

GUIDANCE DOCUMENT

Coupling Geothermal Heat Pumps (GHP) with Underground Seasonal Thermal Energy Storage (USTES)

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The American Ground Water Trust, Concord, NH

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ACRONYMS AND ABBREVIATIONS

| | |
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| AGWT | American Ground Water Trust |
| AHRI | Air Conditioning Heating and Refrigeration Institute |
| ATES | Aquifer Thermal Energy Storage |
| BTES | Borehole Thermal Energy Storage |
| EPA | Environmental Protection Agency |
| GHP | Geothermal Heat Pumps |
| HDPE | High density polyethylene |
| HVAC | heating, ventilating and air conditioning |
| IGSHPA | International Ground Source Heat Pump Association |
| MCLB | Marine Corps Logistics Base |
| UIC | Underground Injection Control |
| US | United States |
| UESC | Utility Energy Service Contracts |
| USTES | Underground Seasonal Energy Storage Systems |
| UTES | Underground Thermal Energy Storage |

1.0 INTRODUCTION

This document is to be used as a tool to help guide engineers, architects, contractors, owners, property managers, energy managers, or other stakeholders in the process of obtaining the proper permitting to design or install Geothermal Heat Pumps with Underground Seasonal Energy Storage Systems (GHP USTES). The body of the report contains crucial information regarding understanding what GHP USTES systems are and how they can be applied to a building's heating, ventilating and air conditioning (HVAC) system to greatly improve energy efficiency, and lower water usage.

The data presented in Appendix A—State by State Environmental Regulatory and Reporting Requirements—were recently updated. The American Ground Water Trust attempted to contact each state in the U.S. to gain updates on the environmental regulations and reports required for implementation of Underground Thermal Energy Storage Systems. The updated data in Appendix A was obtained during the period of August to December 2020.

The State by State Environmental Regulatory and Reporting Requirements contained in Appendix A reflect the most recent data acquired by The American Ground Water Trust. Appendix A should only be used as a guide to achieve a starting point in the Environmental Regulatory and Reporting Requirements process when installing a GHP USTES system. Obtaining all the required permits and documents for the applicable state is the sole responsibility of the owner, and/or personnel performing and/or planning the GHP USTES system.

Underground Thermal Energy Storage (UTES) is a form of energy storage that can efficiently utilize renewable energy at a large scale. The principal UTES technologies are Aquifer Thermal Energy Storage (ATES) and Borehole Thermal Energy Storage (BTES). Both are technologies that have the potential to significantly reduce the energy load and carbon emissions associated with temperature air conditioning in residential commercial and institutional buildings of all sizes. (Velvis, 2015, Lee, 2010; Shennan and Snijders, 2006, Pyne, 2005). ATES and BTES are relatively new technologies in the sphere of accepted and established geothermal loop field applications in the United States but the concept goes back to 1912 when the first ground source heat pump was patented by Heinrich Zoelly in Switzerland, (Zogg, 2008).

These technologies involve penetrating the subsurface via vertical drilling and, for ATES, intercepting aquifers and groundwater; and for BTES, accessing geologic formations with the capability of storing heat. Whenever the subsurface is accessed through vertical drilling, horizontal trenching or boring, the potential exists for environmental impacts on groundwater resources. During installation, surface activities may also lead to effects on groundwater via accidental surface spills during handling and/or disposal of materials. It has long been recognized that properly designed and installed systems can access the potential of sub-surface storage of heat without adverse impacts to water resources, (U.S. Department of Energy, 1981, ATES Research, 2012).

UTES systems have been operating successfully in Europe since the late 1980s (Paksoy et al., 2009), whereas the U.S. has been slow to adopt the technology. UTES is now frequently adopted as the basis for air conditioning. For example, in Sweden there were over ten ATES systems in 2012 (Andersson, 2013) and 2,740 in the Netherlands, (CBS, 2013). It has been estimated that about 20,000 ATES systems could be installed in the Netherlands by 2020, (Godschalk, 2009).

In terms of conventional geothermal heat pumps, the U.S. now has over one million installations. (Water Furnace, 2017).

This report outlines some of the environmental issues related to ATES and BTES installation in the U.S. The report has been prepared by the American Ground Water Trust (AGWT) to accompany the state-by-state spreadsheet of regulatory requirements. The non-profit AGWT is a national water resource education organization focused on educating the public, business, government, communities, and citizens about the importance and value of the nation's ground and surface water resources. The sustainable use of water resources and implementation of the best technologies and resource management programs is the heart of the AGWT's education outreach to attain the highest and best use of the resource among competing environmental, economic, and social demands. Sound science should be the foundation for decisions leading to long-term sustainable water use and management programs that will stand the test of time.

2.0 BACKGROUND TO ATES AND BTES IN THE U.S.

In 1892, Boise Idaho became the first community to use the natural high temperature water associated with hot springs for a community heating system (Office of Energy Efficiency, 2012). The first documented residential use of "low temperature" ground source heating and cooling geothermal heat pumps (GHP) was in 1948 when Professor Carl Nielsen of Ohio State University installed a system in his home. At the same time, in Portland, Oregon an engineer named J.D. Knocker was exploring the application of a groundwater sourced heat pump system in a commercial building (Office of Energy Efficiency and Renewable Energy, 2012). Although *Life* magazine published an article (Fireless Furnace, 1948) that same year showcasing the General Engineering and Manufacturing Company's "Miracula" ground source heat pump system, it was not until the 1970's oil price shock that low temperature GHP systems began to get more widespread entrepreneurial attention.

The high fossil fuel prices fostered a nascent open loop GHP system industry that was followed by early innovations of closed loop installations using new-to-market plastic pipe products made from polybutylene and polyethylene. Polybutylene plastic pipe is not used in the GHP closed loop industry today because it had a high failure rate in certain situations. High density polyethylene (HDPE) and PEX (cross-linked polyethylene) pipe are now the standard options per guidance from the International Ground Source Heat Pump Association (IGSHPA), a non-profit organization formed in 1987 and headquartered at Oklahoma State University. The organization developed a set of guidance documents and training certifications that cover the design, installation, and operation methods and scientific concepts that underpin the GHP industry (IGSHPA, 2012b).

Through the 1980s up to the first few years of the 21st century, GHP installations represented only a small fraction of the HVAC market. The Air Conditioning Heating and Refrigeration Institute (AHRI) reported from manufacturer's data that GHP shipments in 2008 indicated that about 2.6 percent of new homes installed a GHP system, up from less than 0.5 percent just a few years before (AHRI, 2012). As the absolute number of GHP installations has grown and become more visible and accepted in the built environment, many state environmental regulation agencies now recognize that loop fields, both open and closed, represent a possible threat to groundwater.

Between 2007 and 2016, in cooperation with experts from the geothermal heat pump industry and experts from the heating and air conditioning industry, the AGWT convened seventy-seven education forums and workshops across the country on GHP technology and groundwater impacts.

The principal target audiences for these events were architects and developers. Over this ten-year period, the AGWT has witnessed a significant increase in attention by state regulatory agencies because of the environmental implications of drilling operations. Regulatory guidelines for water wells were typically invoked as the basis for regulating ground source heat pump installations. In some cases, new regulations were to address the possible effects of interaction between GHP loop fields and groundwater. Each state has taken a slightly different approach to regulating GHP loop fields. There is no overarching regulatory framework at the federal level that specifically targets GHPs, although federal underground injection control rules may apply.

3.0 HOW ATES AND BTES SYSTEMS WORK

ATES is an open-loop energy storage system that uses groundwater as the energy transfer medium between the ground and the conditioned building. Other components needed for an ATES system are heat exchangers, piping, mechanical systems and controls to integrate with the HVAC system of the target building(s). It relies on seasonal storage of cold and/or warm groundwater in an aquifer. ATES is a nuanced application of the well-established “open loop” ground source heat pump installations that have been in service across the United States since the 1970s. A traditional vertical open loop well system draws groundwater from a supply well and discharges it to a receiving well and the flow direction is never reversed. However, an ATES installation extracts groundwater from source wells during one space conditioning season (heating) and discharges to aquifers via receiving wells in a nearby well field. During the (cooling) space conditioning season the flow direction is reversed. This process serves to enhance the groundwater temperatures (energy) in the receiving well relative to the required energy for the next conditioning season (cooler groundwater for the cooling season and warmer for the heating season).

ATES can provide an efficient system of heat storage and transfer with seasonal energy efficiency ratio values of over 60 (Underground Energy LLC, 2017). Efficiencies are measured as a ratio of thermal power output to electrical power input and ATES is typically four to six times more efficient than conventional heating and cooling systems. An ATES system uses natural heating and cooling and stores that heat in an aquifer until the following cooling or heating season. Provided there is not a dynamic flow system, an aquifer can effectively serve as a place to store and recover heat. Because a relatively large site footprint is required for both cool and warm storage, ATES is not suitable for a single residential property but presents great opportunities for commercial, industrial and institutional buildings and campuses.

BTES geothermal systems operate on a similar principle as ATES with underground storage of thermal energy. BTES systems are closed loop field installations with heat storage in the geology conveyed underground by fluids in a closed system that does not connect or have contact with groundwater. BTES does not need to be installed in water bearing rock formations and is suitable for both small- and large-scale applications. The system uses plastic piping to carry a water-based energy transfer fluid between the loop field and the geothermal heat pumps. In a traditional closed loop design, the loop field must be sized to balance the difference between the heating and cooling loads of the building, which requires matching the dominant building load and accounting for the climate conditions that renew the ground energy.

According to Underground Energy LLC, (2017) BTES is an improvement on conventional closed-loop ground source heat pump geothermal systems. In BTES the ground heat exchanger array system is designed and operated so that heat is stored or abstracted seasonally. In conventional geothermal the loops are designed to simply dissipate heat (or cold) into the subsurface. The analogy is that BTES uses the subsurface geology as a thermal battery, as opposed to a radiator. BTES is a design solution in areas where there are not aquifers suitable for ATES or where there may be concerns about the quality of the groundwater or the potential risks to groundwater. BTES systems do not connect with groundwater and may therefore have a lower threshold for permitting than ATES systems.

In a BTES design there is typically a compact radial loop field constructed through a cylindrical volume of rock. Flow and heat transfer through the vertical loops is designed to build heat in the core of the field during the cooling season and extract it during the heating season. The energy transfer fluid is directed to or from the core of the field depending on the conditioning needs of the building.

4.0 REGULATIONS RELATED TO ATES AND BTES INSTALLATIONS

Throughout the US, in virtually all instances, permits are required for any process that involves drilling into sub-surface formations and particularly when such drilling may impact water resources. Regulation for source water protection are promulgated and enforced mostly at the state and local municipal levels of government. ATES and BTES design and installation permits and approvals are not consistently handled by the same agencies state by state, although ATES projects fall under the federal underground injection regulations. Most states have primacy for administering these regulations although some are handled via staff in U.S. Environmental Protection Agency (EPA) regional offices. State by state regulatory and reporting requirements are detailed in the spreadsheet accompanying this report. The information provided is categorized under the following headings:

- Agency issuing Underground Injection Control Permits
- State Agency regulating wells producing water
- State agency regulating non-producing boreholes
- Other units of government if part of permit process
- Open-loop permit requirements
- Closed-loop permit requirements
- Closed-loop post-installation inspection/reporting requirements
- Open-loop post-installation inspection/reporting requirements
- Open-loop driller license requirements
- Closed-loop driller license requirements
- Are out of state drillers allowed to perform work?
- Comments on driller continuing education requirements
- Additional Notes and Comments
- Additional information source(s) contact information
- URL of state agencies

4.1 CLOSED LOOP REGULATIONS (BTES)

BTES installations are similar to a traditional closed loop geexchange field in that they both use plastic pipe as a conduit for heat exchange fluid flow between the GHP(s) and the loop field. They both incorporate a heat exchange fluid to collect and transport energy from the ground to the GHP in a continuous route with on-going flow when the GHP is in operation. During this review of the regulatory conditions surrounding closed loop geexchange fields no indication was found that BTES would be treated differently than a large traditional closed loop geexchange field. In most states closed loop geexchange fields are regulated by extension of established water well construction regulations. Bldg. 3700 at the Marine Corps Logistics Base (MCLB) located in Albany, GA attempted, and succeeded, in being the first known BTES system in the United States (US). Subsequently three new BTES systems were constructed at MCLB Albany serving buildings: 7600, 7360, 7520, 7106, 7108, and 7112. These systems became operational summer of 2019.

Closed loop geexchange loop fields as the proxy for BTES installations are not regulated specifically at the federal government level. Regulatory agency representatives at AGWT education programs have frequently informed their audiences that state regulations on ground source heat pump installations are still evolving. Most states require individuals who construct closed loop geexchange systems incorporating vertical boreholes to be licensed, registered, or certified water well drilling contractors.

4.2 OPEN LOOP REGULATIONS (ATES)

ATES and BTES system regulations are principally concerned with protection of groundwater quality. ATES installations are similar to a traditional vertical well open loop geexchange field in that they both use groundwater as the heat exchange fluid between the GHP(s) and the loop field and must return the groundwater to the subsurface via a series of wells. In most states open loop geexchange systems are regulated by extension of established water well construction regulations. While there are numerous operational ATES systems around the world, the ATES system for building 3215 at Ft. Benning located in Columbus, GA is the first system of this configuration type and operation in the U.S. For the Department of Defense, there are perhaps a half dozen or so other ATES systems in the U.S. Due to the success of the building 3215 system, DoD has elected to promote ATES systems via a Technology Transfer Contract and at least two Utility Energy Service Contracts (UESC). Specifically, in 2018, ESTCP awarded a Contract to the Gulf Power Company to implement another ATES system at the Naval Air Station Pensacola. This ESTCP seed money of sorts, provided engineering support and test wells for the proposed ATES system, but the vast majority of the construction cost is to come via the UESC funding vehicle. Similarly, in 2019, ESTCP awarded a contract for another ATES system to Dominion Energy that is anticipated to be constructed at Fort Langley-Eustis in Virginia. DoD anticipates many more ATES projects to be constructed over the next several years and as additional experience is gained interacting with the Regulatory Community, the permitting process should become more streamlined and better understood. The spreadsheet information herein lists the existing rules and regulations that would apply to an open loop ATES project. In general, the federally (EPA) required Underground Injection Control (UIC) regulations and permits are applicable to all ATES systems and have already been issued in the past to the ATES wells close “cousins” often known as an “open loop geothermal heat pump well” or sometimes an “air conditioning return well”.

All of these are considered a “Class V” UIC well. Enforcement activities and issuance of a Class V ATES UIC Permit is sometimes (fairly rarely) administered by the EPA itself, but more oftentimes, EPA has delegated their authority to a specific state’s internal environmental agency. In either event, UIC permits are generally handled in one of the three manners listed below in order of increasing complexity and expense:

- “Permit by Rule”—In this protocol, for the benign application of ATES, there is generally a “rule” that is promulgated that recognizes that simply extracting existing ground water and heating and cooling it by a few degrees, and then placing it back into the same aquifer, is not a high risk or complex affair and accordingly, a “rule” is issued to this affect, and all ATES wells operate under this “rule” without an actual permit or permit number being issued to a specific individual ATES well in that particular regulatory region of the country. Sometimes some simple descriptions (e.g., GPS coordinates) are required to be submitted to the regulating authority where this information is kept on file for “inventory” purposes, but generally no other actions are required. This is the simplest of all situations and typically has no cost or complexities involved.
- “Permit by General Permit”—This only slightly more complex methodology is utilized in some regions where, while the benign nature of ATES Wells is understood, addition documentation/scrutiny is desired. The regulators will typically have spelled out specific criteria related to well construction, aquifer use, and metering requirements., but since all wells are built under these fairly prescriptive requirements, hundreds, if not thousands, of wells may operate under a single Permit like UIC Permit #0001. While the applicant is often required to fill out paperwork and pay a fee, the former is generally not complex, and the latter is not expensive. Typically, applications are only a few pages long and the time required to obtain an appropriate permit with a “clean” application is a matter of days.
- Individual Permit—under this protocol, each well must have an individual permit application that is sometimes complex, possibly requiring Hydro geological analysis and justification and can be expensive and time-consuming, though this is not always true. Beyond the permit application and approval process, the regulatory authority may place expensive requirements on the ATES well owner, such as quarterly water chemistry testing and flow monitoring to ensure the permits’ listed water volumes, injection pressures, etc. are not exceeded.

Open loop geoexchange fields may be considered a proxy for ATES installations. ATES systems are not regulated directly at the federal government level. Because system operation calls for injection of groundwater, a few states require UIC permits for ATES installations. Even though there is no drinking water consumption involved, most states regulate open loop wells used for heat exchange as drinking water wells regarding setbacks, and construction materials and methods (i.e., casing and grouting and drilling.

Environmental permits are driven by water quantity and quality concerns. The direct access to groundwater in open loop systems creates a situation for potential impact or over-use conditions. To date, open loop installations have been on residential lots and/or situations where available water was sufficient to avoid conflicts between neighboring properties. As systems become more common in new construction projects and perhaps sited on multiple adjacent properties, it may

become more common for state regulatory agencies to require water withdrawal permits for open loop well fields. (Industry Insights, 2010).

5.0 ENVIRONMENTAL IMPACT

ATES and BTES systems are not regulated directly by the EPA and to date there are no installation or operational experiences of environmental impacts. One 1,600-ton system was operating at Richard Stockton College in Galloway, New Jersey from 1994 until approximately 2018 (Richard Stockton College, 2013), and may resume operation in the future. In contrast, systems have been operating successfully in Europe since the late 1980s (Paksoy et al., 2009). The many ATES systems in the Netherlands (Godschalk and Bakema, 2011) demonstrate the practical utility of the technology and give a strong indication that there are not significant environmental issues.

Environmental impacts to subsurface conditions associated with ATES and BTES installations may result from four categories: hydrological, thermal, chemical, or microbiological. The degree of the impact will depend on the operational characteristics of the UTES system and the state of the anthropogenic and natural environments of the installation site and surrounding land area (Evans et al., 2009). UTES systems have the potential to affect both surface and subsurface conditions (Ferguson, 2009). (Philippe et al 2017).

Hydrological impacts may result from the dynamic changes to groundwater quantity within an aquifer as the ATES pumping and recharge regime adjusts to meet seasonal heating and cooling demands throughout the year. Bonte et al (2011) reviewed the fundamental hydrogeological impacts that may occur as the result of operating an ATES system near a dedicated extraction well. ATES pumping and recharge create disturbances in aquifer flow patterns and water levels. If these changes intersect the design-capture zone of proximal dedicated extraction wells, the design capture zone limits will increase or decrease to some extent reflecting either the ATES' cone of depression associated with the pumping field or the groundwater mounding geometry around the reinjection field, respectively. Because of the seasonal reversal of the ATES pumping and injection locations, the design-capture zone of a proximal dedicated extraction well could be in flux for extended periods through the year creating potential unintended interference and water mixing conditions. If one of the ATES wells is sited within the extraction well design-capture zone, groundwater from outside the design limit will be introduced to the extraction well water budget when the ATES system reinjects at this location.

Groundwater-surface water interactions may be affected by the periodic mounding and depressing of the water table near ATES systems. The interactions may be additive or subtractive with regard to surface water availability with consequent effects on the flora and fauna of the impacted habitat. ATES sites near wetlands or areas of potential saltwater intrusion should be evaluated to identify possible changes to the ecology of these areas resulting from transient pumping and injection activities.

Cross-impact of aquifers may occur when the ATES production wells and injection wells access different aquifers separated by low-permeability rock layers (aquitards and aquicludes) (Santi et al., 2006). ATES and BTES systems may also cross-impact aquifers or provide access for surface water impact if borehole construction is poor including unsatisfactory grout placement due to inadequate quantity and/ or quality (Bonte et al., 2011). Debonding of the grout from the heat-

transfer piping in BTES systems may occur due to differential thermal expansion between the materials, potentially creating preferential pathways between aquifers and/ or the surface (Philippacopoulos and Brendt, 2001; Mehnert, 2004). The Illinois Geological Survey found that Mix 111 (a thermally enhanced grout developed by the Brookhaven National Laboratory) did not debond, and maintained hydraulic conductivities below 10^{-7} cm/sec during testing (McNulty and Rowe, 2000; Mehnert, 2004).

The development of conventional geoeexchange heating and cooling systems to this point in time generally has been on property with few on-site above ground or underground limitations, or competing off-site water demands (Ferguson, 2009). In recent years, the geoeexchange industry has seen the installation of increasingly larger systems (Dougherty, 2012) such as the 9,000-borehole closed loop installation at Ball State University in Indiana (Ball State University, 2013). Installations in more urban, densely built environments such as New York City are also becoming more common and receiving added recognition from government leaders (Franks, 2013).

As UTES systems become larger and more closely spaced, the potential for system problems related to interference between proximal systems increases. Industry and government design and oversight professionals must recognize these potential situations in order to design and construct sustainable UTES systems that avoid conflicts. ATEs systems may be unsustainable and fail due to thermal issues under three scenarios:

- Insufficient water supply.
- Increases (or decreases) in temperature of the production well water source due to on-site reinjection.
- Increases (or decreases) in temperature of the production well water source due to off-site injection (Ferguson and Woodbury, 2006).

On an annual basis the temperature variation in ATEs well fields are on the order of 10 degrees Celsius. The temperature range for BTES systems will be somewhat higher (Bonte et al., 2011). If the system is not in long-term thermal balance, then the geoeexchange system temperatures may drift over time. The “cold field” will get progressively colder or the “warm field” will get progressively hotter unless chillers or boilers are added to the loop to release or add heat to keep the system in overall balance. Out of balance systems will degrade in efficiency as the stored energy rises (or falls) and potentially results in migration out of the system-design temperature interval. This was demonstrated in a study of an aquifer in Winnipeg, Canada that was used solely for cooling purposes. Injected water from several systems and within individual systems eventually broke through to the production wells compromising the efficacy of the systems. This indicates that there are minimum separation distances between production and injection wells that must be determined and maintained based on-site specific conditions (Ferguson and Woodbury, 2006).

ATEs installations mix groundwater as part of system operation by taking production water and injecting it back into the aquifer at a separate location. Mixing groundwater may alter the chemistry of the natural groundwater regime through redistribution of elevated concentration levels of natural minerals, anthropogenic impact, pH, dissolved oxygen, dissolved solids/metals, microbial activity, nutrient levels, organic matter content, and trace elements. (Holm et al., 1987; Zuurbier et al., 2013). Substances that were substantially immobile under natural conditions may be solubilized and transported to the injection well location. Changing the thermal regime may enhance the

mobilization process as Holm et al. (1987) reported with regard to quartz and calcium in recovered groundwater at a test ATES site. However, water temperatures above 30 degrees Celsius may be required for temperature to have a significant role in altering mineral solubilities, reaction kinetics, or organic matter oxidation (Bonte, 2011).

BTES systems may require the use of antifreeze in most installations to protect against freeze-up of the transfer fluid during the heating portion of the year in cold climates. Several antifreeze-water mixture options have been applied in the past including methanol, ethanol, potassium acetate, ethylene glycol, propylene glycol, calcium magnesium acetate and urea (USEPA, 1998; Mehnert, 2004; Klotzbücher et al., 2007; IGSHPA, 2009). Non-toxic (“food-grade”) propylene glycol is the most common antifreeze chemical used in the geexchange industry today. Water-methanol antifreeze mixtures have superior pumping characteristics relative to propylene glycol, but many states have banned its use because of its toxicity profile. Geexchange loop circuits incorporating HDPE pipe that are assembled using properly applied industry standard thermal fusion methods and subsequently pressure tested prior to burial are unlikely to leak during operation unless the pipes are damaged during a future excavation event within the loop area.

Groundwater aquifers are ecosystems that only in the last two decades have begun to receive recognition and assessment on a level comparable to terrestrial and surface water habitats (Lovley and Chapelle, 1995; Goldscheider et al., 2006; Griebler and Lueders, 2009). Much of the research has focused on the use of microbes to remediate impacted groundwater and less on the characteristics of the natural faunal communities. The current level of knowledge suggests generally that oligotrophic pristine aquifers characterized by limited carbon, energy and nutrient sources are either habitats with relatively low microbial biodiversity or are low abundance habitats that existing collection and evaluation methods are not precise enough to appropriately assess (Goldscheider et al., 2006; Lehman, 2007; Griebler and Lueders, 2009).

Changes to groundwater hydrogeochemistry and temperature are the main parameters of operating ATES and BTES systems that may alter aquifer ecology and potentially create risk (Hall et al., 2008). There is a paucity of information assessing aquifer vulnerability to these threats and consequent risk related to UTES (Bonte et al., 2011). The lack of risk assessment information may be due in part to the relatively nascent understanding of the natural aquifer conditions that would form the backdrop for quantifying threats, vulnerabilities, and associated risks. At this time, it appears that setback requirements between UTES systems and potable water supplies remain an important and necessary part of preventing adverse impacts between these two groundwater use activities (Schijven et al., 2006; Bonte et al., 2011).

6.0 REFERENCES

- AHRI. (2012) Geothermal Heat Pumps: Geothermal Heat Pumps. Arlington, VA, Air conditioning Heating and Refrigeration Institute. Retrieved June 26, 2012 from <http://www.ahrinet.org/geothermal+heat+pumps.aspx>.
- Andersson, O., J. Ekkestubbe, and A. Ekdahl, UTES (Underground Thermal Energy Storage) Applications and Market Development in Sweden. J. Energ. Pow. Eng, 2013.

- Ball State University. (2013) Going Geothermal. 10tockton10 June 15 2013 from <http://cms.bsu.edu/about/geothermal>.
- Bonte, M., Stuyfzand, P.J., Hulsmann, A. and Van Beelen, P. (2011) Underground thermal energy storage: environmental risks and policy development in the Netherlands and European Union. *Ecology and Society* 16(1):22. Retrieved June 6 2013 from <http://www.ecologyandsociety.org/vol16/iss1/art22/>.
- CBS (213), Hernieuwbare energie in Nederland 2012 (Renewable energy in the Netherlands 2012). 2013, Centraal bureau voor de statistiek: Den Haag
- Dougherty, D. (June 2012) The Status of the Geothermal Industry. Power Point Presentation at the American Ground Water Trust, Ground Source Heating and Cooling for Residential and Commercial Properties – Latest Technologies, Economic Advantages, Environmental Impacts and Regulations Forum. Crystal City, Virginia. June 12, 2012.
- Evans, D., Stephenson, M. and Shaw, R. (2009) The present and future use of ‘land’ below ground. *Land Use Policy*. Elsevier Ltd. London. DOI: 10.1016/j.landusepol.2009.09.015.
- Ferguson, G. (2009) Unfinished business in geothermal energy. *Ground Water* 47(2):167.
- Ferguson, G. and Woodbury, A. D. (2006) Observed thermal pollution and post-development simulations of low-temperature geothermal systems in Winnipeg, Canada. *Hydrogeology Journal* 14(7):1206-1215.
- Fireless Furnace. (1948, October 25) *Life*, p. 83-84. Retrieved June 16, 2012 from <http://books.google.com>. Franks, M., (May 22, 2013) Creating Awareness: Geothermal for a Sustainable Future in New York City.
- Franks (2013) *RenewableEnergyWorld.com*. Retrieved on June 22, 2013 from <http://www.renewableenergyworld.com/rea/blog/post/2013/05/creating-awareness-geothermal-for-a-cleaner-sustainable-future-in-new-york-city>.
- Godschalk, M.S.; Bakema, G. (2009). “20,000 ATEs Systems in the Netherlands in 2020 – Major step towards a sustainable energy supply” (PDF). *Proceedings Effstock*. Available from: https://en.wikipedia.org/wiki/Aquifer_thermal_energy_storage
- Goldscheider, N., Hunkeleer, D. and Rossi, P. (2006) Review: Microbial biocenses in pristine aquifers and an assessment of investigative methods. *Hydrogeology Journal* 14(6):926-941. DOI: 10.1007/s10040-005-0009-9.
- Griebler, C. and Lueders, T. (2009) Microbial biodiversity in groundwater ecosystems. *Freshwater Biology* 54(4):649-677. DOI: 10.1111/j.1365-2427.2008.02013.
- Hall, E. K., Neuhauser, C., and Cotner, J. B. (2008) Toward a mechanistic understanding of how natural bacterial communities respond to changes in temperature in aquatic ecosystems. *ISME Journal* 2(5):471-481.

- Holm, T. R., Eisenreich, S. J., Rosenberg, H. L. and Holm, N. P. (1987) Groundwater geochemistry of short- term aquifer thermal energy storage test cycles. *Water Resources Research* 23(6): 1005-1019. DOI: 10.1029/WR029/WR023i006p01005.
- Industry Insights. 2010. 2009/2010 Geothermal Heating and Cooling Systems State Regulatory Oversight Survey: jointly published by the Geothermal Heat Pump Consortium (GeoExchange), Ground Water Protection Council, International Ground Source Heat Pump Association and the National Ground Water Association (NGWA), 637p. Retrieved from <http://info.ngwa.org>.
- International Ground Source Heat Pump Association (IGSHPA). (2009) Ground source heat pump residential and light commercial design and installation guide. IGSHPA, Oklahoma State University, Stillwater, OK. ISBN: 978-0-929974-07-1.
- International Ground Source Heat Pump Association (IGSHPA). (2012a) What is IGSHPA?: International Ground Source Heat Pump Association, Oklahoma State University, Stillwater, OK. Retrieved June 15, 2012 from http://www.igshpa.okstate.edu/about/about_us.htm#2.
- International Ground Source Heat Pump Association (IGSHPA). (2012b) Why should you use IGSHPA accredited installers and designers?: International Ground Source Heat Pump Association, Oklahoma State University, Stillwater, OK. Retrieved June 15, 2012 from <http://www.igshpa.okstate.edu/directory/directory.htm>.
- Klotzbücher, T., Kappler, A., Straub, K. L. and Haderlein, S. B. (2007) Biodegradability and ground water pollutant potential of organic anti-freeze liquids used in borehole heat exchangers. *Geothermics* 36(4):348-361.
- Lee, K. S. (2010). A Review on Concepts, Applications, and Models of Aquifer Thermal Energy Storage Systems. *Energies* 2010, 3, 1320-1334. Retrieved from <http://www.mdpi.com/1996-1073/3/6/1320>.
- R. Michael Lehman mlehman@ngirl.ars.usda.gov (2007) Understanding of Aquifer Microbiology is Tightly Linked to Sampling Approaches, *Geomicrobiology Journal*, 24:3-4, 331-341, DOI: 10.1080/01490450701456941
- Lovley D. R. and Chapelle, F. H. (1995) Deep subsurface microbial processes. *Reviews of Geophysics* 33(3): 365-381. DOI: 10.1029/95RG01305
- McNulty, K. and Rowe, M. S. (2000) Formula for Environment-Friendly Grout Revives Heat Pump Industry in New Jersey and Wins Award for Brookhaven Scientists. Brookhaven National Laboratory. Retrieved June 15, 2013 from <http://www.bnl.gov/bnlweb/pubaf/pr/2000/bnlpr022500.html>.
- Mehnert, E. (2004) The environmental effects of ground-source heat pumps – A preliminary overview. Illinois State Geological Survey Open-file Series Report 2004-2. Retrieved on June 20, 2013 from <http://library.isgs.uiuc.edu/Pubs/pdfs/ofs/2004/ofs2004-02.pdf>.

- Office of Energy Efficiency and Renewable Energy. U. S. Department of Energy. (June 5 2012) A History of Geothermal Energy in the United States. *Geothermal Technologies Program*. Retrieved June 10, 2012 from <http://www1.eere.energy.gov/geothermal/history.html>.
- Paksoy, Halime, Snijders, Aart., Stiles, Lynn., (2009) State-of-the-Art Review of Aquifer Thermal Energy Storage Systems for Heating and Cooling Buildings. Retrieved June 24, 2013 from http://intraweb.stockton.edu/eyos/energy_studies/content/docs/effstock09/Session_6_3_ATES_Applications/53.Pdf.
- Philippe M. and D. Marchio , S. Hagspiel , P. Riederer , V. Partenay (2017) ANALYSIS OF 30 UNDERGROUND THERMAL ENERGY STORAGE SYSTEMS FOR BUILDING HEATING AND COOLING AND DISTRICT HEATING: Available from https://intraweb.stockton.edu/eyos/energy_studies/content/docs/effstock09/Session_11_1_Case%20studies_Overviews/100.pdf
- Philippacopoulos, A. J. and Berndt, M. L. (2001) Influence of debonding in ground heat exchangers used with geothermal heat pumps. *Geothermics* 30(5): 527-545.
- Pyne, D. (2005) Aquifer Storage and Recovery: A Guide to Groundwater Recharge Through Wells. Gainesville, FL. ASR Press. 608p.
- Richard Stockton College. (2013) Energy Studies at the Richard Stockton College of New Jersey: Geothermal System Overview. Galloway, New Jersey. Retrieved June 24, 2013 from <http://intraweb.stockton.edu/eyos/page.cfm?siteID=82&pageID=27>.
- Santi, P. M., McCray, J. E. and Martens, J. L. (2006) Investigating cross-contamination of aquifers. *Hydrogeology Journal* 14(1-2):51-68. DOI: 10.1007/s10040-004-0403-8.
- Schijven, J. F., Mülschlegel, J. H. C., Hassanizadeh, S. M., Teunis, P. F. M. and de Roda Husman, A. M. (2006) Determination of protection zones for Dutch groundwater wells against virus contamination- uncertainty and sensitivity analysis. *Journal of Water and Health* 4(3):297-312.
- Shennan, R., and Snijders, A. (2006) The Application of Aquifer Thermal Energy Storage to a City Centre Carbon Emissions Reduction Program at the South Kensington Cultural and Academic Estate, London, England. Energy Studies Forum at Richard Stockton College of New Jersey. Retrieved June 10, 2012 from http://intraweb.stockton.edu/eyos/energy_studies/content/docs/FINAL_PAPERS/5A-2.pdf.
- US Department of Energy, (1981), Environmental Assessment: Aquifer Thermal Energy Storage Program Office of Energy Systems research, Washington DC, DOE/EA-0131 January 1981 Available from: <https://books.google.com/books>
- US Environmental Protection Agency (USEPA) (1998) Evaluation of consequences of spills from geothermal heat pumps. EPA Document number 1998-615-003/60624.

Underground energy LLC (2017) Aquifer Thermal Energy Storage: Available from
<http://www.underground-energy.com/ATES.html>

Velvis, H, 2015, District ATES systems in the Netherlands: best practices of a grown-up technology, Posted Dec 24, 2015, by IDEA Industry news. Available from:
<http://www.districtenergy.org/blog/2015/12/24/district-ates-systems-in-the-netherlands-best-practices-of-a-grown-up-technology/>

Water Furnace, 2017, Water Furnace Web-site Knowledge Center. Available from:
<http://www.waterfurnace.com/growing.aspx>

Zogg, M. (May 2008) History of Heat Pumps, Swiss Contributions and International Milestones: Swiss Federal Office of Energy, Department of Environment, Transport, Energy and Communications (DETEC), Presented at the 9th International IEA Heat Pump Conference, Zürich, Switzerland. 114 p. Retrieved June 21, 2012 from <http://www.zogg-engineering.ch/publi/HistoryHP.pdf>.

Zuurbier, K. G., Hartog, N., Valstar, J., Post, V. E. A. and Van Breukelen, B. M. (2013) The impact of low- temperature seasonal aquifer thermal energy storage (SATES) systems on chlorinated solvent contaminated groundwater: Modeling of spreading and degradation. Journal of Contaminant Hydrology 147(April):1-13. DOI: 10.1016/j.jconhyd.2013.01.002.

APPENDIX A STATE BY STATE ENVIRONMENTAL REGULATORY AND REPORTING REQUIREMENTS

| | ALABAMA | ALASKA |
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| Agency issuing Underground Injection Control Permits | Billie Jean Wascher, Alabama Department of Environmental Management, Land Division - 334-271-7953, billiejean.wascher@adem.alabama.gov | Alaska Oil and Gas Conservation Commission, 333 W 7th Avenue, Suite 100, Anchorage, AK 99501; 907-279-1433; aogcc.customer.svc@alaska.gov |
| State Agency regulating wells producing water | ADEM regulates the drilling of production wells via the agency's Division 10 (Well Driller Licensing) regulation and Div 7 (Public Water Supply) regulation. | State of Alaska, Department of Natural Resources, Division of Mining, Land, and Water Resources Section, 550 West 7th Avenue, Suite 1020, Anchorage, AK 99501-3577, Tom Barrett, Chief of Water Resources 907-269-8645 |
| State agency regulating non-producing boreholes | ADEM does not regulate (from a well driller licensing standpoint) the drilling of boreholes. Soil and groundwater contamination sites are regulated by ADEM, but a drilling license is not required to install boreholes. | State of Alaska, Department of Natural Resources, Division of Mining, Land, and Water Resources Section, 550 West 7th Avenue, Suite 1020, Anchorage, AK 99501-3577, Tom Barrett, Chief of Water Resources 907-269-8645 |
| Other units of government if part of permit process | Production wells are only permitted by ADEM if the well serves as a "Public Water Supply". Alabama Dept of Public Health helps monitor private wells and the Geological Survey of Alabama maintains a database of private well locations. | Randy Bates, Director, Alaska Department of Environmental Conservation, Division of Water, PO Box 111800, Juneau, AK 99811, (907) 465-5180, randy.bates@alaska.gov |
| Open-loop permit requirements | UIC permit required. | Regulation 20 AAC 25.705 grants the Alaska Oil and Gas OGCC jurisdiction over all geothermal drilling and production activities conducted on all land in the state lawfully subject to its police powers, including Federal lands. Regulations 20 AAC 25.710 through 20 AAC 25.740 governs these activities. By reference, Permit to Drill application requirements for geothermal wells are specified in 20 AAC 25.005. |
| Closed-loop permit requirements | No UIC permit required. | Regulation 20 AAC 25.705 grants the Alaska Oil and Gas OGCC jurisdiction over all geothermal drilling and production activities conducted on all land in the state lawfully subject to its police powers, including Federal lands. Regulations 20 AAC 25.710 through 20 AAC 25.740 governs these activities. By reference, Permit to Drill application requirements for geothermal wells are specified in 20 AAC 25.005. |
| Closed-loop post-installation inspection/ reporting requirements | Unknown | Well logs must be submitted within 45 days of well completion |
| Open-loop post-installation inspection/ reporting requirements | As per UIC permit | Well logs must be submitted within 45 days of well completion |
| Open-loop driller license requirements | Not currently regulated under ADEM's Well Driller Licensing Requirements. | Alaska requires water well contractors and well service companies to have a general or subcontractor's license, but not to be specifically certified for well construction. |
| Closed-loop driller license requirements | Not currently regulated under ADEM's Well Driller Licensing Requirements. | Alaska requires water well contractors and well service companies to have a general or subcontractor's license, but not to be specifically certified for well construction. |
| Are out of state drillers allowed to perform work? | All wells drilled in Alabama must be drilled by a person holding an Alabama Well Driller License. Reciprocity to drillers from out of state will be considered on an individual basis. | No restriction on out-of-state drillers except that they must be well-control certified. See 20 AAC 25.527(d) http://www.akleg.gov/basis/aac.asp#20.25.527 . Also must follow International Association of Drilling Contractors Recommended Practices. See 20 AAC 25.710 http://www.akleg.gov/basis/aac.asp#20.25.710 , which by reference incorporates 20 AAC 25.527. |

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| Comments on driller continuing ed requirements | No continuing education requirements at this time. | Well-control certified. See 20 AAC 25.527(d) http://www.akleg.gov/basis/aac.asp#20.25.527 . Follow International Association of Drilling Contractors Recommended Practices. See 20 AAC 25.710 http://www.akleg.gov/basis/aac.asp#20.25.710 , which by reference incorporates 20 AAC 25.527.. |
| Additional Notes and Comments | None | AOGCC has regulatory authority over all wells drilled in search of, or in support of the recovery of, geothermal resources and has not yet regulated any such geexchange loop system |
| Additional information source(s) contact information | Jim Garassiano, PE, Chief, Compliance Assistance & Operator Certification Programs, ADEM, 334-279-3071 jgarassiano@adem.alabama.gov . Joe Kelly, JRK@adem.alabama.gov | Stephen Davies, Senior Petroleum Geologist, Alaska Oil and Gas Conservation Commission, 333 W 7th Avenue, Suite 100, Anchorage, AK 99501, 907-793-1224, steve.davies@alaska.gov ; http://dnr.alaska.gov/mlw/factsheetwtr_fs/Fact_Sheet |
| URL of state agencies | http://www.adem.alabama.gov | https://dec.alaska.gov/water.aspx ; AND http://dnr.alaska.gov/mlw/water/ ; AND https://www.commerce.alaska.gov/web/aogcc |

| | ARIZONA | ARKANSAS |
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| Agency issuing Underground Injection Control Permits | Luke Peterson, Aquifer Protection Permits, Arizona Department of Environmental Quality, 602-771-2322, peterson.luke@azdeq.gov. In future: Jerry Smith smit.jerry@azdeq.gov 602-771-4827 | Linda Hanson, ADEQ, Use Coordinator for State, Office of Water Quality, 501-682-0646, Hanson@ADEQ.state.AR.us |
| State Agency regulating wells producing water | AZ, Dept of Water Resources, Groundwater Permitting and Wells Section, Stella Murillo, Manager (602) 771-8594, samurillo@azwater.gov. Regulates Water Wells. | Arkansas Water Well Construction Commission, Arkansas Department of Agriculture, 1 Natural Resources Drive, Little Rock, AR 72205, 501-225-1598. info@agriculture.arkansas.gov. |
| State agency regulating non-producing boreholes | AZ Dept of Water Resources, 1110 Washington Street #310, Phoenix, AZ 85007, (602) 771-8500 | AR Department of Environmental Quality, 5301 Northshore Drive, North Little Rock, AR 72118-5317, 501-682-0744 |
| Other units of government if part of permit process | None | None |
| Open-loop permit requirements | Permit is required and wells must be registered at DWR | Construction reports are required on all wells. |
| Closed-loop permit requirements | Wells must be registered at DWR. | Construction reports are required on all wells. Class V Wells are "authorized" by the ADEQ. |
| Closed-loop post-installation inspection/ reporting requirements | None | Authorized Class V wells are inspected. |
| Open-loop post-installation inspection/ reporting requirements | None | Within 90 days after a water well has been constructed, constructor shall submit a report of construction to the Arkansas Water Well Construction Commission. |
| Open-loop driller license requirements | Need to have a AZ Water Well Drillers License. | Arkansas water well contractor license. Arkansas Registered Professional Engineers and Arkansas Registered Professional Geologists practicing geotechnical engineering or geologic investigations may be declared exempt from certification, bonding, and testing requirements upon application for exemption from the Commission. |
| Closed-loop driller license requirements | Need to have a AZ Water Well Drillers License. | Arkansas water well contractor license. Arkansas Registered Professional Engineers and Arkansas Registered Professional Geologists practicing geotechnical engineering or geologic investigations may be declared exempt from certification, bonding, and testing requirements upon application for exemption from the Commission. |
| Are out of state drillers allowed to perform work? | No, need to have a AZ Water Well Drillers License. | Any person who contracts for or is engaged in well construction or pump installation shall hold or be employed by a person holding an Arkansas Water Well Contractor License. |
| Comments on driller continuing ed requirements | No CE requirement | 6 CEUs required per licensing year. Additional 2 credits for each additional water well driller or pump installer employed by contractor. |
| Additional Notes and Comments | DWR regulates wells in the 5 active management areas (comprised of 5 metropolitan areas). Outside of these areas there are not regulated. | None |
| Additional information source(s) contact information | Aquifer Protection Permits 602-771-4999 | Jackie Broach, Administrative Analyst, Arkansas Department of Agriculture, Natural Resources Division, 101 E. Capitol, Suite 350, Little Rock, AR 72201 501-682-3900 Jackie.Broach@arkansas.gov; agriculture.arkansas.gov |

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| URL of state agencies | http://www.azwater.gov/azdwr/ ; AND http://www.azdeq.gov/node/5204 | www.arkansas.gov/awwcc/ ; AND http://www.adeq.state.ar.us/ ; AND https://www.agriculture.arkansas.gov/arkansas-water-well-construction-commission/information-for-licensed-contractors-and-permitees/ |
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| | CALIFORNIA | COLORADO |
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| Agency issuing Underground Injection Control Permits | Ken Harris, State Oil and Gas Supervisor, Natural Resources Agency, Department of Conservation, California Department of Oil, Gas and Geothermal Resources, 801K Street, MS 18-05, Sacramento, CA 95814, 916-323-1777, ken.harris@conservation.ca.gov; and US EPA Region 9 Office. In CA the State Water Resources Control Board & the Regional Water Quality | Omar Sierra-Lopez, Class V Well, U.S. EPA Region 8, (8WD-SDU), 1595 Wynkoop Street, Denver, CO 80202-1129, 303-312-7045, sierra-lopez.omar@epa.gov. |
| State Agency regulating wells producing water | Local enforcing agencies regulate water well construction, except for public supply wells (serving more than 200 service connections). Public supply wells are regulated by SWRCB Division of Drinking Water. The Water Boards have broad regulatory authority over groundwater protection in CA. In contaminated areas, the CA Dept of Toxic Substances Control has regulatory authority over wells. | Kevin Rein, State Engineer/Director Colorado Division of Water Resources, Department of Natural Resources, 1313 Sherman Street, Suite 821, Denver, CO 80203, 303-866-3581. |
| State agency regulating non-producing boreholes | These are treated as two different types in CA. Local agencies have authority but no mandate to regulate non-producing boreholes "exploratory borings" - some do and some don't. Per the CA Water Code, local agencies must regulate closed loops, which are referred to as "Geothermal Heat | Groundwater monitoring holes, monitoring wells, and test holes are subject to regulation by BOE and/or DWR |
| Other units of government if part of permit process | The Water Boards have broad regulatory authority over groundwater protection in California. In contaminated areas, the CA Department of Toxic Substances Control has regulatory authority over wells. | DWR is the only agency authorized to issue water well permits in Colorado. |
| Open-loop permit requirements | The requirements for open-loops are the same as for water wells. | State Engineer/DWR administers all geothermal resources. Form GWS-45 is used to apply for a permit to construct an open system. Geothermal open loops are installed by licensed water well contractors (not certified and permitted geothermal closed-loop |
| Closed-loop permit requirements | Local agencies set the permit process for closed loops. | All geothermal resources of the State of Colorado are administered by the State Engineer/DWR. Permits are only issued to qualified geoechange closed-loop installers. Prior to issuance of a permit, the applicant must become certified. Use Form GX-02 to apply for |
| Closed-loop post-installation inspection/ reporting requirements | Post-installation inspection/reporting for closed loops are the purview of the local enforcing agency. Reporting requirements are per the CA Water Code: a well completion report must be submitted to the State Department of Water Resources within | Where a well has been constructed in accordance with a well permit issued by the State Engineer that authorized construction of the well at any location within a specified tract of land, the well construction contractor must submit the Well Construction and Test |
| Open-loop post-installation inspection/ reporting requirements | Open-loop post-installation inspection/reporting requirements are the same as for water wells: The local agency has authority to conduct inspections and well completion reports must be submitted to the State Department of Water Resources within | Where a well has been constructed in accordance with a well permit issued by the State Engineer that authorized construction of the well at any location within a specified tract of land, the well construction contractor must submit the Well Construction and Test |
| Open-loop driller license requirements | Drillers for open loops must have a C-57 Water Well Driller's license from the CA Contractors State License Board. | Well drillers and pump installers in Colorado are required to maintain a current license as specified by the Board of Examiners Administration Rules (2CCR |
| Closed-loop driller license requirements | Per the Water Code, a C-57 license is required for closed-loops. | Well drillers and pump installers in Colorado are required to maintain a current license as specified by the Board of Examiners Administration Rules (2CCR |
| Are out of state drillers allowed to perform work? | Only if they have a C-57 license. | Only if they are licensed in Colorado. |
| Comments on driller continuing ed requirements | No continuing education is required | Board of Examiners requires 8 hours of continuing education annually for water well contractors. See BOE Administration Rules (2CCR-14) Rule 8. |
| Additional Notes and Comments | None | Colorado DNR Guide to Colorado Well Permits, Water Rights, and Water Administration - https://www.colorado.gov/pacific/sites/default/files/well |

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| Additional information source(s) contact information | Julie Haas, CA DWR - Julie.Haas@water.ca.gov; Michael Rohner, CA Water Board, Michael.Rohner@Waterboards.ca.gov | Questions about open-loop geothermal projects - Omar Sierra-Lopez, Physical Scientist, US EPA Region 8, 303-312-7045, sierra-lopez.omar@epa.gov. |
| URL of state agencies | https://www.conservation.ca.gov AND https://www.waterboards.ca.gov/ | https://dwr.colorado.gov/services/well-permitting ; AND https://dwr.colorado.gov/public-information/boards-and-commissions |

| | CONNECTICUT | DELAWARE |
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| Agency issuing Underground Injection Control Permits | Connecticut Department of Energy and Environmental Protection (CT DEEP) Central Permit Processing Unit, 79 Elm Street, Hartford, CT 06106-5127 | John Rebar, Program Manager, Ground Water Discharges Section, 89 Kings Highway, Dover, DE 19901, 302-739-9948 x9333, John.Rebar@delaware.gov |
| State Agency regulating wells producing water | Local Health Departments and Districts have the authority over private wells in their respective towns. Public Water Systems: CT Department of Public Health (CT DPH), Drinking Water Section, 410 Capitol Avenue, MS#12DWS, PO Box 340308, Hartford, CT 06134-0308 | Alan Pongratz, Branch Supervisor, State of Delaware, Division of Natural Resources and Environmental Control, Water Supply Section, Well Permits Branch, 302-739-9944, alan.pongratz@delaware.gov. |
| State agency regulating non-producing boreholes | Connecticut Department of Consumer Protection 450 Columbus Boulevard, Suite 901 Hartford, Connecticut 06103-1840 | Unknown |
| Other units of government if part of permit process | Connecticut Department of Consumer Protection is proposing new regulations for geothermal systems | For UIC permits the Water Supply has applicable regulations. Office of Drinking Water regulations may also apply. |
| Open-loop permit requirements | The Connecticut Department of Consumer Protection is proposing new regulations for geothermal systems | Before any well construction activities commence to install any well, the property owner or property owner's authorized agent must obtain the prior approval of the Department of Natural Resources and Environmental Control to construct the well in the form of a well permit. Also a UIC project. |
| Closed-loop permit requirements | Connecticut Department of Consumer Protection is proposing new regulations for geothermal systems | Not a UIC project. Before any well construction activities commence to install any well, the property owner or property owner's authorized agent must obtain the prior approval of the Department of Natural Resources and Environmental Control to construct the well in the form of a well permit. |
| Closed-loop post-installation inspection/ reporting requirements | Connecticut Department of Consumer Protection is proposing new regulations for geothermal systems | Not a UIC project. Upon completion of the well, the water well contractor shall submit to the Department a legible well completion report and formation log. |
| Open-loop post-installation inspection/ reporting requirements | Connecticut Department of Consumer Protection is proposing new regulations for geothermal systems | Upon completion of the well, the water well contractor shall submit to the Department a legible well completion report and formation log. Also a UIC project. |
| Open-loop driller license requirements | Well drillers must be licensed by the Department of Consumer Protection | All wells in Delaware must be constructed by a well driller or well driver licensed with State of Delaware, Division of Natural Resources and Environmental Control, Water Well Licensing Board. |
| Closed-loop driller license requirements | Well drillers must be licensed by the Department of Consumer Protection | All wells in Delaware must be constructed by a well driller or well driver licensed with State of Delaware, Division of Natural Resources and Environmental Control, Water Well Licensing Board. |
| Are out of state drillers allowed to perform work? | Well drillers must be licensed by the Department of Consumer Protection | All wells in Delaware must be constructed by a well driller or well driver licensed with State of Delaware, Division of Natural Resources and Environmental Control, Water Well Licensing Board. |
| Comments on driller continuing ed requirements | Unknown for well drillers. Section 2-2234d of the CT General Statutes requires plumbing license holders, with the exception of P-6 and P-7 plumber and piping license types, to obtain continuing education hours of instruction to renew their licenses. | Minimum of 4 continuing education hours required yearly. |

| | CONNECTICUT | DELAWARE |
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| Additional Notes and Comments | None | 7102 Regulations Governing Underground Injection Control http://regulations.delaware.gov/AdminCode/title7/7000/7100/7102.shtml |
| Additional information source(s) contact information | Richard Huiburt, Director, Department of Consumer Protection, Occupational & Professional Licensing Division, 450 Columbus Blvd, Suite 901, Hartford, CT 06103, 860-713-6135, dcp.occupationalprofessional@ct.gov ; Lori J. Mathieu, Public Health Branch Chief, Environmental Health & Drinking Water Branch, Connecticut State Department of Public Health, 410 Capitol Avenue, Hartford, CT 06134. Lori.mathieu@ct.gov , Cell: 860-305-1906. Ryan Tetreault, Supervising Environmental Analyst, Connecticut Department of Public Health | Kathy Potter, MS. Environmental Engineer, Groundwater Discharges Section, DNREC Div of Water Kathy.Potter@state.de.us 302-734-8682. |
| URL of state agencies | https://portal.ct.gov/dph ; AND https://portal.ct.gov/deep ; AND https://portal.ct.gov/DCP/Common-Elements/Consumer-Facts-and-Contacts/Water ; AND https://portal.ct.gov/DCP/License-Services-Division/All-c/License-Applications/Well-Drilling | https://dnrec.alpha.delaware.gov/water/supply/well-permits/ ; AND https://dnrec.alpha.delaware.gov/water/groundwater/ui |

| | FLORIDA | GEORGIA |
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| Agency issuing Underground Injection Control Permits | Cindy Fischler, Administrator, Aquifer Protection Program, Florida Department of Environmental Protection, 2600 Blair Stone Road, Mail Station 3530, Tallahassee, FL 32399-2400, 850-245-8658, Cindy.fischler@floridadep.gov | Edward Rooks, Georgia Environmental Protection Division, 2 MLK Jr. Drive S.E., Suite 1362 E, Atlanta, GA 30334-9000, 229-391-2409 edward.rooks@dnr.ga.gov |
| State Agency regulating wells producing water | Jamie Shakar, Aquifer Protection Program, Florida Department of Environmental Protection, 2600 Blair Stone Road, Mail Station 3500, Tallahassee, FL 32399-2400, 850-245-8626, Jamie.shakar@floridadep.gov | Abigail Knapp, Georgia Environmental Protection Division, 2 MLK Jr. Drive S.E., Suite 1362 E, Atlanta, GA 30334-9000, 404-463-0671 Abigail.Knapp@dnr.ga.gov |
| State agency regulating non-producing boreholes | Unknown | Unknown |
| Other units of government if part of permit process | Florida Department of Environment, Florida Water Management Districts (5), 3900 Commonwealth Boulevard MS 49, Tallahassee, FL 23299, 850-245-2118 | Peter Nwogu, Drinking Water Permitting. EPD, 2 Martin Luther King Jr. Drive SE, Suite 1456, East Tower Atlanta, GA 30334, 404-651-8427 |
| Open-loop permit requirements | Open-loop post-installation inspection/reporting required. | Open-Loop are prohibited |
| Closed-loop permit requirements | Florida Department of Environment, Florida Water Management Districts (5), 3900 Commonwealth Boulevard MS 49, Tallahassee, FL 23299, 850-245-2118 | Needs to be licensed driller. |
| Closed-loop post-installation inspection/ reporting requirements | Non-Major Class V wells are permitted through the FL Department of Environmental Protection district offices. These wells include domestic wastewater wells below the USDW, closed loop heat pump/ air conditioning return flow wells, swimming pool drainage wells, stormwater wells, and remediation wells. | None known. |
| Open-loop post-installation inspection/ reporting requirements | UIC Permits | Open-Loop are prohibited |
| Open-loop driller license requirements | Florida Well Driller's License required | Open-Loop are prohibited |
| Closed-loop driller license requirements | Florida Well Driller's License required | GA Well Driller's License required |
| Are out of state drillers allowed to perform work? | Florida Well Driller's License required | GA Well Driller's License required |
| Comments on driller continuing ed requirements | 12 hours of continuing education required. Regulated by Water Management District | 8 hours of continuing education is required every 2 years |
| Additional Notes and Comments | Drillers regulated by Florida Department of Environment, Florida Water Management District, 3900 Commonwealth Boulevard MS 49, Tallahassee, FL 23299, 850-245-2118; | None |
| Additional information source(s) contact information | Aquifer Protection Program, Florida Department of Environmental Protection, 2600 Blair Stone Road, Mail Station 3530, Tallahassee, Florida 32399-2400, 850-245-8655; Florida Water Well Contractors Continuing Education Program, Florida Water Well Administrator, 225 John Knox Road, Suite L 102, Tallahassee, FL | https://epd.georgia.gov/about-us/watershed-protection-branch |
| URL of state agencies | https://floridadep.gov/ | https://epd.georgia.gov/forms-permits/watershed-protection-branch-forms-permits/wastewater-permitting/underground-injection ; AND https://epd.georgia.gov/rules-laws-enforcement/existing-rules-and-corresponding-laws |

| | HAWAII | IDAHO |
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| Agency issuing Underground Injection Control Permits | Norris Uehara, State of Hawaii, Department of Health, Safe Drinking Water Branch, 808-586-4258 | Nathaniel Fischer, UIC Hydrogeologist, Idaho Department of Water Resources, PO Box 83720, Boise, ID 83720-0098, 208-287-4991, nate.fischer@idwr.idaho.gov |
| State Agency regulating wells producing water | Roy Hardy, Groundwater Program Manager, Hawaii State Commission on Water Resources Management, PO Box 621, Honolulu, Hawaii 96813 | Chad Hersley, Well Drillers Regulations, 208-287-4930 chad.hersley@idwr.idaho.gov |
| State agency regulating non-producing boreholes | Norris Uehara, State of Hawaii, Department of Health, Safe Drinking Water Branch, 808-586-4258 | Local municipalities may have additional requirements. |
| Other units of government if part of permit process | Department of Land & Natural Resources, Land Division; Division of Historic Preservation; Office of Conservation and Coastal Lands, Land Use Commission, County Planning Department, County Water Department (Oahu and Maui only). | Local municipalities may have additional requirements. |
| Open-loop permit requirements | UIC Permit required by State Dept of Health, Geothermal permit required by State Department of Land & Natural Resources. | Yes, required if wells are deeper than 18 feet. |
| Closed-loop permit requirements | Geothermal permit required by State Department of Land & Natural Resources | Yes, required if wells are deeper than 18 feet. |
| Closed-loop post-installation inspection/ reporting requirements | Within 60 days after the completion of the construction, modification, or repair of a well, the permittee shall file with the Commission, a well construction report and for all permanent pumps, a pump installation report. | File a well log with IDWR |
| Open-loop post-installation inspection/ reporting | Within 60 days after the completion of the construction, modification, or repair of a well, the permittee shall file with the Commission, a well construction report and for all permanent pumps, a pump installation report. | File a well log with IDWR |
| Open-loop driller license requirements | A General Engineering Contractor License or a Injection Well (C-57b) License or a Well Contractor (C-57) License is required | Well Driller's License required |
| Closed-loop driller license requirements | A General Engineering Contractor License or a Injection Well (C-57b) License or a Well Contractor (C-57) License is required | Yes, required if wells are deeper than 18 feet. |
| Are out of state drillers allowed to perform work? | Must have a C-57 license through State Department Of Commerce & Consumer Affairs. | Must have well driller license from IDWR |
| Comments on driller continuing ed requirements | None | 12 Continuing Education Units (CEUs) are required during 2-year period, two CEUs must be Idaho Rules & Regs. |
| Additional Notes and Comments | UIC Program is regulated under Hawaii Administrative Rules Title 11, Department of Health, Chapter 23. See Amendment http://health.hawaii.gov/opppd/files/2015/06/11-23appa.pdf . Geothermal wells must meet permit requirements Department of Land and Natural Resources, Engineering Division, Title 13 Chapter 183 Rules. The Commission on Water Resources Management doesn't require a permit for geothermal wells. DNLR Hawaii Well Construction & Pump Installation Standards Handbook https://files.hawaii.gov/dlnr/cwrm/regulations/hwcpis04.pdf ; | Continuing Education Required per IDAPA Rule 37.01.10-Well Driller Licensing Rules. The Idaho Groundwater Association (IGWA) is responsible for the continuing education program. |
| Additional information source(s) contact information | None | Erik Boe, Section Mgr, Ground Water Protection, Idaho Dept of Water Resources, 322 East Front Street, PO Box 8370, Boise, ID 83720, 208-287-4800, erik.boe@idwr.idaho.gov. IGWA Continuing Education contact 208-381-0294, info@igwa.info. |
| URL of state agencies | http://health.hawaii.gov/ ; AND https://dlnr.hawaii.gov/idwr/ ; AND http://luc.hawaii.gov/ ; AND http://doh.hawaii.gov/bul/bocde/contractor | https://idwr.idaho.gov/wells/deep-injection-wells.html AND http://idwr.idaho.gov/wells/driller-licensing.html |

| | ILLINOIS | INDIANA |
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| Agency issuing Underground Injection Control Permits | Rhett Rossi, Environmental Protection Agency, 1021 North Grand Avenue, Springfield, IL 62794, 217-782-9283, Rhett.Rossi@illinois.gov | Ross Micham, UIC Branch, U.S. EPA Region 5, 312-886-4237, micham.ross@epa.gov |
| State Agency regulating wells producing water | Illinois Department of Public Health/County Health Departments, Illinois Environmental Protection Agency - Community Water Supply Wells, David Cook, 217-782-1724 | IN Dept of Natural Resource, 402 West Washington Street, Indianapolis, IN 46204.GWSection@idem.IN.gov, WaterQualityEDF@idem.IN.gov. http://www.in.gov/dnr/ |
| State agency regulating non-producing boreholes | Same agency that issued the permit to construct | IN Dept of Natural Resource, 402 West Washington Street, Indianapolis, IN 46204, http://www.in.gov/dnr/ |
| Other units of government if part of permit process | None | Lucio Ternieden, Section Chief, Lternieden@idem.IN.gov. 21 Counties have a well ordinance and some municipalities also regulate water wells. |
| Open-loop permit requirements | UIC Requirements, minimum of submission of Class V injection well inventory information. Permit required by Illinois Dept of Public Health and County Health Department. | Not at State level, some on County level. |
| Closed-loop permit requirements | Permit required by Illinois Dept of Public Health and County Health Department. | Not at State level, some on County level. |
| Closed-loop post-installation inspection/ reporting requirements | Well Construction Report must be submitted with Illinois Dept of Public Health and County Health Department. | Not that DNR is aware of |
| Open-loop post-installation inspection/ reporting requirements | Well Construction Report must be submitted with Illinois Dept of Public Health and County Health Department. | Not that DNR is aware of |
| Open-loop driller license requirements | Must have IL Water Well Contractor's License | IN Water Well Drilling license required |
| Closed-loop driller license requirements | Must have IL Water Well Contractor's License and State Closed Loop Certification | IN Water Well Drilling license required |
| Are out of state drillers allowed to perform work? | Contact Illinois Dept of Public Health | Must have IN Water Well Driller License |
| Comments on driller continuing ed requirements | Required-to attend atleast one continuing education session consisting of of 6 classroom contact hours in a two-year period. Class must be approved by Illinois Dept of Public Health | A well driller who has held a well driller license for at least one calendar year must complete at least 6 hours of approved continuing education during each two year cycle to be eligible for license renewal. |

| | ILLINOIS | INDIANA |
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| Additional Notes and Comments | Water wells are regulated pursuant to the Illinois Water Well Construction Code 77 Ill. Adm. Code 920. Community water supply wells are permitted pursuant to 35 Ill. Adm. Code 602 and 604; Water Well and Pump Installation Contractor's License Act - http://www.idph.state.il.us/envhealth/pdf/915WaterWellandPumpInstallationContractorLicenseCodeAndAct04102014.pdf | See 312 Indiana Admin. Code 13-8-1 for Rule 8. Other Wells and Structures for Geothermal heat pump wells |
| Additional information source(s) contact information | Michael Summers, 217-782-1-20, michael.summers@illinois.gov , Charles W Jones, 217-557-7964, charles.w.jones@illinois.gov . Rick Cobb, 217-524-5377, rick.cobb@illinois.gov ; | Monique Riggs, IN Department of Natural Resources, Water Rights & Use, Division of Water, 402W Washington St, Rom: W264, Indianapolis, IN 46204, 317-234-1085, mriggs@dnr.in.gov . Indiana Department of Environmental Management Office of Water Quality 100 North Senate Avenue Indianapolis, IN 46204 (317) 234-7430 |
| URL of state agencies | https://www2.illinois.gov/epa/topics/waste-management/Pages/underground-injection-control.aspx ; AND http://www.idph.state.il.us/envhealth/waterwells.htm ; AND http://www.dph.illinois.gov ; AND https://www2.illinois.gov/epa/topics/forms/water- | https://www.in.gov/idem/cleanwater/ ; AND https://www.in.gov/idem/5221.htm ; AND http://www.in.gov/dnr/water/ |

| | IOWA | KANSAS |
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| Agency issuing Underground Injection Control Permits | Benjamin Meissner, US EPA Region 7, Water, Wetlands & Pesticides Division, 11201 Renner Boulevard, Lenexa KS 66219, 913-551-7992, Meissner.Benjamin@epa.gov | Kansas Department of Health and Environment, Bureau of Water, Geology & Well Technology Unit, Underground Injection Control (UIC) Program (KDHE/BOW/GWTU). 1000 SW Jackson St., Suite 420, Topeka, KS 66612-1367; Carrie Ridley, Chief, GWTU, 785-296-5560, Carrie.Ridley@ks.gov. Sue Ann Funk, UIC Class V, 785-296-6803, sue.funk@ks.gov |
| State Agency regulating wells producing water | Russell Tell, Environmental Specialist Senior, Iowa Department of Natural Resources, Wallace State Office Building, 502 E 9th Street, Des Moines, IA 50319-0034, 515-725-0642, russell.tell@dnr.iowa.gov | Kansas Department of Agriculture, Division of Water Resources (DWR), 785-564-6640; Chris Beightel, Acting Chief Engineer & Water Management Services Program Manager; Terry Medley, Water Structures Program Manager; Lane Letourneau, Water Appropriations Program Manager. |
| State agency regulating non-producing boreholes | Russell Tell, Environmental Specialist Senior, Iowa Department of Natural Resources, Wallace State Office Building, 502 E 9th Street, Des Moines, IA 50319-0034, 515-725-0642, russell.tell@dnr.iowa.gov | Pam Chaffee, Geologist, water well Program mgr., Geology & Well Technology, KDHE/BOW/GWTU/Water Well Program, 1000 SW Jackson St., Ste 420, Topeka, KS 66612-1367 785-296-2565 Pam.Chaffee@ks.gov |
| Other units of government if part of permit process | The UIC program in Iowa is a dual track in that both EPA and IDNR have authorities over injection wells in the state. People who plan on installing an injection well need to contact both the state and EPA to seek approval of projects before they begin installation of those injection systems. If either EPA or IDNR do not approve an injection project, it may not go into operation. | Don Carlson, Chief, 785-296-5547, don.carlson@ks.gov, KDHE/BOW/Water Permitting & Compliance Section/Industrial Programs Unit-NPDES & Stormwater, 1000 SW Jackson St., Suite 420, Topeka, KS 66612-1367. |
| Open-loop permit requirements | All closed loop systems that are 20 feet or greater in depth and all open loop systems require the issuance of a private well construction permit before any loop drilling, trenching, or boring takes place. | To extract water, permit required from DWR and possibly from local entity (GMD), To discharge water to surface, permit may be required from local entity and/or KDHE/BOW Industrial Programs Unit. |
| Closed-loop permit requirements | All closed loop systems that are 20 feet or greater in depth and all open loop systems require the issuance of a private well construction permit before any loop drilling, trenching, or boring takes place. | No state permit required. Local permit may be required.KDHE/BOW/GTWU Procedure for Geothermal Closed Loop Heat Pump Systems Using Vertical Boreholes (Procedure #WWP-8). |
| Closed-loop post-installation inspection/ reporting requirements | Filing of well log is a requirement in Iowa for all new well construction. | Water well record (WWC-5 Form) required within 30-days of installation. Local requirements may apply. |
| Open-loop post-installation inspection/ reporting requirements | Filing of well log is a requirement in Iowa for all new well construction. | Water well record (WWC-5 Form) required within 30-days of installation. Local requirements may apply. |
| Open-loop driller license requirements | Iowa DNR Certified Well Contractor (http://www.iowadnr.gov/Environmental-Protection/Water-Quality/Private-Well-Program/Contractor-Certification) | Water well contractors must be licensed to construct, reconstruct, and treat water wells, including open-loop heat-exchange wells in accordance with minimum standards for water well construction, reconstruction, and plugging in Article 30 (K.A.R. 28-20-2, et seq.). |

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| Closed-loop driller license requirements | Iowa DNR Certified Well Contractor | Water well contractors must be licensed to install closed-loop heat-exchange systems in accordance with minimum standards in Article 30 (K.A.R. 28-30-2, et seq.). |
| Are out of state drillers allowed to perform work? | Must have Iowa DNR Well Contractor License and will need to post a surety bond to work within Iowa's borders. | Must have Kansas Well Drilling License. |
| Comments on driller continuing ed requirements | 1.6 qualifying CEUs or 16 contact hours every two years is required. | Driller must complete 8 hours of continuing education units and submit them for approval by the Education Committee in care of the KGWA. Once approved, a report is sent to the Kansas Department of Health and Environment for the license renewal. A fee of \$10 per CEU is required to process the requests for approval. |
| Additional Notes and Comments | Iowa DNR is developing a new general permit. This permit would authorize discharges from the following activities: Excavation dewatering associated with construction activity, Temporary groundwater dewatering to facilitate construction activity, Residential open-loop geothermal heating and cooling systems (8/26/16) | To discharge below ground, Inventory Report is required to be submitted to KDHE/BOW/GWTU/UIC Class V: https://www.kdheks.gov/uic/download/CVHeatAC.pdf . Procedure for Geothermal Closed Loop Heat Pump Systems Using Vertical Boreholes (Procedure #WWP-8) at https://www.kdheks.gov/waterwell/download/WWP-8.pdf . Local requirements may apply for required |
| Additional information source(s) contact information | Kurt Hildebrandt, US EPA Region 7, Water, Wetlands & Pesticides Division, 11201 Renner Boulevard, Lenexa KS 66219, 913-551-7413, hildebrandt.kurt@epa.gov ; Laurie Sharp, Well Contractor Certification Program, Wallace State Office Bldg, 502E 9th Street, Des Moines, IA 50319-0034, laurie.sharp@dnr.iowa.gov | Local governmental entities may include: cities, counties, groundwater management districts (GMDs), and local environmental protection programs (LEPPs). Rachel Marlett, 785-296-8501, Rachel.marlett@ks.gov , and Katie Basiotis, 785-296-5558, Katie.basiotis@ks.gov . County Sanitarians and LEPPs, KDHE/Environmental Field Services/Watershed Management Section/LEPP |
| URL of state agencies | https://www.epa.gov/aboutepa/epa-region-7-midwest ; AND https://www.iowadnr.gov/Environmental-Protection/Water-Quality/Private-Well-Program/Contractor-Certification ; AND https://www.iowadnr.gov/Environmental-Protection/Water-Quality/Private-Well-Program/Contractor-Certification | https://www.kdheks.gov/waterwell/ ; AND https://kgwa.org/ceus/ |

| | KENTUCKY | LOUISIANA |
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| Agency issuing Underground Injection Control Permits | Robert Olive, GW/UIC, US EPA Region 4, 61 Forsyth Street SW, Atlanta, GA 30303-8960, 404-562-9423, olive.robert@epa.gov. Issues permits and other authorizations for UIC Class 1, 3, and 6 wells. | Steve Lee, Direction, Injection & Mining Division, Louisiana Department of Natural Resources, Office of Conservation, PO Box 94275, 225-342-5569, stephen.lee@la.gov |
| State Agency regulating wells producing water | Scotty Robertson, Commonwealth of Kentucky Energy & Environment Cabinet, Kentucky DEP, Division of Water, Water Well Drillers Certification Program Coordinator, Watershed Management Branch, 300 Sower Boulevard, 3 rd Fl. Frankfort, KY 40601, 502-782-7054, scotty.robertson@ky.gov | State of Louisiana, Department of Natural Resources, Office of Conservation, Ground Water Resources Program, PO Box 94275, Baton Rouge, LA 70804, 225-342-8244. |
| State agency regulating non-producing boreholes | Scotty Robertson, Commonwealth of Kentucky Energy & Environment Cabinet, Kentucky DEP, Division of Water, Water Well Drillers Certification Program Coordinator, Watershed Management Branch, 300 Sower Boulevard, 3 rd Fl. Frankfort, KY 40601, 502-782-7054, scotty.robertson@ky.gov | State of Louisiana, Department of Natural Resources, Office of Conservation, Ground Water Resources Program, PO Box 94275, Baton Rouge, LA 70804, 225-342-8244. |
| Other units of government if part of permit process | If water well is Public or Semi-Public, water well may need Drinking Water Permit 401 KAR Chapter 8, Water Withdrawal Permit if more than 10,000 gpd used 401 KAR Chapter 4, Wellhead Protection Plans, Groundwater Protection Plan 401 KAR 5:037, Commonwealth of Kentucky Energy and Environment Cabinet, DEP, Division of Water, Water Well Drillers Certification Program Coordinator, Watershed Management Branch, 300 Sower Boulevard, 3rd floor, Frankfort, KY 40601. Robert.Blair@ky.gov, Chloe.Brently@ky.gov and Adam.Nolte@ky.gov. | None |
| Open-loop permit requirements | EPA Region 4 UIC program, Robert Olive authorizes injection of open-loop injection wells. May be additional Kentucky requirements, possible permits required by other agencies. Open loop vertical geoexchange wells fall under Kentuckys Statute KRS 223.400. Well driller must install and report well, Driller needs Groundwater Protection Plan 401 KAR 5:037 and if discharge to surface water may need KPDES permit 401 KAR Chapter 5. Plumbing and construction permits maybe required by other agencies. | Must complete State of Louisiana Office of Conservation Form GR-10-1 (Application for Permit) |
| Closed-loop permit requirements | No permit required from Kentucky Division of Water, but plumbing and construction permits maybe required by other agencies. Driller needs Groundwater Protection Plan 401 KAR 5:037 Adam.Nolte@ky.gov | Must complete State of Louisiana Office of Conservation Form GR-10-1 (Application for Permit) |
| Closed-loop post-installation inspection/ reporting requirements | Not Required | The contractor who drills a well or hole shall complete and submit to the department the original copy of the Water Well Registration Form within 30 calendar days after each well or hole has been completed. |
| Open-loop post-installation inspection/ reporting requirements | Commonwealth of Kentucky Energy and Environment Cabinet, DEP, Division of Water, Water Well Drillers Certification Program Coordinator, Watershed Management Branch, 300 Sower Boulevard, 3rd floor, Frankfort, KY 40601, 502-782-7054, scotty.robertson@ky.gov Certified water well driller must file report of open-well loop within 60 days of construction to the Kentucky Division of Water per Kentucky Administrative Regulation 401 KAR6:310. | The contractor who drills a well or hole shall complete and submit to the department the original copy of the Water Well Registration Form within 30 calendar days after each well or hole has been completed. |

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| Open-loop driller license requirements | Water well driller certification required 401 KAR 6:320 Commonwealth of Kentucky Energy and Environment Cabinet, Department of Environmental Protection, Division of Water. | Must be licensed with the Louisiana Department of Natural Resources. |
| Closed-loop driller license requirements | No license required by Kentucky Division of Water at this time. | Must be licensed with the Louisiana Department of Natural Resources. |
| Are out of state drillers allowed to perform work? | If they obtain Water Well Drillers Certification per 401 KAR 6:320 Commonwealth of Kentucky Energy and Environment Cabinet, Department of Environmental Protection, Division of Water, Water Well Drillers Certification Program Coordinator, Watershed Management Branch, 300 Sower Boulevard, 3rd floor, Frankfort, KY 40601, 502-782-7054, scotty.robertson@ky.gov | The department, upon receipt of an application and the required license fee, will issue a license to any person, firm or corporation who holds a valid driller's license from any other state, provided the standards under which the license was issued are at least equivalent to those of Louisiana and provided that the state which issued the license will accord similar privileges to the licensed Louisiana drillers who may wish to apply for a license from that state. |
| Comments on driller continuing ed requirements | Water Well Drillers Certification per 401 KAR 6:320, 5 hours required per year for Water Well Driller, 8 hours required for Water Well Drillers Assistant. | 6 hours of continuing education required annually |
| Additional Notes and Comments | Driller may need Groundwater Protection Plan 401 KAR 5:037. | None |
| Additional information source(s) contact information | Kenya Stump, Assistant Director, Kentucky Department for Energy Development and Independence, Division of Renewable Energy, 500 Mero Street, 12th Floor, Frankfort, KY 40601, 502-782-7083, kenya.stump@ky.gov. | Well Driller License Questions - Nicholas Kien, Louisiana Department of Natural Resources, 225-342-5724. |
| URL of state agencies | https://apps.legislature.ky.gov/law/statutes/statute.aspx?id=48579 ; AND https://apps.legislature.ky.gov/law/statutes/statute.aspx?id=48580 ; AND https://eec.ky.gov/Environmental-Protection/Water/GW/Pages/GWDrillers.aspx | http://www.dnr.louisiana.gov/index.cfm?md=pagebuilder&tmp=home&pid=141&pnid=29&nid=81 ; AND http://www.dnr.louisiana.gov/index.cfm?md=pagebuilder&tmp=home&pid=1217 |

| | MAINE | MARYLAND |
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| Agency issuing Underground Injection Control Permits | Cindy Dionne, Maine Department of Environmental Protection, Division of Water Quality Management, Cindy.L.Dionne@maine.gov | Dr. Ching-Tzone Tien, Chief, Groundwater Permits Division, Water Management Administration, Maryland Department of the Environment, 1800 Washington Boulevard, Baltimore, MD 21230, 410-537-3662, Cell 443-798-4312 chin-tzone.tien@maryland.gov |
| State Agency regulating wells producing water | Cindy Dionne, Maine Department of Environmental Protection, Division of Water Quality Management, Cindy.L.Dionne@maine.gov | Dr. Ching-Tzone Tien, Chief, Groundwater Permits Division, Water Management Administration, Maryland Department of the Environment, 1800 Washington Boulevard, Baltimore, MD 21230, 410-537-3662, chin-tzone.tien@maryland.gov |
| State agency regulating non-producing boreholes | Cindy Dionne, Maine Department of Environmental Protection, Division of Water Quality Management, Cindy.L.Dionne@maine.gov | Maryland Department of the Environment |
| Other units of government if part of permit process | Maine Well Drillers Commission. | The State Board of Well Drillers, Local Health Departments and other local Permitting Agencies (Approving Authorities) are delegated authority by MDE to enforce the State's water well construction regulations. |
| Open-loop permit requirements | Class V wells are authorized by rule provided they are registered with the DEP. (Must follow the rule requirements and register the well using a special form.) | To obtain a well construction permit, a licensed well driller submits an application to the local County Approving Authority. |
| Closed-loop permit requirements | Class V wells are authorized by rule provided they are registered with the DEP. (Must follow the rule requirements and register the well using a special form.) | To obtain a well construction permit, a licensed well driller submits an application to the local County Approving Authority. |
| Closed-loop post-installation inspection/ reporting requirements | Class V wells are authorized by rule provided they are registered with the DEP. (Must follow the rule requirements and register the well using a special form.) | Driller must submit post-installation Well Completion Report to the Approving Authority. If the well is to be used as a potable water supply, a Certificate of Potability (COP) is required before it is put into service. A COP is issued after a series of laboratory tests indicate the water is safe for human consumption. Contact jurisdiction's local Approving Authority for well permitting or the Onsite Systems Division. |
| Open-loop post-installation inspection/ reporting requirements | Class V wells are authorized by rule provided they are registered with the DEP. (Must follow the rule requirements and register the well using a special form.) | Driller must submit post-installation Well Completion Report to the Approving Authority. If the well is to be used as a potable water supply, a Certificate of Potability (COP) is required before it is put into service. A COP is issued after a series of laboratory tests indicate the water is safe for human consumption. Contact jurisdiction's local Approving Authority for well |
| Open-loop driller license requirements | Must be licensed with the Maine Well Drillers Commission | Must be licensed with Maryland State Board of Well Drillers |
| Closed-loop driller license requirements | Must be licensed with the Maine Well Drillers Commission | Must be licensed with Maryland State Board of Well Drillers |
| Are out of state drillers allowed to perform work? | Must have a Maine license for the work proposed. | Must have Maryland well drillers license. |
| Comments on driller continuing ed requirements | Not required. | 20 hours of continuing education are required every two years. |

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| Additional Notes and Comments | As of March 21, 2017, the ME Well Drillers Commission has advised licensees that the Internal Plumbing Code does not allow the use of a potable water source (well) for the disposal of the return water from an open-loop system. A second well for return water is required per the Internal Plumbing Code. | Local Health Departments and other local Permitting Agencies (Approving Authorities) are delegated authority by MDE. |
| Additional information source(s) contact information | Enid Mitnik, enid.mitnik@maine.gov, ME DEP, Bureau of Water Quality, Underground Injection Control, 17 Sate House Station, Augusta, ME 04333. 207-592-2068 | Contact the Maryland Department of the Environment at (410) 537-3784 for additional questions about construction of wells in the State of Maryland. For Continuing Education questions, contact Duane Johnson, The State Board of Well Drillers, 1800 Washington Blvd, Baltimore, WA 21230 |
| URL of state agencies | http://www.maine.gov/dep/ ; AND http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/professionals/wellDrillers.shtml | https://mde.maryland.gov/programs/Permits/EnvironmentalBoards/Pages/boardofwelldrillers.aspx ; AND https://mde.state.md.us/programs/water/BayRestorationFund/OnsiteDisposalSystems/Pages/WellConstruction.aspx |

| | MASSACHUSETTS | MICHIGAN |
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| Agency issuing Underground Injection Control Permits | Joe Cerutti, Massachusetts Department of Environmental Protection (MassDEP), UIC Program/Drinking Water Program, 1 Winter Street, 5th Floor, Boston, MA 02108, 617-292-5859, joseph.cerutti@mass.gov | Michigan Department of Environment, Great Lakes, and Energy P.O. Box 30241 517-284-6526 or 517-898-3589 |
| State Agency regulating wells producing water | Duane LeVangie, MassDEP Water Management Act Program, 1 Winter Street, 5th Floor, Boston, MA 02108, 617-292-5706, duane.levangie@mass.gov | David DeYoung, Michigan Department of Environmental Quality to Michigan Department of Environment, Great Lakes, and Energy PO Box 30241, Lansing, MI 48909, 517-284-6526, devounad@michigan.gov |
| State agency regulating non-producing boreholes | The closed-loop wells must be drilled by a MassDEP Certified Well Driller. | Closed-loops associated with a GHPS are not regulated under the state well code, regulated by counties. |
| Other units of government if part of permit process | Local board of health/health department | Local health departments |
| Open-loop permit requirements | Local well drilling permit required by board of health/health department and MassDEP UIC Registration application submitted for all geo-exchange systems except single family homes. | Well construction permit issued by the local health department. Depending on the particular GHPS design, additional permits may be needed from the Department of Environmental Quality (DEQ). |
| Closed-loop permit requirements | Local well drilling permit may be required by board of health/health department. | Well construction permit issued by the local health department. Depending on the particular GHPS design, additional permits may be needed from the Department of Environmental Quality (DEQ). |
| Closed-loop post-installation inspection/ reporting requirements | Well driller must submit a Well Completion Report to MassDEP Well Driller Program and local board of health/health department. | Not regulated by state, but by counties. |
| Open-loop post-installation inspection/ reporting requirements | Well driller must submit a Well Completion Report to MassDEP Well Driller Program and local board of health/health department. MassDEP UIC program requires submittal of water quality laboratory test results. | Inspection done after installation by local health department. |
| Open-loop driller license requirements | Steve Hallem, MassDEP Well Driller Program, 1 Winter Street, 5th Floor, Boston, MA 02108, 617-292-5681, stephen.hallem@mass.gov | Must be registered with Michigan Department of Environment, Great Lakes, and Energy (EGLE) |
| Closed-loop driller license requirements | Steve Hallem, MassDEP Well Driller Program, 1 Winter Street, 5th Floor, Boston, MA 02108, 617-292-5681, stephen.hallem@mass.gov | Closed-loop driller license requirements-EGLE Certificate of Registration is not required. Counties may have requirements. |
| Are out of state drillers allowed to perform work? | Yes, but must be MassDEP Certified Well Driller. | Out of state drillers must first be licensed/registered in another state to apply for Michigan registration. |
| Comments on driller continuing ed requirements | Not required. | Not required. Must make annual payment of \$40.00. |
| Additional Notes and Comments | MassDEP Guidelines for Ground Source Heat Pump Wells specifies recommended PE license/other training qualifications for the designer of the geoexchange systems, https://www.mass.gov/files/documents/2016/08/ot/gshpguid.pdf . | See url for Michigan Best Practices for Geothermal Vertical Closed-Loop Installations. Michigan is not a UIC primacy state. The federal UIC program is implemented directly by the U.S. Environmental Protection Agency, Region V, Chicago, Illinois. |
| Additional information source(s) contact information | None | None |
| URL of state agencies | https://www.mass.gov/underground-injection-control-uic ; AND https://northeastgeo.com/massachusetts-permitting/ | https://www.michigan.gov/egle/0,9429,7-135-3313_3675_3694-304596--,00.html ; AND https://www.michigan.gov/statelicensesearch/0,4671,7-180-24786-81634--,00.html |

| | MINNESOTA | MISSISSIPPI |
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| Agency issuing Underground Injection Control | Ross Micham, UIC Branch, U.S. EPA Region 5, 312-886-4237, micham.ross@epa.gov | Jimmy Sparks, Mississippi Department of Environmental Quality, UIC Program Manager, PO Box 2261, Jackson, MS 39225, 601-961-5640, |
| State Agency regulating wells producing water | Minnesota Department of Health, Well Management Section, 651-201-4600 625 North Robert Street, PO Box 64975, St. Paul, MN 55164-0975, health.wells@state.mn.us | Jimmy Sparks, Mississippi Department of Environmental Quality, Office of Land and Water Resources, PO Box 2309, Jackson, MS 39225, 601-961-5555. |
| State agency regulating non-producing boreholes | Minnesota Department of Health, Well Management Section, 651-201-4600 625 North Robert Street, PO Box 64975, St. Paul, MN 55164-0975, health.wells@state.mn.us | Mississippi Department of Environmental Quality |
| Other units of government if part of permit process | None | None |
| Open-loop permit requirements | Effective January 1, 2015, the DNR is not allowed to issue a permit for any new once-through geothermal system (i.e. those that use between 1 and 5 MGY). The law was changed by the 2014 Legislature. Existing once-through systems may not be expanded and must convert to water-efficient alternatives within the design life of existing equipment. An open-loop geothermal system does not meet the definition of a groundwater thermal exchange device or a bored geothermal heat exchanger, and thus is not regulated by MDH | Permit required from Mississippi DEQ Permit Board |
| Closed-loop permit requirements | Permit required by Minnesota Department of Health. Systems withdrawing more than 10,000 gallons per day (e.g., 6.9 g.p.m. continuous operation for 24 hours) or 1 million gallons per year (e.g., 1.9 g.p.m. continuous operation for 365 days) requires an appropriations permit from the Minnesota Department of Natural Resources. For more information, email Water Appropriations Permit Program at mpars.dnr@state.mn.us . | Permit required from Mississippi DEQ Permit Board |
| Closed-loop post-installation inspection/ reporting requirements | A construction record must be submitted within 60 days of construction, and the stipulations outlined on the permit must be met. | Must complete and file State Well Report Form with Mississippi DEQ Office of Land and Water Resources within 30 days of completion of drilling of the well or borehole. |
| Open-loop post-installation inspection/ reporting requirements | Not regulated by MDH, so not applicable. | Must complete and file State Well Report Form with Mississippi DEQ Office of Land and Water Resources within 30 days of completion of drilling of the well or borehole. |
| Open-loop driller license requirements | Not regulated by MDH, so not applicable. | Individuals desiring to engage in the business of water well contracting must file an application for a water well driller's license with the Office of Land and Water Resources. Individuals desiring to engage in other businesses that require drilling of boreholes or wells (other than water supply wells) may file an application for a restricted driller's license. |
| Closed-loop driller license requirements | Licensed by Minnesota Department of Health. | Individuals desiring to engage in the business of water well contracting must file an application for a water well driller's license with the Office of Land and Water Resources. Individuals desiring to engage in other businesses that require drilling of boreholes or wells (other than water supply wells) may file an application for a restricted driller's license. |
| Are out of state drillers allowed to perform work? | Yes, as long as the contractor is licensed to do work in Minnesota. | Contact Office of Land and Water Resources to complete application. |

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| Comments on driller continuing ed requirements | 2 hours of continuing education are required for annual license renewal. | 4 hours of continuing education are required each year in order to maintain license |
| Additional Notes and Comments | A bored geothermal heat exchanger must be installed by a well contractor or bored geothermal heat exchanger contractor licensed by the Minnesota Dept. of Health. | Mississippi DEQ Surface Water and Groundwater Use and Protection Regulations, Part 7, Chapter 1- https://www.mdeq.ms.gov/wp-content/uploads/2017/06/11-Miss.-Admin.-Code-Pt.-7- |
| Additional information source(s) contact information | Kara Dennis, Minnesota Department of Health, Well Management, 651-201-4589, 626 North Robert Street, St. Paul, MN 55155-2538, kara.dennis@state.mn.us , Norm McField, MDH, Well | Water well contractor information - Office of Land and Water Resources |
| URL of state agencies | https://www.health.state.mn.us/communities/environment/water/wells/construction/dnrapproval.html AND https://www.dnr.state.mn.us/waters/watermgmt_section/appropriations/permits.html | https://www.mdeq.ms.gov/permits/water-well-drillers/ ; AND https://www.mdeq.ms.gov/water/ ; AND https://www.epa.gov/uic/underground-injection-control-epa-region-4-al-fl-ga-ky-ms-nc-sc-and-tn#primacy |

| | MISSOURI | MONTANA |
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| Agency issuing Underground Injection Control Permits | Water Protection Program, Missouri Department of Natural Resources, PO Box 176, Jefferson City, MO 65102, 800-361-4827, 573-751-1300. | Omar Sierra-Lopez, Underground Injection Control Program, Class V Well, U.S. EPA Region 8, (8WP-SUI), 1595 Wynkoop Street, Denver, CO 80202-1129, 303-312-7045, sierra-lopez.omar@epa.gov |
| State Agency regulating wells producing water | Well Installation Section, Department of Natural Resources, Missouri Geological Survey, 111 Fairgrounds Road, Rolla, MO 65401, 573-368-2165, welldrillers@dnr.mo.gov | The Environmental Protection Agency only regulates open loop ground source heat pumps. If proposed heat pump system does not need a permit, the system will be "rule authorized." Also regulated by Montana Department of Natural Resources and Conservation, 1424 Ninth Avenue, Helena MT 59620-1601, 406-444-2074 and Montana Department of Environmental Quality (if discharge). |
| State agency regulating non-producing boreholes | Well Installation Section, Department of Natural Resources, Missouri Geological Survey, 111 Fairgrounds Road, Rolla, MO 65401, 573-368-2165, welldrillers@dnr.mo.gov | Not regulated by state, just by local municipalities. |
| Other units of government if part of permit process | None. | The three permitting agencies include: The Environmental Protection Agency (EPA), Montana Department of Natural Resources and Conservation (DNRC), and the Montana Department of Environmental Quality (DEQ). |
| Open-loop permit requirements | Installer must hold permit, but permit isn't site specific. | Department of Natural Resources and Conservation, and Omar Sierra-Lopez, Underground Injection Control Program, Class V Well, U.S. EPA Region 8, (8WP-SUI), 1595 Wynkoop Street, Denver, CO 80202-1129, 303-312-7045, sierra-lopez.omar@epa.gov. |
| Closed-loop permit requirements | Installer must hold permit, but permit isn't site specific. | No permit requirement, contact local municipality. |
| Closed-loop post-installation inspection/ reporting requirements | Must complete and file report with Missouri Dept. of Natural Resources. https://dnr.mo.gov/forms/780-1413-f.pdf | Local municipality inspection |
| Open-loop post-installation inspection/ reporting requirements | Must complete and file report with Missouri Dept. of Natural Resources. https://dnr.mo.gov/forms/780-1901-f.pdf | Local municipality inspection |
| Open-loop driller license requirements | Driller or installer is required to hold a "heat pump installation" permit through DNR | Well drillers license required. |
| Closed-loop driller license requirements | Driller or installer is required to hold a "heat pump installation" permit through DNR | Well drillers license required. |
| Are out of state drillers allowed to perform work? | Out of state drillers must obtain the appropriate Missouri non-restricted well installation permit | The board may waive the apprenticeship requirements and examination requirements if it finds that the standards and requirements of the state in which the applicant is licensed are equal to or exceed those of Montana. |
| Comments on driller continuing ed requirements | Continuing education is not required. An apprenticeship requirement prior to issuance of an "unrestricted" permit. | Four hours of board approved continuing education are required annually prior to license renewal each July. |
| Additional Notes and Comments | If installer doesn't intend to full-length grout closed loop heat pump wells, then installer must pre-notify Investigation and Remediation Unit of DNR before beginning. Well or system owner will receive a certification letter and the installer will complete and return to DNR. Owner isn't required to get permit before installation. At time of research, the Underground Injection Wells webpage was under | The Department of Energy's GDOET program has compiled information from such analyses, which indicates that Montana has more than 25,000 square miles of high-potential sites and areas. Specific information for 50 geothermal sites is now available. |

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| Additional information source(s) contact information | Justin Davis, Chief, Investigation and Remediation Unit, Wellhead Protection Section, Department of Natural Resources, Missouri Geological Survey, 111 Fairgrounds Road, Rolla, MO 65401, 573-368-2165, justin.davis@dnr.mo.gov; Missouri Well Installation Rules. | Ben Brouwer, Geothermal Energy Program, Montana Department of Environmental Quality, 1520n East 6th Avenue, Helena, MT 59601, 406-444-6586, bbrouwer@mt.gov |
| URL of state agencies | https://dnr.mo.gov/ ; AND https://www.sos.mo.gov/adrules/csr/current/10csr/10csr.asp#10-23 . | http://deq.mt.gov/Energy/EnergizeMT/Geothermal ; AND http://en.openei.org/wiki/RAPID/Geothermal/Montana ; AND http://www.epa.gov/uic/underground-injection-control-epa-region-8-co-mt-nd-sd-ut-and-wy |

| | NEBRASKA | NEVADA |
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| Agency issuing Underground Injection Control Permits | Amanda Osborn, Coordinator for UIC. Nebraska Dept of Environmental Quality, PO Box 98922, Lincoln, NE 68509, 402-471- 4290, amanda.osborne | Andrew Kowler, Ph.D., Environmental Scientist Underground Injection Control Program Bureau of Water Pollution Control - Permits Branch Nevada Division Environmental Protection Department of Conservation & Natural Resources 901 S. Stewart St., Ste. 4001, Carson City, NV 89701 (O) 775-687-9428, (F) 775-687-4684 akowler@ndep.nv.gov |
| State Agency regulating wells producing water | David Miesbach Program Manager, NDEQ. Well construction, including open loop and closed loop, and well drilling licenses, currently under an agreement with Nebr. Health and Human Services. 402/471-4982. David.Miesbach@nebraska.gov | Mike Visser, Administrator, State of Nevada Commission on Mineral Resources, Division of Minerals, 400 W King Street, Suite 106, Carson City, NV 89703, 775-684-7044, mvisser@minerals.nv.gov |
| State agency regulating non-producing boreholes | David Miesbach Program Manager, NDEQ. Well construction, including open loop and closed loop, and well drilling licenses, currently under an agreement with Nebr. Health and Human Services. 402/471-4982. David.Miesbach@nebraska.gov | Mike Visser, Administrator, State of Nevada Commission on Mineral Resources, Division of Minerals, 400 W King Street, Suite 106, Carson City, NV 89703, 775-684-7044, mvisser@minerals.nv.gov |
| Other units of government if part of permit process | Nebraska Health and Human Services is currently under an agreement to manage it for NDEQ. DHHS Licensure Unit, Attn: Well Driller, PO Box 94986, Lincoln NE 68509-4986. DHHS.RehabOffice@nebraska.gov | None |
| Open-loop permit requirements | UIC Authorization (Title 122) Class I, III, and V UIC wells. | All geothermal wells drilled in Nevada must be permitted by the Nevada Division of Minerals. |
| Closed-loop permit requirements | Nebraska Health and Human Services (DHHS), 10+ loops must notify DHHS before construction | All geothermal wells drilled in Nevada must be permitted by the Nevada Division of Minerals. |
| Closed-loop post-installation inspection/ reporting requirements | All wells must be registered with Nebraska Department of Natural Resources | The Nevada Division of Minerals oversees the drilling and subsequent completion operations through daily reporting to the Division by the operator, as well as inspect the wells after they are completed. |
| Open-loop post-installation inspection/ reporting requirements | All wells must be registered with Nebraska Department of Natural Resources | The Nevada Division of Minerals oversees the drilling and subsequent completion operations through daily reporting to the Division by the operator, as well as inspect the wells after they are completed. |
| Open-loop driller license requirements | All well drillers must be licensed by Nebraska Health and Human Services | Every well drilled in the state of Nevada must be drilled by a licensed well driller. |
| Closed-loop driller license requirements | All well drillers must be licensed by Nebraska Health and Human Services | Every well drilled in the state of Nevada must be drilled by a licensed well driller. |
| Are out of state drillers allowed to perform work? | Yes, but must be licensed by NHHS. | The state of Nevada has a reciprocity agreement with California, Arizona and Utah. |
| Comments on driller continuing ed requirements | On or before December 31st of even numbered years, well drillers with an active NE license must complete at least 12 hours of approved continuing education during the preceeding 24 month period. | 8 Continuing Education Units are required during the period beginning July 1st or the previous year to June 30th of the current year. |
| Additional Notes and Comments | Permits to drill some wells, in some areas of the state are issued by one of the 23 Natural Resources Districts. A map of Nebraska's Natural Resources Districts can be found using link below. | None |
| Additional information source(s) contact information | Marty Link, Water Quality Div. Administrator, Nebraska Dept of Environmental Quality, PO Box 98922, Lincoln, NE 68509, 402/471-4270, marty.link@nebraska.gov; Alternate contact: Pam Miller 402-471-0546 | Jake Echeverria, Water Resource Specialist II, State of Nevada Division of Water Resources, Carson City Office, jecheverria@water.nv.gov. |
| URL of state agencies | http://dhhs.ne.gov/licensure/Pages/Well-Drillers.aspx ; AND http://deq.ne.gov/RuleAndR.nsf/Title_122.xsp ; AND https://www.nrdnet.org/ | http://minerals.nv.gov/Programs/Geo/Geo/ ; AND http://water.nv.gov/ AND https://ndep.nv.gov/water/water-pollution-control/resources/streamlined-permitting-process |

| | NEW HAMPSHIRE | NEW JERSEY |
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| Agency issuing Underground Injection Control Permits | Steve Roy, Manager of Groundwater Permitting technical group, New Hampshire Department of Environmental Services, Drinking Water Source Protection Program, PO Box 95, Concord, NH 03302-0095, 603-271-3918 stephen.roy@des.nh.gov | Brian Sage, Environmental Specialist 3, Acting Supervisor brian.sage@dep.nj.gov |
| State Agency regulating wells producing water | Steve Roy, Manager of Groundwater Permitting technical group, New Hampshire Department of Environmental Services, Drinking Water Source Protection Program, PO Box 95, Concord, NH 03302-0095, 603-271-3918 stephen.roy@des.nh.gov | NJDEP Division of Water Supply & Geoscience, Bureau of Water Allocation & Well Permitting, wellpermitting@dep.nj.gov. |
| State agency regulating non-producing boreholes | Steve Roy, Manager of Groundwater Permitting technical group, New Hampshire Department of Environmental Services, Drinking Water Source Protection Program, PO Box 95, Concord, NH 03302-0095, 603-271-3918 stephen.roy@des.nh.gov | NJDEP Division of Water Supply & Geoscience, Bureau of Water Allocation & Well Permitting, wellpermitting@dep.nj.gov. |
| Other units of government if part of permit process | None | Other NJDEP programs within the Division regulate public supply wells and large volume water users (over 70 GPM pump capacity): Bureau of Safe Drinking Water, Bureau of Water Systems Engineering and Water Allocation Unit within the Bureau of Water Allocation & Well Permitting. Bureau of Nonpoint Pollution Control Division of Water Quality regulates the injection of water in aquifer storage and recovery (ASR) wells. |
| Open-loop permit requirements | No permit required, UIC Registration form must be filed. | Permit required by NJDEP, Bureau of Water Allocation & Well Permitting |
| Closed-loop permit requirements | No permit required, UIC Registration form must be filed (to register location of closed loop) | Permit required by NJDEP, Bureau of Water Allocation & Well Permitting. One permit required for each well if under 10 wells to be drilled. If 10 or more wells are to be drilled a site-wide permit may be obtained. |
| Closed-loop post-installation inspection/ reporting requirements | None | NJ licensed well driller must file well record (electronically) to the Bureau of Water Allocation within 90 days of completion. |
| Open-loop post-installation inspection/ reporting requirements | An annual sampling requirement for non-residential systems. | NJ licensed well driller must file well record (electronically) to the Bureau of Water Allocation within 90 days of completion. |
| Open-loop driller license requirements | License issued by NH Water Well Board required | NJ licensed well driller of the proper class must install/directly oversee the installation of the well(s). |
| Closed-loop driller license requirements | License issued by NH Water Well Board required | NJ licensed well driller of the proper class must install/directly oversee the installation of the well(s). One licensed driller must be onsite for each drill rig in operation |
| Are out of state drillers allowed to perform work? | Must have NH License from Water Well Board | Must have NJ License |
| Comments on driller continuing ed requirements | Licensed pump installers are required by law, RSA 482-B:5, V, to obtain 2 continuing education hours annually as a condition for license renewal. The Water Well Board has adopted rules stipulating that continuing education must pertain to water pumps, water wells, water conditioning and treatment systems, occupational safety, business management, hydrogeology, and/or water resources management and protection. This requirement applies to the person named as the qualified individual on the license. | 21 continuing education points (CEPs) must be completed within each 3-year licensing cycle to be eligible for renewal. All CEPs must be approved by the NJ State Well Drillers and Pump installers Examining and Advisory Board. |

| | NEW HAMPSHIRE | NEW JERSEY |
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| Additional Notes and Comments | New Hampshire Safe Drinking Water Act, authorizing DES to adopt rules to regulate the heat exchange fluids used in closed loop geothermal systems and to prohibit the construction of open loop geothermal systems where such installations will contaminate freshwater aquifers with brackish or saline groundwater. Licensed pump installers are required by law, RSA 482-B:5, V. to obtain 2 continuing education hours annually as a condition for license renewal. | Other NJDEP programs within the Division regulate public supply wells and large volume water users (over 70 GPM pump capacity): Bureau of Safe Drinking Water, Bureau of Water Systems Engineering and Water Allocation Unit within the Bureau of Water Allocation & Well Permitting. Bureau of Nonpoint Pollution Control Division of Water Quality regulates the injection of water in aquifer storage and recovery (ASR) wells. |
| Additional information source(s) contact information | None | Steven Reya, Bureau of Water Allocation & Well Permitting, contact regarding well driller licensing, permitting or construction questions, steven.reya@dep.nj.gov or Mark Ortega: mark.ortega@dep.nj.gov or |
| URL of state agencies | https://www.des.nh.gov/ | http://www.state.nj.us/dep/dwq ; AND https://www.state.nj.us/dep/watersupply/pw_permit.html |

| | NEW MEXICO | NEW YORK |
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| Agency issuing Underground Injection Control Permits | Melanie Sandoval, NMED, GWQB. Issues Class V UIC Permits, (aquifer storage and recovery wells, infiltration basins, septic tank leach fields etc). melanie.sandoval@state.nm.us | Aidan Conway, US EPA Region 2, 212-637-4227, 290 Broadway, 19th Floor, New York, NY Conway.Aidan@Epa.gov |
| State Agency regulating wells producing water | Jerri Pohl, New Mexico Office of the State Engineer (OSE), PO Box 25102, Santa Fe, NM 87504, 505-827-7848, Jerri.pohl@state.nm.us . | NYSDEC, Division of Water Water Well Program 625 Broadway Albany, NY 12233-3508 877-472-2619, NYSWaterWells@dec.ny.gov for wells under 500 feet in depth. Wells over 500 feet are regulated by DEC;s Division of Mineral Resources, 518-402-8056. |
| State agency regulating non-producing boreholes | Jerri Pohl, New Mexico Office of the State Engineer (OSE), PO Box 25102, Santa Fe, NM 87504, 505-827-7848, Jerri.pohl@state.nm.us . | New York DEC;s Division of Mineral Resources, 518-402-8056 |
| Other units of government if part of permit process | Aquifer Injection and Recovery wells are conjunctively managed and permitted by the NMED and the OSE. | Local Health Department offices in Nassau, Suffolk, Kings and Queens counties require additional permits. |
| Open-loop permit requirements | New Mexico Office of the State Engineer (OSE) is the state regulatory agency with regards to the water rights required for an open-looped system and any drilling into saturated units to install the loop system. | NYS law requires that preliminary notice reports be filed with DOW for open-loop or standing column systems. |
| Closed-loop permit requirements | New Mexico Office of the State Engineer (OSE) is the state regulatory agency with regards to the water rights required for an open-looped system and any drilling into saturated units to install the loop system. | NYS law does not require pre-notification for closed loop geothermal systems with boreholes drilled up to 500 feet deep. Geothermal wells over 500 feet must obtain a permit by DEC's Division of Mineral Resources (DMN). |
| Closed-loop post-installation inspection/ reporting requirements | None | NYS law does not require well completion report for closed-loop geothermal systems with boreholes drilled up to 500 feet deep. Geothermal wells over 500 feet are regulated by DEC's Division of Mineral Resources (DMN) and must comply with regulations. |

| | NEW HAMPSHIRE | NEW JERSEY |
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| Open-loop post-installation inspection/ reporting requirements | None | NYS law requires that well completion reports be filed with DOW for open-loop or standing column systems with boreholes drilled up to 500 feet deep. |
| Open-loop driller license requirements | Well drillers are licensed by the method by which they drill. The OSE Well Drillers Licensing Program is administered by the Statewide Projects Team within the Water Rights Allocation Program. | NYS law requires driller and pump installer registration and certification with DOW for open-loop or standing column systems. |
| Closed-loop driller license requirements | Well drillers are licensed by the method by which they drill. The OSE Well Drillers Licensing Program is administered by the Statewide Projects Team within the Water Rights Allocation Program. | New York State law does not require driller registration and certification for closed-loop geothermal systems with boreholes drilled up to 500 feet deep. Geothermal contractors may take Certified Vertical Closed Loop Driller (CVCLD) Exam offered by NGWA and may also be accredited and/or certified by the International Ground Source Heat Pump Association (IGSHPA). |
| Are out of state drillers allowed to perform work? | Yes, They are subject to all the licensing requirements found in 19.27.4.12 NMAC and the application process and review found in 19.27.4.15 NMAC. | Yes |
| Comments on driller continuing ed requirements | Well drillers are expected to obtain eight hours of continuing education, including 6 hours specific to well drilling or well drilling activities and two hours New Mexico Rules and Regulations every two years. | Required continuing education unit (CEUs) is 10 hours of personal participation in an organized continuing education course, training meeting, workshop, etc. approved by the New York State Department of Health. |
| Additional Notes and Comments | GWQB successfully strengthened our groundwater standards in 2018.20.6.2.3103 NMAC; Title 20 Chapter 6 Environmental Protection Water Quality Ground and Surface Water Protection - http://164.64.110.134/parts/title20/20.006.0002.html . | None |
| Additional information source(s) contact information | Michelle Hunter, Bureau Chief, Ground Water Quality Bureau, New Mexico Environment Department, Harold Runnels Building Room M2250, 1190 St. Francis Drive, Santa Fe, NM 87505, 505-827-6891, Michelle.Hunter@state.nm.us . Questions about OSE Well Drillers Licensing Program contact Frank Scott | Beth Guidetti, Professional Geologist I, Division of Water, New York State Department of Environmental Conservation, 625 Broadway, Albany, NY 12233-3508. 518-402-8203, beth.guidetti@dec.ny.gov . DEC Division of Mineral Resources Statewide-Compliance & Enforcement 518-402-8056 |
| URL of state agencies | https://www.env.nm.gov/water/ ; AND https://www.env.nm.gov/gwqb/ ; AND https://www.ose.state.nm.us/Statewide/index.php | https://www.dec.ny.gov/energy/1772.html ; AND https://www.dec.ny.gov/lands/61176.html ; AND https://www.dec.ny.gov/energy/205.html |

| | NORTH CAROLINA | NORTH DAKOTA |
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| Agency issuing Underground Injection Control Permits | Kenneth White, Underground Injection Control, Well Construction & Permitting, North Carolina Department of Environment Quality. 910-433-3338, kenneth.white@ncdenr.gov | North Dakota Department of Environmental Quality (NDDEQ), Division of Water Quality, UIC, Carl Anderson, 701-328-5210, cjanders@nd.gov |
| State Agency regulating wells producing water | Rick Boich, Section Chief, Groundwater Resources Section, North Carolina Department of Environment and Natural Resources (DEQ), 919-707-3671, rick.boich@ncdenr.gov | North Dakota Department of Environmental Quality (NDDEQ), Division of Water Quality, UIC, Carl Anderson, 701-328-5210, cjanders@nd.gov |
| State agency regulating non-producing boreholes | North Carolina Department of Environment and Natural Resources (DEQ) | Office of State Geologist, Industrial Commission of North Dakota Geological Survey, 600 E Boulevard Avenue, Bismarck, ND 58505 |
| Other units of government if part of permit process | Specific type of geothermal heat pump system determines necessary permits/notification. | Office of State Geologist, Industrial Commission of North Dakota Geological Survey, 600 E Boulevard Avenue, Bismarck, ND 58505 |
| Open-loop permit requirements | State permit required and inspection will visit site. | UIC Requirements – NDAC 33. 1-25-01, Must complete Geothermal Energy Extraction Permit Application and file with the office of the State Geologist. |
| Closed-loop permit requirements | State permit not required, but need to file Notice of Intent prior to construction, County/municipality may have additional requirements. | Must complete Geothermal Energy Extraction Permit Application and file with the office of the State Geologist. |
| Closed-loop post-installation inspection/ reporting requirements | Not with the state, but county or municipality may have post-inspection/reporting requirements. | Within thirty days after completion, a completion report must be filed with the state geologist, on a form prescribed by the commission. |
| Open-loop post-installation inspection/ reporting requirements | Post construction of well and heat pump, inspector will inspect well and collect necessary samples. | Within thirty days after completion, a completion report must be filed with the state geologist, on a form prescribed by the commission. |
| Open-loop driller license requirements | Certified Well Driller's license required per Well Contractors Certification Commission | All wells must be made by a certified water or monitoring well contractor. |
| Closed-loop driller license requirements | Certified Well Driller's license required per Well Contractors Certification Commission | All wells must be made by a certified water or monitoring well contractor. |
| Are out of state drillers allowed to perform work? | Reciprocity agreement is in place between NC and TN. Licensed well drillers from other states may submit request certification using reciprocity. | Yes, the State Board of Water Well Contractors may grant certification to contractors certified by other states upon payment of the required fee and furnishing of a bond as provided by section 43-35-14, and provide proof of qualifications. |
| Comments on driller continuing ed requirements | 2 CEUs are required each certification year for the 1st three years of certification. There is no "carry-over." | Must earn 6 hours of continuing education during every two-year reporting cycle. |
| Additional Notes and Comments | Only HVAC contractors licensed by the State Board of Examiners of Plumbing, Heating and Fire Sprinkler Contractors may install heat exchange tubing into a well/borehole. | The NDDEQ regulates Class I, IV, and V wells. The ND Division of Oil and Gas regulates Class VI wells. Permit Application - https://www.dmr.nd.gov/ndgs/geothermal/PDF/gefrm1.pdf . State Board of Water Well Contractors, Chapter 43-35 - https://www.legis.nd.gov/cencode/t43c35.pdf . |
| Additional information source(s) contact information | Jay Barber, Water Resources - Water Quality Regional Operations Section, North Carolina Department of Environment and Natural Resources (DEQ), 910-433-3340, jim.barber@ncdenr.gov. Geoff Kegley Water Resources - Water Quality Wilmington Regional | Lorraine Manz, Geological Survey Div., 701-328-8005. Regulates Class III wells. Mark Bohrer, ND Division of Oil & Gas., 701-328-8020. Regulates Class VI wells. |

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| URL of state agencies | https://deq.nc.gov/about/divisions/water-resources/water-resources-permits ; AND https://deq.nc.gov/about/divisions/water-resources/water-resources-permits/wastewater-branch/ground-water-protection/geothermal ; AND http://www.ncwelldriller.org/web/eh/wcc | https://deq.nd.gov/WQ/1_Groundwater/2_UIC.aspx ; AND https://www.dmr.nd.gov/ndgs/geothermal/2013AdministrativeCode.asp ; AND https://www.swc.nd.gov/reg_approp/waterpermits/ |
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| | OHIO | OKLAHOMA |
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| Agency issuing Underground Injection Control Permits | Lindsay Taliferro, Ohio Environmental Protection Agency, 614-644-2771, lindsay.taliferro@epa.state.oh.us Ohio EPA only issues permits for Class I and V injection wells. Class IV wells are banned. Class II and III injection wells are issued by Ohio DNR. | Hilary Young, Chief Engineer, Land Protection Division Oklahoma Department of Environmental Quality, 707 N Robinson, PO Box 1677, Oklahoma City, OK 73101-1677, 405-702-5188, hilary.young@deq.ok.gov |
| State Agency regulating wells producing water | Andrew Adgate, Ohio Department of Natural Resources, UIC, 614-265-6673, andrew.adgate@dnr.state.oh.us | Hilary Young, Chief Engineer, Land Protection Division Oklahoma Department of Environmental Quality, 707 N Robinson, PO Box 1677, Oklahoma City, OK 73101-1677, 405-702-5188, hilary.young@deq.ok.gov |
| State agency regulating non-producing boreholes | Ohio EPA, Division of Drinking and Ground Waters, 614-644-2752 whp@epa.ohio.gov | Oklahoma Department of Environment Quality |
| Other units of government if part of permit process | For Ohio EPA issued permits, Ohio statute requires input from Ohio DNR during permit process. For Closed-loop installations, may need local health, zoning board or commission and/or building | Oklahoma Water Resources Board, 3800 N Classen Blvd, Oklahoma City, OK 73118, 405-530-8800 |
| Open-loop permit requirements | Local health district permit or OEPA-DDA GW well approval to drill is required per OAC 3745-34-11. If the system pumps more than 100,000gpd, then register with ODNR-DSWR. If system discharges to groundwater and water contains chemical additives, a permit from OEPA-UIC is also required. If system discharges to surface water and doesn't meet water quality standards, an Individual NPDES Permit from OEPA-DSW is required. | Submit application to the Board (OWRB) for permit, with the exception of "domestic use" only well. |
| Closed-loop permit requirements | No state permits are required by Ohio EPA for closed-loop systems, but may need local health, zoning board or commission and/or building department approval. | Submit application to the Board (OWRB) for permit, with the exception of "domestic use" only well. |
| Closed-loop post-installation inspection/ reporting requirements | For closed-loop system with less than 20 borings, a minimum of one well record is required. For systems with greater than 20 borings, live well records need to be submitted to the ODNR Division of Soil and Water and other agencies depending on the type of use (local health district if well is used for domestic purposes or Ohio EPA UIC Program if the well is a return well). | Submit completion report to the Board (OWRB) within 60 days of completion. |
| Open-loop post-installation inspection/ reporting requirements | A well record needs to be filed for each well. All well records should be submitted to the ODNR Division of Soil and Water and other agencies depending on the type of use (local health district if well is used for domestic purposes or Ohio EPA UIC Program if the well is a return well). | Submit completion report to the Board (OWRB) within 60 days of completion. |
| Open-loop driller license requirements | Ohio does not require a license for installing geothermal systems. | Must have well driller license by the Oklahoma Water Resources Board (OWRB) |
| Closed-loop driller license requirements | Ohio does not require a license for installing geothermal systems. | Must have well driller license by the Oklahoma Water Resources Board (OWRB) |
| Are out of state drillers allowed to perform work? | Ohio does not require a license for installing geothermal systems. | Contact OWBR about reciprocity provisions for nonresidents. |
| Comments on driller continuing ed requirements | Water well driller must obtain 6 hours of continuing education credits annually in order to renew their registration. | Required to attend at least 4 units (1 unit is equal to 50 minutes) of approved continuing education during each year period (from July 1 through June 30) or a total of 8 units for each two-year period of renewal. |

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| Additional Notes and Comments | OWRC Recommendations for Geothermal Heating and Cooling Systems Handbook - https://epa.ohio.gov/portals/28/documents/sccgw/GHC_S.pdf . Ohio EPA rules regarding types of injection wells located at OAC 3745-34-04 as to what Ohio EPA regulates and to OAC 3745-34-11 and 12 to see what permits are required for which kinds of wells. | OWRB Well Driller Licensing Fact Sheet - https://www.owrb.ok.gov/about/about_pdf/Fact-WellDrillerLicensing.pdf . |
| Additional information source(s) contact information | Craig Smith, Information Officer, Ohio EPA, Division of Drinking and Ground Waters, PO Box 1049, Columbus, OH 43216, 614-644-2752, craig.smith@epa.ohio.gov . Jim Raab, Chairman, Ohio Department of Natural Resources, Division of Geological Survey, 2045 Morse Road, Bldg C-2, Columbus, OH 43229, 614-265-6747, jim.raab@dnr.state.oh.us . Craig Nelson, Vice-chairman, Ohio Department of Natural Resources, Division of Geological Survey, 614-265-6603, craig.nelson@dnr.state.oh.us . | Well drilling & pump installation questions - Charles O'Malley, Oklahoma Water Resources Board, 3800 N Classen Blvd, Oklahoma City, OK 73118, 405-530-8800, charles.omalley@owrb.ok.gov or John Bowen, john.bowen@owrb.ok.gov . |
| URL of state agencies | http://www.epa.ohio.gov/ddagw/uic.aspx#114042767-class-v-wells ; AND https://www.epa.state.oh.us/ddagw/sccgw/geothermal#:~:text=In%20Ohio%2C%20state%20law%20does,a%20source%20water%20protection%20area ; AND https://www.epa.state.oh.us/ddagw/sccgw/geothermal#159468986-do-well-records-need-to-be-filed-for-geothermal-systems | https://www.deq.ok.gov/land-protection-division/underground-injection-control/ ; AND https://www.owrb.ok.gov/welldrilling/ce.php ; AND https://www.owrb.ok.gov/welldrilling/index.php |

| | OREGON | PENNSYLVANIA |
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| Agency issuing Underground Injection Control Permits | Derek Sandoz, Oregon Department of Environmental Quality, 503-229-5099, sandoz.derek@deq.state.or.us | Mark Nelson, EPA Region 3, Class V Team Leader and Technical Representative, UIC Class 5 Permitting and Rule Authorization, 1060 Chapline Street, Wheeling, WV 26003-2995, 304-234-0286, nelson.mark@epa.gov |
| State Agency regulating wells producing water | Oregon Water Resources Department. 725 Summer St NE Suite A, Salem, OR 97301, 503-986-0900. | No state level regulation; regulated by county/township |
| State agency regulating non-producing boreholes | Oregon Water Resources Department. 725 Summer St NE Suite A, Salem, OR 97301, 503-986-0900. | No state level regulation; regulated by county/township |
| Other units of government if part of permit process | Department of Geology's Mineral Land Regulation & Reclamation Office, 229 Broadalbin Street SW, Albany, OR 97321, 541-967-2039, mlrr.info@oregon.gov. Some Oregon counties require land use permits for certain developments. Contact county government for development requirements. | Department of Conservation and Natural Resources |
| Open-loop permit requirements | Must submit application for permit to Department of Geology's Mineral Land Regulation & Reclamation office. Must obtain a water right permit from OWRD | Permit required |
| Closed-loop permit requirements | Must submit application for permit to Department of Geology's Mineral Land Regulation & Reclamation office | Permit required |
| Closed-loop post-installation inspection/ reporting requirements | Within 30 days of completion of well, the driller will submit a well report describing how the well was built. | Drillers are required to submit completion reports for the Bureau of Geological Survey. |
| Open-loop post-installation inspection/ reporting requirements | Within 30 days of completion of well, the driller will submit a well report describing how the well was built. | Drillers are required to submit completion reports for the Bureau of Geological Survey. |
| Open-loop driller license requirements | Must be licensed to drill in Oregon | All well drillers must be licensed by PA Department of Conservation and Natural Resources |
| Closed-loop driller license requirements | Must be licensed to drill in Oregon | All well drillers must be licensed by PA Department of Conservation and Natural Resources |
| Are out of state drillers allowed to perform work? | Only if licensed by Oregon. | Yes, after obtaining a license from the state of PA |
| Comments on driller continuing ed requirements | Required to obtain a minimum of 14 continuing education credits during each licensing period. | No Continuing Ed requirement. |
| Additional Notes and Comments | Water Well Owner's Handbook: A guide to water wells in Oregon https://www.oregon.gov/owrd/WRDPublications1/Well_Water_Handbook.pdf | None |
| Additional information source(s) contact information | Kristopher Byrd, Well Construction and Compliance Section Manager, 725 Summer St NE Suite A, Salem, OR, 97301. 503-986-0851. Kristopher.R.Byrd@oregon.gov; Buffy Gillis, Oregon Water Resources Department, 725 Summer St NE Suite A, Salem, OR 97301 503-986-0866 | Stuart Reese, Geologist Manager, PA Department of Conservation and Natural Resources, Pennsylvania Geological Survey, 3240 Schoolhouse Road, Middletown, PA 17057-3534, 717-702-2028, streese@pa.gov. |
| URL of state agencies | https://www.oregon.gov/owrd/Pages/index.aspx ; AND https://www.oregon.gov/OWRD/programs/GWWL/WCC/resourcesforwellconstructors/Pages/Continuing-Education.aspx ; AND https://www.oregonaeology.org/mlrr/geothermal.htm | https://www.dcnr.pa.gov/Conservation/Water/Groundwater/Pages/default.aspx |

| | RHODE ISLAND | SOUTH CAROLINA |
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| Agency issuing Underground Injection Control Permits | Craig Roy, Principal Environmental Scientist, Rhode Island of Environmental Management, Office of Water Resources, Groundwater Discharge Program craig.roy@dem.ri.gov 401-222-4700, x 7604 | Bruce Crawford, IUC Program, South Carolina Department of Health and Environmental Control, 2600 Bull Street, Columbia, SC 29201, 803-898-4177, crawford@dhec.sc.gov |
| State Agency regulating wells producing water | The Groundwater Discharge Program administers the Underground Injection Control (UIC) Program under the Groundwater Discharge Rule 250-RICR-150-05-4 | Bruce Crawford, IUC Program, South Carolina Department of Health and Environmental Control, 2600 Bull Street, Columbia, SC 29201, 803-898-4177, crawford@dhec.sc.gov |
| State agency regulating non-producing boreholes | If the boreholes are to be used for injection, emplacement or disposal of fluids, they would be regulated under the Groundwater Discharge Rules (UIC Program). Rhode Island only allows for discharge to Class V UIC wells (shallow injection wells) and specific Class IV wells as identified in the Groundwater Discharge Rules. Class I, II, III, and almost all Class IV UIC wells are prohibited in RI. | Unknown |
| Other units of government if part of permit process | Contractors Registration and Licensing Board (RICRLB) 560 Jefferson Blvd., Suite 100, Warwick, RI 02886, 401-921-1590, ricrb@doa.ri.gov | South Carolina Water Resources Commission |
| Open-loop permit requirements | Open-loop geothermal wells at commercial, industrial and institutional facilities are regulated under Rule 4.9 of the Groundwater Discharge Rules. All registration requirements for open-loop geothermal wells can be found in Rule 4.9. Additionally, Rule 4.9 requires that an open-loop geothermal well be drilled by a well driller licensed by the RICRLB (see below). | A permit is required from the SCDHEC prior to constructing, operating or using V. A. well for injection. |
| Closed-loop permit requirements | Closed-loop geothermal wells are not regulated by the RIDEM. | A permit is required from the SCDHEC prior to constructing, operating or using V. A. well for injection. |
| Closed-loop post-installation inspection/ reporting requirements | Closed-loop geothermal wells are not regulated by the RIDEM. | The Water Well Record Form 1903 or other approved form shall be completed and submitted to the Department by the contactor within thirty days after well completion. |
| Open-loop post-installation inspection/ reporting requirements | The RI State agency that administers the well drilling regulations and well drillers in RI is the Rhode Island Contractors Registration and Licensing Board (RICRLB). | Injection may not commence until the SCDHEC has inspected or otherwise reviewed the injection well and finds it in compliance with regulations. |
| Open-loop driller license requirements | Drillers must be licensed with the Contractors Registration and Licensing Board (RICRLB). | Must be South Carolina certified well driller per S.C. Code Section 40-23-10 et seq.2. |
| Closed-loop driller license requirements | Drillers must be licensed with the Contractors Registration and Licensing Board (RICRLB). | Must be South Carolina certified well driller per S.C. Code Section 40-23-10 et seq.2. |
| Are out of state drillers allowed to perform work? | The RI State agency that administers the well drilling regulations and well drillers in RI is the Rhode Island Contractors Registration and Licensing Board (RICRLB). | South Carolina does not have an agreement with any other state; reciprocity is determined on an individual basis. |
| Comments on driller continuing ed requirements | Well drillers must complete 10 hours of Board approved continuing education courses with a Board approved provider during each two year period. | Between July 1 and June 30 of each odd numbered year every well driller must obtain a total of 12 hours of continuing education or pass the state examination. |
| Additional Notes and Comments | None | https://scdhec.gov/sites/default/files/media/document/R121-8.0_121-8.28.pdf |
| Additional information source(s) contact information | James Cambio, State Building Code Comm., Contractors Registration and Licensing Board (RICRLB) 560 Jefferson Blvd., Suite 100, Warwick, RI 02886, 401-921-1590, James.Cambio@dbr.ri.gov or ricrb@doa.ri.gov . | Christopher Wargo, SCDHEC, 803-898-3799, wargoca@dhec.sc.gov . |

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| URL of state agencies | http://www.crb.ri.gov/welldrillers/index.php ; AND https://rules.sos.ri.gov/regulations/part/250-150-05-4 | http://www.scdhec.gov ; AND https://www.llr.sc.gov/env/ce.aspx |
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| | SOUTH DAKOTA | TENNESSEE |
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| Agency issuing Underground Injection Control Permits | Omar Sierra-Lopez, Class V Well, U.S. EPA Region 8, (8WD-SDU), 1595 Wynkoop Street, Denver, CO 80202-1129, 303-312-7045, sierra-lopez.omar@epa.gov | Brian Ham, Tennessee Department of Environment and Conservation, Division of Water Resources, Drinking Water Unit, 312 Rosa L. Parks Avenue, Nashville, TN 37243, 615-532-9224, Brian.Ham@TN.gov. |
| State Agency regulating wells producing water | Eric Gronlund, Chief Engineer, Water Rights Program, South Dakota Department of Environment and Natural Resources, 523 E Capitol Avenue, Pierre, SD 57501, 605-773-3352, denrinternet@state.sd.us. | Richard W. Rogers, Tennessee Department of Environment and Conservation, Division of Water Resources, Drinking Waer Unit, 312 Rosa L. Parks Ave. Nashville, TN 37243, 615-532-0180, Richard.Rogers@TN.gov. |
| State agency regulating non-producing boreholes | South Dakota Department of Environmental and Natural Resources | Wells are regulated by Tennessee Department of Environment and Conservation, Division of Water Resources. Oil and gas wells are under the Oil & Gas Program and mineral test hole permits are under the Mining Unit. |
| Other units of government if part of permit process | None | None |
| Open-loop permit requirements | If water right permit is needed, state law requires the permit to be approved prior to doing any well drilling or you may seek permission from the chief engineer of the Water Rights Program to have a test well constructed prior to a obtaining a water right permit. | A UIC authorization is required if fluids are being discharged to the subsurface. A notice of intent to drill a well (NOI), NOI fee and a driller report must be filed. Please refer to the Water Well Licensing Regulations and Well Construction Standards. |
| Closed-loop permit requirements | If water right permit is needed, state law requires the permit to be approved prior to doing any well drilling or you may seek permission from the chief engineer of the Water Rights Program to have a test well constructed prior to a obtaining a water right permit. | A permit is not required for the installation of a closed-loop system; however, a notice of intent to drill a well (NOI), NOI fee and a driller report must be filed. Please refer to the Water Well Licensing Regulations and Well Construction Standards. |
| Closed-loop post-installation inspection/ reporting requirements | If water right permit is needed, a record of the water well construction (Notice of Completion of Works) shall be funished to the chief engineer of the Water Rights Program and the well owner. | A "Report of Well Driller" for a closed loop geothermal borehole system shall be submitted by the driller to the Department within sixty (60) days after the drilling or closure of the last closed loop borehole in the system at the site. Please see additional reporting requirements listed in the Water Well Licensing Regulations and Well Construction Standards. |
| Open-loop post-installation inspection/ reporting requirements | If water right permit is needed, a record of the water well construction (Notice of Completion of Works) shall be funished to the chief engineer of the Water Rights Program and the well owner. | Water wells for open-loop systems are treated as a water supply well. Please see UIC requirements if subsurface discharge is planned. |
| Open-loop driller license requirements | Unless you are drilling your own well, you need to hire a well driller licensed in South Dakota. | A water well license (W) is required for open-loop well installations. |
| Closed-loop driller license requirements | Unless you are drilling your own well, you need to hire a well driller licensed in South Dakota. | "For closed-loop geothermal systems in Tennessee, the geothermal boreholes must be drilled by a contractor with a Geothermal Driller's License (G) or a Borehole only driller's license (B). The loops must be installed in the boreholes by a contractor with a geothermal driller's licence (G) or a loop installer's license (L)." |
| Are out of state drillers allowed to perform work? | Must be a well driller licensed in South Dakota. | Drillers must have a license issued by the State of Tennessee to drill in Tennessee. |
| Comments on driller continuing ed requirements | Must complete four hours of continuing education activities annually. Continuing education hours shall be earned between January 1 and December 31 of each year. Continuing education hours in excess of four hours may be carried over to the next calendar year. | Water well drillers, pump installers, and treatment system installers are required to obtain 5 hours of continuing education credits per year. |

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| Additional Notes and Comments | None | Class V wells generally are authorized by reference in the Tennessee Rules for Underground Injection Control. In this case, the applications are reviewed within two (2) to four (4) weeks. If the proposed project is complex, the Division will issue a permit rather than an authorization. A permit may take up to six (6) months to process. |
| Additional information source(s) contact information | Adam Mathiowetz, Engineer III, Water Rights Program, South Dakota Department of Environment and Natural Resources, 605-773-3352. | None |
| URL of state agencies | https://denr.sd.gov/des/wr/driller.aspx ; AND https://sdlegislature.gov/#/Rules/Administrative/26420 ; AND https://sdlegislature.gov/Rules/Administrative/26457 ; AND https://www.epa.gov/uic/underground-injection-control-epa-region-8-co-mt-nd-sd-ut-and-wy | https://www.tn.gov/environment/program-areas/wr-water-resources/water-quality/well-water.html ; AND https://www.tn.gov/environment/permit-permits/water-permits1/underground-injection-control-permit.html |

| | TEXAS | UTAH |
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| Agency issuing Underground Injection Control Permits | Lorrie Council, Texas Commission on Environmental Quality, PO Box 13087, Austin, TX 78711-3087, 512-239-6461, lorrie.council@tceq.texas.gov. | Drummond Earley III, Utah Department of Environmental Quality, Division of Water Quality UIC, 195 North 1950 West Salt Lake City, UT 84116, dearley@utah.gov. A UIC permit is not required for an Open or Closed Loop well in Utah. |
| State Agency regulating wells producing water | Lorrie Council, Texas Commission on Environmental Quality, PO Box 13087, Austin, TX 78711-3087, 512-239-6461, lorrie.council@tceq.texas.gov. | Utah Division of Water Rights/State Engineer's Office Jim Goddard, Well & Geothermal Program Manager 1594 W North Temple #200, SLC UT 84116 801-538-7314, jimgoddard@utah.gov |
| State agency regulating non-producing boreholes | Texas Commission on Environmental Quality regulates well construction specifications. Texas Railroad Commission regulates wells for oil and gas. | Utah Division of Water Rights/State Engineer's Office Jim Goddard, Well & Geothermal Program Manager 1594 W North Temple #200, SLC UT 84116 801-538-7314, jimgoddard@utah.gov |
| Other units of government if part of permit process | Local municipalities. | Utah Division of Drinking Water also regulates public supply wells. Geothermal wells (>120 degrees C) are subject to Section 73-22-1 "Utah Geothermal Resource Conservation Act" Utah Code Annotated |
| Open-loop permit requirements | Water removed from the ground in order to obtain geothermal resources is regulated as part of mineral resource and not otherwise subject to Texas water law. | Yes, regulated by the Utah Division of Water Rights. UIC permits are not required for open loop systems or geothermal injection wells. |
| Closed-loop permit requirements | No reporting prior to construction is necessary for closed loop wells. | Yes, regulated by the Utah Division of Water Rights. UIC permits are not required for closed loop systems or geothermal injection wells. |
| Closed-loop post-installation inspection/ reporting requirements | The Texas Department of Licensing and Regulation State Well Report form shall be completed and submitted to the executive director within 30 days from the date the well construction is completed. Any additives, constituents, or fluids (other than potable water) that are used in the closed loop injection well system shall be reported in the Water Quality Section on the form. | Not regulated at State-level. May be regulated at local city/county jurisdiction level. |
| Open-loop post-installation inspection/ reporting requirements | After completion of construction, the Texas Department of Licensing and Regulation state well report form shall be submitted to the executive director within 30 days from the date the well construction is completed. | Yes, regulated by the Utah Division of Water Rights |
| Open-loop driller license requirements | Water well driller licensed by Texas Department of Licensing and Regulation required. A person may not act or offer to act as a driller or pump installer unless the person is licensed or registered by the executive director pursuant to the Code. A licensee, not licensed to perform all types of well drilling and pump installation, may apply for endorsements. Upon examination of the applicant's qualifications, the executive director must deny or grant additional endorsements to an existing license. | Utah Well Driller's License required |
| Closed-loop driller license requirements | A person may not act or offer to act as a driller or pump installer unless the person is licensed or registered by the executive director pursuant to the Code. A licensee, not licensed to perform all types of well drilling and pump installation, may apply for endorsements. Upon examination of the applicant's qualifications, the executive director must deny or grant additional endorsements to an existing license. | Utah Well Driller's License required |
| Are out of state drillers allowed to perform work? | Anyone who performs well drilling/pump installations work in the state of Texas must be licensed. | Yes, if they have a Utah Well Driller's License |
| Comments on driller continuing ed requirements | Water Well Driller or Pump Installer licensees must complete 4 hours of continuing education in courses approved by the department. | Licensees must earn 12 credits (hours) of continuing education every two years to renew. |

| | TEXAS | UTAH |
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| Additional Notes and Comments | Private wells do not serve public water supply and there are no federal or state requirements for domestic water well owners. Groundwater Conservation Districts also maintain records and registrations for water wells specific to their jurisdictions. | See Geothermal Heat Pump Well Permitting and Regulatory Requirements by Jim Goddard, https://geology.utah.gov/docs/emp/geothermal/ugwg/pdf/goddard0409.pdf and the State of Utah Water Well Handbook which contains rules, statute, and other pertinent information. |
| Additional information source(s) contact information | Texas Department of Licensing and Regulation (TDLR), PO Box 12157, Austin, TX 78711, 512-463-6599, water.well@tdlr.texas.gov . | Jim Goddard, Utah Division of Water Rights, 801-538-7314, jimgoddard@utah.gov |
| URL of state agencies | https://www.tceq.texas.gov/groundwater ; AND https://texreg.sos.state.tx.us/public/readtac\$ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&p_g=1&p_tac=&ti=30&pt=1&ch=331&rl=132 AND https://www.tdlr.texas.gov/wwd/wwdrules.htm ; AND https://www.tceq.texas.gov/permitting/radmat/uic_permits/RRCT_wells.html | https://waterrights.utah.gov/wellinfo/default.asp ; AND https://deq.utah.gov/division-drinking-water |

| | VERMONT | VIRGINIA |
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| Agency issuing Underground Injection Control Permits | Nathan Kie, UIC Program Administrator, State of Vermont ANR-DEC, Drinking Water and Groundwater Protection Division, UIC Program, 1 National Life Drive, Main 2, Montpelier, VT 05620, 802-522-3008, nathan.kie@vermont.gov. | James Bennett, Source Water & UIC Section, US EPA Region 3, 1060 Chapline Street, Wheeling, WV 26003-2995, 215-814-5469, bennett.james@epa.gov. |
| State Agency regulating wells producing water | Rodney Pingree, Water Resources Section Supervisor, Vermont Department of Environmental Conservation, 1 National Life Drive, Montpelier, VT 05620, 802-585-4912, rodney.pingree@vermont.gov. | Joseph Grist, Surface Water Withdrawal Manager, Water Withdrawal Permitting and Compliance, Virginia Department of Environmental Quality, PO Box 1105, Richmond, VA 23218, 804-698-4031, joseph.grist@deq.virginia.gov. |
| State agency regulating non-producing boreholes | Department of Environmental Conservation, Vermont Geological Survey, 1 National Life Drive, Montpelier, VT 05620 | Michael Skiffington, Director of Policy and Planning, Virginia Department of Mines, Minerals and Energy, 1100 Bank Street, 8th Floor, Richmond, VA, 23210, 804-692-3212, mike.skiffington@dmme.virginia.gov. |
| Other units of government if part of permit process | None | Local health department |
| Open-loop permit requirements | Permit required but are exempt from UIC permitting if certain conditions are met. See Section 11-320(b) and 11-303(a)(2). A Groundwater Withdrawal Permit is required for new or increased groundwater withdrawal of greater than 57,600 gallons per day from a single tract of land/place of business. | A single application and a single fee are required for any geothermal well system, regardless of the number of wells include in the system. |
| Closed-loop permit requirements | Permit required under 10 V.S.A., Section 6651b or 10 V.S.A., Chapter 159, subchapter 3 | A single application and a single fee are required for any geothermal well system, regardless of the number of wells include in the system. A registration statement for closed loop construction permitting shall be made on a form provided and approved by the division. |
| Closed-loop post-installation inspection/ reporting requirements | Well completion report must be completed and submitted within 90 days of well completion. | Drilling log must be submitted to Department of Mines, Minerals and Energy within 90 days of well completion. |
| Open-loop post-installation inspection/ reporting requirements | Well completion report must be completed and submitted within 90 days of well completion. A Groundwater Report Form needs to be submitted for existing or new groundwater withdrawals of greater than 20,000 gallons/day need to be reported annually for water usage. | Drilling log must be submitted to Department of Mines, Minerals and Energy within 90 days of well completion. |
| Open-loop driller license requirements | Vermont Well Driller's License required | Must be licensed by Commonwealth of Virginia. |
| Closed-loop driller license requirements | Vermont Well Driller's License required | Must be licensed by Commonwealth of Virginia. |
| Are out of state drillers allowed to perform work? | May be accepted in lieu of requirements in sections 15-503© and (d) and 15-504 of the Environmental Protection Rule and if reciprocal agreement is in place between Department and licensing body for that state, territory or province. Applicant required to pass Vermont licensing test. | Must be licensed by Commonwealth of Virginia. |
| Comments on driller continuing ed requirements | Licensee needs to participate in at least 8 hours of education and training activities over the last three year renewal period. | A certified water well systems provider must completed at least 8 hours of continuing education approved by the Board. |
| Additional Notes and Comments | Well drilling is regulated by the Water Supply Section. Also see State of Vermont Agency of Natural Resources Department of Environmental Conservation Well Driller Licensing Rules http://dec.vermont.gov/sites/dec/files/dwgwp/welldriller/pdf/welldrillerlicensingrulesigned2002.pdf . | None |

| | VERMONT | VIRGINIA |
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| Additional information source(s) contact information | Well driller licensing contact Heather Campbell, Well Driller Licensing and Reporting, Vermont DEC, Drinking Water & Groundwater Protection Division, 802-585-4893, heather.campbell@vermont.gov. | None |
| URL of state agencies | http://dec.vermont.gov/water/underground-injection-control/ ; AND https://dec.vermont.gov/water/groundwater/groundwater-large-withdrawal/ ; AND https://dec.vermont.gov/water/groundwater/well-drillers | https://law.lis.virginia.gov/admincode/title12/agency5/chapter630/section271/ ; AND https://www.vdh.virginia.gov/environmental-health/onsite-sewage-water-services-updated/private-well-program/ ; AND https://www.deq.virginia.gov/permits-regulations/permits/water/water-withdrawal |

| | WASHINGTON | WEST VIRGINIA |
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| Agency issuing Underground Injection Control Permits | Mary Shaleen Hansen, Water Resources Program,, Washington Department of Ecology, PO Box 47600, Olympia, WA 98504-7600, 360-407-6143, maha461@ecy.wa.gov or mary.shaleen- | Michelle Finney, Environmental Resources Specialist 3, West Virginia Division of Environmental Protection, Division of Water and Waste Management, 601 57th Street SE, Charlestown, WV 25304, 304-926-0499 |
| State Agency regulating wells producing water | Scott Malone, Water Resources PM, State of Washington, Department of Ecology, 360-407-6648, scma461@ecy.wa.gov. | West Virginia Department of Health & Human Resources, Bureau For Public Health, Office of Environmental Health Services, Environmental Engineering Division, Capitol and Washington Streets |
| State agency regulating non-producing boreholes | Scott Malone, Water Resources PM, State of Washington, Department of Ecology, 360-407-6648 scma461@ecy.wa.gov. | West Virginia Department of Environment Protection, Division of Water and Waste Management, 601 57th Street SE, Charlestown, WV 25304. |
| Other units of government if part of permit process | Department of Labor and Industries (LNI), and local health departments | Local health department |
| Open-loop permit requirements | UIC Permit required. Before drilling a well, you must submit a notice of intent (NOI) to the Department of Ecology. This document needs to be submitted to Ecology 72 hours before the well is drilled | It is the homeowner's responsibility to obtain required permits to drill from the Director of the WV Department of Health. Permit shall be applied for at least 15 days prior to actual well drilling or construction |
| Closed-loop permit requirements | Before drilling a well, you must submit a notice of intent (NOI) to the Department of Ecology. This document needs to be submitted to Ecology 72 hours before the well is drilled | water well contractor or owner shall obtain permit to drill from the Director of the WV Department of Health. Permit shall be applied for at least 15 days prior to actual well drilling or construction |
| Closed-loop post-installation inspection/ reporting | A well report must be mailed to the nearest Ecology regional office servicing that particular county within 30 days after completing well. | Within 30 days after completion of water well, the water well contractor shall provide the Director of the WV Department of Health with 2 copies of a well completion report. |
| Open-loop post-installation inspection/ reporting requirements | A well report must be mailed to the nearest Ecology regional office servicing that particular county within 30 days after completing well. | Within 30 days after completion of water well, the water well contractor shall provide the Director of the WV Department of Health with 2 copies of a well completion report. |
| Open-loop driller license requirements | A Water Well Operator License is required. | Must have valid West Virginia water well certification |
| Closed-loop driller license requirements | Either a Water Well or a Research Protection Operator License is required. | Must have valid West Virginia water well certification |
| Are out of state drillers allowed to perform work? | Yes, must be licensed and submit a completed application to the department, and pay an application fee. Must obtain 32 continuing education units as approved by the department, and also pass a written examination as provided for in RCW 18.104.080 | Applicant shall be reviewed individually by the Commissioner. |
| Comments on driller continuing ed requirements | Must complete 14 continuing education units during the past twenty-four months of the license term. A minimum of 2 continuing education units out of the 14 required units must be within a college class. | Must completed 3 continuing education hours (plus 2 hours related to pumps if conducting pump installations) annually. |
| Additional Notes and Comments | Class V wells are allowed in Washington if they can meet the requirements of Chapter 173-218 WAC (Underground Injection Control Program) and Chapter 173-200 WAC (Water Quality Standards for Ground Waters of the State of Washington). Public work, including publicly-funded projects, must comply with the Department of Labor and Industries (LNI) prevailing | West Virginia Water Well Regulations - http://www.wvdhhr.org/phs/water/historical/64csr19_-_water_well_regulations.pdf ; |
| Additional information source(s) contact information | None | None |
| URL of state agencies | http://www.ecy.wa.gov/programs/wr/wells/wellhome.html ; AND http://apps.leg.wa.gov/wac/default.aspx?cite=173-162 ; AND https://apps.leg.wa.gov/wac/default.aspx?cite=173-160 ; AND http://www.oria.wa.gov/site/alias__oria/463/default.aspx | http://www.wvdhhr.org/phs/ced/swap/trainingandcertification/waterwell/certification.asp ; AND https://casetext.com/regulation/west-virginia-administrative-code/agency-64-health/title-64-legislative-rule-bureau-for-public-health/series-64-46-water-well-design-standards/section-64-46-10-heat-pump-construction ; AND https://dep.wv.gov/WWE/Programs/gw/Pages/gwhom |

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| Agency issuing Underground Injection Control Permits | Brian Austin, Underground Injection Control Coordinator, Division of Environmental Management, Wisconsin Department of Natural Resources, PO Box 7921, Madison, WI 53707-7921, 608-266-3415, brian.austin@wisconsin.gov. | Kathy Shreve, Wyoming Department of Environmental Quality, UIC Program, 200 West 17th Street, Cheyenne, WY 82002 307-777-6682, kathy.shreve@wyo.gov |
| State Agency regulating wells producing water | Jared Niewoehner; Hydrogeologist, Division of Environmental Management, Drinking Water and Groundwater Program. Jared.Niewoehner@wisconsin.gov; (608) 267-7895. | State of Wyoming, Office of the State Engineer, Herschler Building 4-E, Cheyenne, WY 82002, 307-777-6163 |
| State agency regulating non-producing boreholes | Wisconsin Department of Natural Resources, 101 S Webster Street, Madison, WI 53707, 608-266-3415 | Kathy Shreve, Wyoming Department of Environmental Quality, UIC Program, 200 West 17th Street, Cheyenne, WY 82002 307-777-6682, kathy.shreve@wyo.gov |
| Other units of government if part of permit process | Wisconsin Department of Safety and Professional Services (DSPS) Division of Industry Services, PO Box 7302, Madison WI 53707-7302 | State of Wyoming, Office of the State Engineer, Herschler Building 4-E, Cheyenne, WY 82002, 307-777-6163 |
| Open-loop permit requirements | Injection Well Inventory Form must be submitted to Wisconsin's Department of Natural Resource's Bureau of Drinking Water and Groundwater. The only type of open-loop geothermal system allowed in Wisconsin is an a pass-through system or "pump and dump" draws water from a well and discharges it back to a surface source. No construction shall begin until the owner or contractor has received a written approval document. | A permit to appropriate ground water must be obtained from the State Engineer's Office prior to commencing construction of the well. |
| Closed-loop permit requirements | NR 812 Well Construction and Pump Installation; Use the Closed Loop Heat Exchange Well Application (Form 3300-255) [PDF] to apply for DNR approval. No construction shall begin until the owner or contractor has received a written approval document. | A permit to appropriate ground water must be obtained from the State Engineer's Office prior to commencing construction of the well. |
| Closed-loop post-installation inspection/ reporting requirements | Must complete and file a Well Completion Report for heat exchange well. | Complete and file Well Completion Statement with the State Engineer's Office. |
| Open-loop post-installation inspection/ reporting requirements | Must complete and file a Well Completion Report for heat exchange well. | Complete and file Well Completion Statement with the State Engineer's Office. |
| Open-loop driller license requirements | A license or registration is required to engage in the businesses of pump installing, water well drilling or heat exchange drilling, and for filling and sealing of water well or heat exchange drill holes. Wisconsin's licensing and registration program is established under section 280.15, Wisconsin Statutes. | Must be a licensed driller in Wyoming per the State Engineer's Office. |

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| Closed-loop driller license requirements | A license or registration is required to engage in the businesses of pump installing, water well drilling or heat exchange drilling, and for filling and sealing of water well or heat exchange drill holes. Wisconsin's licensing and registration program is established under section 280.15, Wisconsin Statutes. | Must be a licensed driller in Wyoming per the State Engineer's Office. |
| Are out of state drillers allowed to perform work? | Applicants who hold a water well driller license in another state may qualify for a license in Wisconsin. For more information on the out-of-state license application process, contact the DNR. | Yes, per State Engineer's Office, applicants currently licensed in another state are required to take the Wyoming Specific Exam for General Contractors. |
| Comments on driller continuing ed requirements | Licensed water well drillers, heat exchange drillers and pump installers are required to attend 6 hours of continuing education during each calendar year for each license held. | All license holders renewing their license will be required as a condition of renewal, to have completed 18 CPC units in each renewal period. Each Water Well Driller's License renewal shall require 9 CPC Units from within subsection (d)(I), (d)(ii) and/or (d)(iii) and directly pertaining to water well construction. |
| Additional Notes and Comments | None | http://wwcb.state.wy.us/PDF/RulesAndRegulations/WaterWellMinimumConstructionStandards.pdf ; AND http://wwcb.state.wy.us/PDF/RulesAndRegulations/RulesandRegulations2015.pdf |
| Additional information source(s) contact information | Ian Anderson, Wisconsin DNR, 608-266-2432, ian.anderson@wisconsin.gov . | None |
| URL of state agencies | http://dnr.wi.gov/topic/Wells/UIW.html ; AND https://dnr.wisconsin.gov/topic/Wells/Geothermal.html ; AND http://dnr.wi.gov/topic/wells/licenses.html | http://deq.wyoming.gov/wqd/underground-injection-control/ ; AND http://seo.wyo.gov/ground-water |

| | DISTRICT OF COLUMBIA |
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| Agency issuing Underground Injection Control Permits | Mark Nelson, EPA Region 3, Class V Team Leader and Technical Representative, UIC Class 5 Permitting and Rule Authorization, 1060 Chapline Street, Wheeling, WV 26003-2995, 304-234-0286, nelson.mark@epa.gov |
| State Agency regulating wells producing water | DC Department of Energy and Environment, Water Quality Division, 1200 First Street NE, Washington, DC 20002, 202-535-2881, doee@dc.gov. Department of Consumer and Regulatory Affairs, 1100 4th Street SW, Washington, DC 20024, 202-442-4400, dcra@dc.gov. |
| State agency regulating non-producing boreholes | DC Department of Energy and Environment, Water Quality Division, 1200 First Street NE, Washington, DC 20002, 202-535-2881, doee@dc.gov. Department of Consumer and Regulatory Affairs, 1100 4th Street SW, Washington, DC 20024, 202-442-4400, dcra@dc.gov. |
| Other units of government if part of permit process | None |
| Open-loop permit requirements | The EPA UIC program regulates open loop, earth coupled systems (those which include a subsurface discharge through a well) as shallow Class V injection wells. 1. The owner/operator of a Class V well must notify EPA in advance and in writing of the intent to construct and operate a well; 2. The construction or operation of the Class V injection well must not endanger underground sources of drinking water; and 3. Permit issued once EPA determines the well does not pose the potential for endangerment. A well construction building permit must be obtained from the DCRA before a well construction building permit must be obtained from the DCRA before beginning construction. The DOEE's final regulations also contain additional requirements for well construction, well owners must submit a well completion report to DOEE for all wells that require well construction building permits and are not subject to a DOEE regulatory action. |
| Closed-loop permit requirements | |
| Closed-loop post-installation inspection/reporting requirements | |
| Open-loop post-installation inspection/reporting requirements | Within 60 days of well construction, well owners must submit a well completion report to DOEE for all wells that require well construction building permits and are not subject to a DOEE regulatory action. |
| Open-loop driller license requirements | Wells in the District may be drilled only by licensed drillers and possess a current Department of Consumer and Regulatory Affairs business license. |
| Closed-loop driller license requirements | Wells in the District may be drilled only by licensed drillers and possess a current Department of Consumer and Regulatory Affairs business license. |
| Are out of state drillers allowed to perform work? | Yes, with proper permits and possess a current Department of Consumer and Regulatory Affairs business license. |
| Comments on driller continuing ed requirements | Drillers are licensed in other states and must meet those state continuing ed requirements. |
| Additional Notes and Comments | Department of Energy and Environment Wells and Borings https://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/Well%20Regulations%20DC%20Reg%2064383.pdf |
| Additional information source(s) contact information | Well Permit questions - Antonio Yaquian-Luna, Department of Energy and Environment, 202-807-9007, antonio.yaquian@dc.gov. |

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| URL of state agencies | http://doee.dc.gov/service/wellpermits ; AND https://doee.dc.gov/publication/well-construction-maintenance-and-abandonment-standards ; AND https://www.hklaw.com/en/insights/publications/2016/11/final-dc-groundwater-well-requirements-will-impact ; AND |
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