists (ČAH) published a *Handbook for the design, permission, and drilling boreholes for “ground-to-water” and “water-to-water” heat pumps* [3], which is intended to help to better design and construction of boreholes for GHP. The material is intended for water law, construction and

other authorities assessing and authorizing these boreholes, and borehole and exploration companies. The issue is also dealt with in detail by Semíková et al. [4], however, this older methodology reflects the legislative status of that time.

The MoE and ČAH handbook has two basic parts:

- design, permission, and drilling boreholes for ground-to-water GHP;
- design, permission, and construction of collection and injection wells for water-to-water GHP.

Both parts discuss the design and placement of boreholes, their design parameters and specific conditions for their construction, the procedure for permitting boreholes, and risks for surface and groundwater bodies, and ways to prevent these risks. The handbook also addresses issues of assessing the impact of these plans on the environment pursuant to Act No. 100/2001 Coll. (EIA).

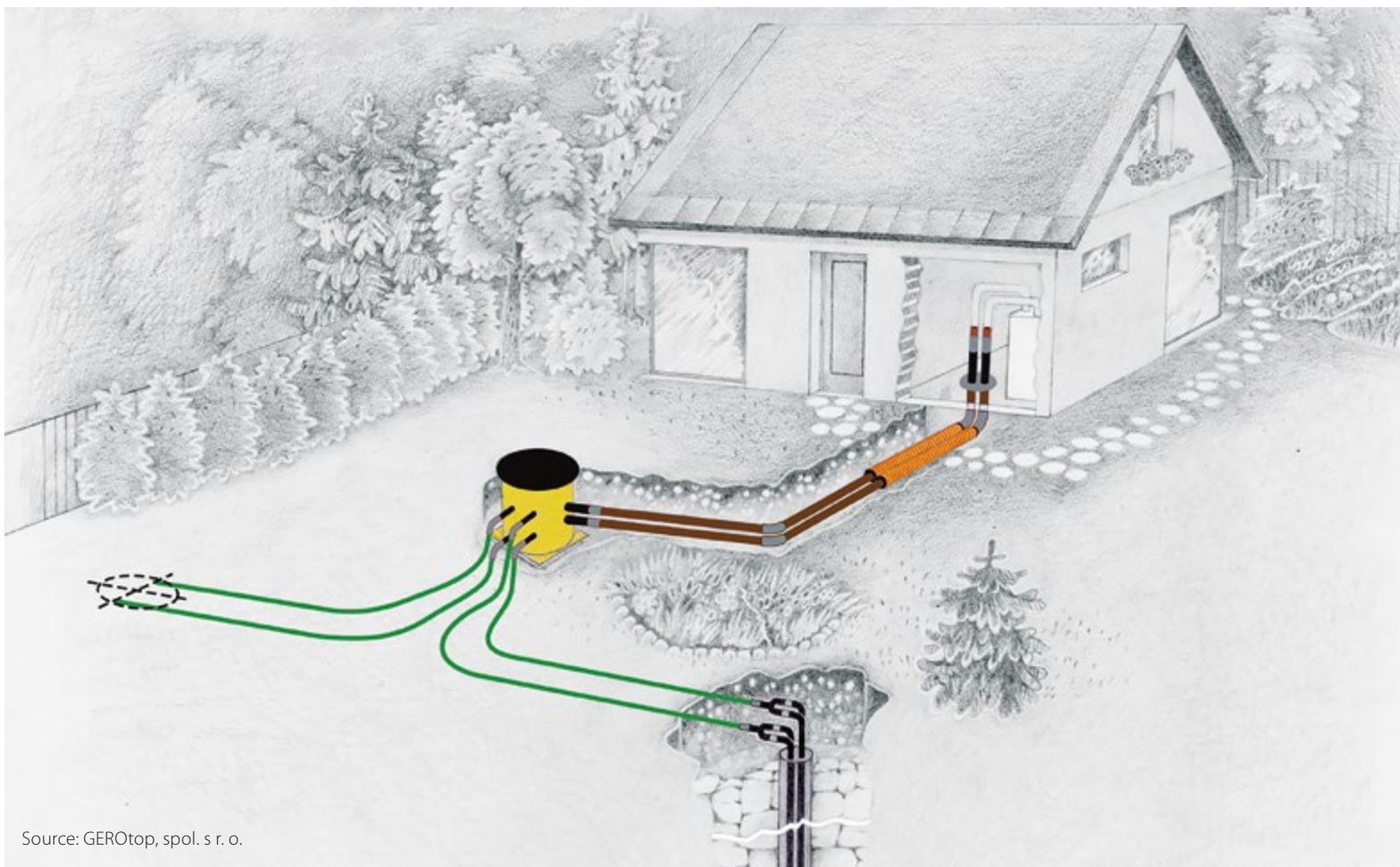
Ground-to-water heat pumps

The risk of boreholes for ground-to-water GHP lies primarily in the danger of disrupting the natural hydrogeological stratification of the rock environment, i.e. in connecting several aquifers, which are often used as sources of water for human needs. Their incorrect drilling therefore risks the reduction of natural groundwater resources and an impact on surrounding water collection facilities. A fundamental requirement is therefore an expert assessment of the impact of boreholes on the water regime of an area (see Annexes No. 7 and No. 11 of Decree No. 183/20218 Coll.). It is recommended that a hydrogeological cross-section of the area is created with the designation of aquifers and aquitards, as well as a proposal for the parameters of the borehole seal, so that GHP boreholes are as detached as possible from their surroundings and, above all, do not connect naturally separated aquifers. This often happens in practice, either due to an inappropriately designed borehole structure or poor-quality construction of the borehole seal. The problem is often an insufficient drilling diameter; the loops of the vertical probe of the primary circuit fill the borehole and there is insufficient space for a functional pressure seal of the borehole.

Water-to-water heat pumps

The second part of the handbook refers to water-to-water GHPs, which serve for groundwater abstraction, the removal of its heat, and the return of the cooled water back to the rock environment. The system therefore usually consists of a collection and injection well (drilled or dug). There have been no fundamental changes to these GHPs; wells or boreholes are waterworks and are built within the framework of Building Act No. 283/2021 Coll., like so-called other structures. The collection and injection of water falls within groundwater treatment, which is permitted by the relevant water authority on the basis of the statement of a person with professional competence in hydrogeology (Section 9, paragraph 1 of the Water Act), the opinion of the basin manager, and other documents.

During the drilling of wells, it is possible to proceed even through the intermediate stage of exploratory hydrogeological boreholes according to



Source: GEROTop, spol. s r. o.

Act No. 62/1988 Coll. (Geology Act), in cases where there is a lack of sufficient documents for proper design and engineering of the waterworks. However, they also require the prior consent of the water authority according to Section 17 paragraph 1 letter i) of the Water Act.

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References

- [1] MINISTERSTVO PRO MÍSTNÍ ROZVOJ. *Umístění, povolení a užívání tepelných čerpadel. Metodický pokyn pro stavební úřady*. Prague: Ministry of Regional Development, Department of Building Regulations, 2023. Available at: <https://mmr.gov.cz/cs/ministerstvo/stavebni-pravo/stanoviska-a-metodiky/uzemni-rozhodovani-a-stavebni-rad/umisteni,-povoleni-a-uzivani-tepelných-čerpadel>
- [2] ŠEDA, S. *Úloha hydrogeologa v projektování, povolování a realizaci vrtů pro tepelná čerpadla typu země-voda a voda-voda*. Seminar of the Czech Association of Hydrogeologists and T. G. Masaryk Water Research Institute. Prague, June 2023.
- [3] ŠEDA, S., DATĚL, J. V., ČÍŽEK, J. *Příručka pro projektování, povolování a realizaci vrtů pro tepelná čerpadla systémů „země x voda“ a „voda x voda“*. Prague: Czech Association of Hydrogeologists for the Ministry of the Environment, 2023. Available at: https://www.mzp.cz/cz/prehled_vyzkumnych_metodik

- [4] SEMÍKOVÁ, H., NOVÁK, P., VANĚČEK, M. *Metodika geologických průzkumných prací pro budování tepelných čerpadel pro využití energetického potenciálu podzemních vod a horninového prostředí*. Pardubice: WATRAD Pardubice for the Ministry of the Environment, 2020. Available at: https://www.mzp.cz/cz/prehled_vyzkumnych_metodik

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