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Private Well Regulations Across the United States

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Private Well Regulations Across the United States

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2011

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An abstract of
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Rollins School of Public Health of Emory University
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Abstract

Private Well Regulations Across the United States

By Kristina Bowen

Purpose: The goal of this study is to characterize the potential vulnerabilities of private well users to contamination by describing the major themes in private well regulations and determining how states differ in their requirements.

Methods: From May to August 2016, two reviewers identified state regulations and categorized each statute according to how it applied to private wells. Results were obtained independently by each reviewer and discussed until consensus. Differences between states were summarized by a principal components analysis.

Results: Half of the variation in well regulations across states was explained by the first two principal components. The first principal component (PC1), explaining 34% of the total variation, distinguished states with less private well regulation from states with more regulation. The second principal component (PC2), explaining 16% of the total variation, distinguished between two sets of regulations. Regulations for design, drilling/construction, inspection, and abandonment increased a state's PC2 score, while regulations for permits, maintenance, water quality, selling a home or property, and rental properties decreased a state's PC2 score. States with a score of zero either had no regulations or had regulations in both categories. Florida and Connecticut had more private well regulations overall (PC1) than other states. Hawaii and Indiana had the highest scores for PC2, indicating the regulations encompass design, drilling/construction, inspection, and abandonment. New Jersey, Wisconsin, and Minnesota had the lowest scores for PC2 illustrating their regulations address permits, maintenance, water quality, selling a home or property, and rental properties.

Conclusion: States vary in the extent and nature of their private well regulations. This policy heterogeneity may leave consumers of private well water differentially vulnerable to water contamination and associated health hazards. The potential relevance of these policy differences for geographic health disparities merits further investigation.

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Table of Contents

1. Introduction

Current Condition of Regulations for Private Wells

Over 43 million people in the United States rely on domestic wells (1), however the laws regulating these wells can often be fragmented and inconsistent across locations because it is the responsibility of the individual states to regulate private water wells. Private wells are not subject to federal regulations of the U.S. Environmental Protection Agency (EPA), and they are minimally regulated by states (2). In January 2017, the EPA conducted its Six Year Review, as required by the Safe Drinking Water Act, to determine if any existing National Primary Drinking Water Regulations needed to be revised (3). The National Primary Drinking Water Regulations and the Six Year Review only apply to public water systems (3) therefore, regulations for private wells do not undergo similar review as regulations for public water systems because they are not federally regulated (4). Due to the non-existent federal standards and absence of review for private well regulations, these wells are not required to undergo routine monitoring. Therefore, the responsibility of ensuring well safety and water quality may be, to a large degree, a responsibility of the well owner.

Water Quality and Adverse Health Effects

A combination of factors such as the stewardship of the well owner and the lack of statewide construction standards can also influence the safety and quality of a private well (4, 5). A study in Pennsylvania investigated the cause of private well water contamination and determined there was a strong correlation between well construction standards and the percentage of wells that failed to meet safe drinking water standards (5). This is not the only study to conclude that private wells are susceptible to contamination. A number of studies determined private wells can be contaminated with ammonium (6), arsenic (7), barium (7),

nitrate (6), organic wastewater compounds (8), pesticides (9), pharmaceuticals (8), radon (10), selenium (7), strontium (7), sulfonamide antimicrobials (6), and volatile organic compounds (9). The range of these contaminants may vary based on location. The sources of private well contamination can include septic systems, natural gas extraction sites, confined animal feeding operations, and naturally occurring compounds in the soil or bedrock. Even at low concentrations, long term exposure to these contaminants may lead to severe health issues such as gastrointestinal illness, reproductive issues, and neurological disorders (11). Susceptible populations such as children, elderly, and immunocompromised individuals may even be more at risk for adverse health effects (11).

A Need for More Information

Despite the amount of research assessing drinking water quality and documenting the associated adverse health effects, there are gaps in understanding the vulnerability of private well users. This vulnerability is the potential harmful health outcome that may occur from the lack of private well regulations and standards. A panel of experts discussed the challenges of protecting private wells and recommended fostering an infrastructure for stewardship (12). They concluded that there is a need for more data to inform well owners, other actors, and address the gaps in information gathering related to private well contamination and testing. To better understand the public health risks and how to best manage private wells, it is important to consider the potential gaps in regulation. Highlighting these potential gaps in legislation will better inform the legal vulnerabilities of private wells. Currently, there is no consolidated summary of the state-level requirements for private well regulations in the United States, which is a great benefit of this research. The goal of this study is to characterize the potential vulnerabilities of private well users by describing the major themes in private well regulations and determining how states differ in requirements for private wells.

2. Methods

Data Collection

The data for this study were obtained from an online (i.e., Google search) review of state regulations from May 15th to August 30th, 2016 using the search terms (*private well + state name)* to identify state level regulations pertaining to private wells. For this study, we defined a private well as a private, domestic, or non-public well that delivers water to one household with less than 10 gallons of water per minute or less than 100,000 gallons of water per day (formulated from (13-15)). We applied this definition in addition to the Centers for Disease Control and Prevention's (CDC) definition of a private water well serving no more than 25 people at least 60 days of the year and with no more than 15 service connections (16). The first two pages from the online search were reviewed, and each search produced 986,000 to 5,230,000 hits. Results included individual documents (e.g., brochures, statutes) and different state agency websites. Each state agency website provided a list of regulations for drinking water, groundwater, or wells. We reviewed both the individual documents identified from the search and the list of regulations provided by each state agency website. Only current, effective regulations directly referencing private wells with a revision date of 1980 or later were included.

Each statute was categorized according to how it applied to private wells. After a pilot stage, a final set of categories were identified to classify state private well regulations. The categories included: drilling/construction, design, permits, inspection, maintenance, water quality, abandonment, rental and selling home/property. For a category to be included, the regulation must have stated a recommendation, procedure, or requirement within the specific category. For example, we defined drilling/construction as a statute containing rules, regulations or standards for the drilling or construction of private wells. For design, the statute outlined the

depth, dimensions and specific materials used for the construction of a private well. For permits, the statute stated whether a permit is required or not. Maintenance was defined as a specific action the owner, driller, or Department must take to maintain the private well. For inspection, the statute granted the Department the authority to inspect the private well. Water quality was defined as the requirements or procedures for active testing of the private well. Abandonment was defined as the procedure for decommissioning, filling, or sealing of an abandoned well. Selling a home/property outlined the procedure for selling a home or the transfer of property with a private well on site. The rental category provided rules or requirements for the landlord to follow when leasing their property with a private well on site.

After applying the category definitions, two independent reviewers abstracted data from the state statutes independently using a standardized protocol and piloted Google forms. They then compared results and discussed until consensus. The abstracted information included the regulation categories and the state agency responsible for regulating private wells, as noted by the statute authority or department definition. The state agencies responsible for regulating private wells were contacted through email to confirm that all relevant statutes have been identified for each state. Thirty-three from the fifty state agencies contacted responded to the email (66% response rate).

Statistical Methods

A principal components analysis was conducted using Stata 14.2 (StataCorp, College Station, TX) to evaluate how states differ in requirements for private wells based on the regulation categories for each state. A tetrachoric correlation of the presence of state regulation categories, and a Spearman correlation of the data for the principal components analysis was performed in R Studio v1.0.136 (R Studio Inc., Boston, MA). Correlational plots of these two

analyses were then created in R Studio v1.0.136. A figure displaying the frequency and variation in regulation categories by state was created in R Studio v1.0.136. The total percentage of each category across states was included in this figure. To illustrate the variation across states in the type of regulatory agency responsible for private wells, a chloropleth map was created in ArcGIS 10.4.1 (Esri, Redlands, CA) using the shapefile *total carbon in USA forests by state* as a basemap for the United States (pcs: WGS_1984_Web_Mercator_Auixiliary_Sphere; gcs: GCS_WGS_1984). The shapefile was obtained from the U.S. Forest Service, Conservation Biology Institute through Data Basin (17). It is licensed under a Creative Commons Attribution-Noncommercial 3.0 license.

3. Results

Figure 1 illustrated the presence and absence of each policy category for every state. Drilling/construction is addressed in at least one statute for every state (100%). In contrast, rental (6%) and selling a home/property (22%) are rarely included in private well regulations. Table 1 summarized the total number of policies that included each category. Some states had multiple private well regulations that included a given category. Table 1 also indicated the total percent of categories in state policies. Drilling/construction (21.6%), abandonment (17.7%), permits (16.0%) design (14.0%) are most often addressed in state regulations for private wells. These categories are also more commonly outlined together in a single statute. The remaining categories: maintenance (7.9%), inspection (9.8%), water quality (7.9%), selling a home/property (4.2%), and rental (0.8%) are less commonly included.

The principal components analysis only explained 61.4% of the variation (Table A, available as a supplement). The first, second, and third principal components had eigenvalues greater than 1, together they contributed to more than half of the variation within the data. The first principal component (PC1) explained 34.1% of the total variation, and it is not strongly

correlated with the nine loading variables. The PC1 loadings of each policy category variable are all positive, thus the principal component distinguished states with less private well regulation from states with more regulation. The second principal component (PC2) explained 16.0% of the total variation. Several variables increased a state's PC2 score: design, drilling/construction, inspection, and abandonment. Other variables decreased a state's PC2 score: permits, maintenance, water quality, selling a home/property, and rental. States with a value of zero for PC2 either had no regulations or had regulations with both negative and positive values. The third principal component (PC3) explained 11.3% of the total variation, and it distinguished design, permits, rental, and water quality from the remaining variables. Design, permits, rental, and water quality decreased a state's PC3 score. Abandonment, drilling/construction, inspection, maintenance, and selling a home/property increased a state's PC3 score.

We produced a score plot of the first and second principal component scores by state because together they accounted for the most variation, 50.1% (Figure 2). PC1 is labeled as more vs. less regulation. PC2 is labeled establishment or closure vs. testing regulations. Florida and Connecticut had the highest scores for the first principal component therefore, these states' statutes cover more categories for private well regulations than the remaining states. New Jersey and Wisconsin had the following highest score. Hawaii and Indiana had the highest scores for the second principal component, indicating the private well regulations included the categories design, drilling/construction, inspection, and abandonment. New Jersey, Wisconsin, and Minnesota had the most negative scores for the second principal component illustrating their regulations addressed the categories: permits, maintenance, water quality, selling a home/property, and rental properties. The majority of states incorporated a combination of these regulation categories, and they had less regulation in comparison to Florida, Connecticut, New Jersey, and Wisconsin.

We created a map illustrating the type of agency per state to indicate the overlapping authority in regulating private wells, as determined by the statutes produced from our search (Figure 3). We identified eight different types of state agencies: the Department of Natural Resources, the Department of Health, the Department of Environmental Quality, the Water Well Board, the Office of State Engineer, Department of Consumer Protection, Energy and Environment Cabinet, Texas Department of Licensing and Regulation. State regions such as the Southwest and Midwest had only one state agency responsible for regulating private wells in contrast to some of the Plains states, in which more than one agency is responsible. In total, 14 states had more than one agency responsible for regulating private wells and Texas was the only state with three responsible agencies.

4. Discussion

Our results indicated the policy categories less commonly addressed in private well regulations (Figure 1). Therefore, the requirements or procedures in the following categories are the major gaps in private well regulations: maintenance, inspection, water quality, selling a home/property, and rental. The majority of states incorporated a combination of the following categories with one or more missing. Hence for every state, private well regulations encompass a unique variety of categories unmatched by other states. Supplemental Figure A, illustrated how similar the state policies are by measuring the correlation of state policy categories for all fifty states. State policies are less similar to each other based on the categories (Figure A, available as a supplement). This is also supported by Supplemental Figure B, indicating there are weak correlations among the state policies. In addition to the discrepancies between regulation categories per state, we also determined there is overlapping jurisdiction for regulating private wells among multiple agencies (Figure 3). The non-uniform state requirements for private wells may be attributed to the different state agencies regulating these wells.

This is the first study to summarize and compare private well regulations for all fifty states. Other studies have assessed ground water quantity regulations in select states, but did not examine their role in private well regulations (18, 19). Some studies have examined groundwater quality in individual states or regions such as Northern Texas, West Virginia, and Pennsylvania concluding wells often exceeded the EPA maximum contaminant level (7, 20). Wells with very poor construction also had a major role in well water quality (5). Flanagan et al. identified water quality as a major gap in private well regulations because it is the owner's sole responsibility to test and treat the water (21). Additionally, in cases where state testing requirements do exist, testing is usually infrequent (22). In 2013 the Water Systems Council, a non-profit organization providing resources to private well owners, received calls from owners in forty-eight states (23). Only 38% of owners reported conducting maintenance activities or testing the well water within the last twelve months, and the primary reason for calling was related to water testing (23). Water quality for private wells is a widespread issue and it corresponds to the strength of other requirements outlined in private well policies. However, this issue originates from the gaps in private well regulations and the ability to enforce existing standards. The challenge remains in measuring compliance and enforcing standards particularly for wells in areas of known contamination, such as naturally occurring arsenic in the groundwater (24). Based on our analysis, this difficulty may be attributed to the overlapping authority to regulate private wells by multiple agencies. Overall, our findings highlight the gaps in private well regulations. These gaps paired with the challenge of enforcing existing standards create potential vulnerabilities for well owners.

It is important to note that there are some limitations to this descriptive analysis. Our list of policy categories conveys the main purpose of regulations for private wells, however the categories were predetermined before data collection and then revised after previewing some

state statutes. Therefore, the regulation categories in this analysis are not an exhaustive list. This raises the issue of content validity and whether our regulation categories accurately measure the statutes we've examined. Our categories were largely influenced by the initial state statutes we reviewed as a pilot. We addressed this by basing the categories on subjects policymakers recognize, such as the different subject headings within a statute. However, some aspects of state regulations may not be truly represented due to the lack of a category. For example, some state statutes such as California referred to county delegation and adoption ordinances to delegate authority to smaller entities (25). They defined unique standards for wells in a specific groundwater basin or sub-basin, also referred to as a management area (25). State statutes referring to private wells in defined management areas are not represented in our analysis. Furthermore, we reviewed private well regulations at the state level rather than a smaller entity such as a county level, thereby potentially missing more stringent private well regulations. In addition, since we did an online review of state regulations restricted to the first two pages of search results, our study relied upon publicly available electronic copies of current regulations which may present selection bias in our analysis. As a data quality-assurance step, we contacted the state agencies referenced in the statutes we compiled to confirm we had obtained all relevant statutes. We did not receive a response from representatives in all fifty states. As a result, we could only confirm the relevant statutes for the thirty-three states that responded.

The results from our analysis indicated states differ in their requirements for private wells and aspects such as testing or selling a property with a private well are rarely addressed in private well regulations. These discrepancies may be attributed to the different state agencies regulating these wells. There are recommended drilling and construction standards for private wells in each state although, whether these standards are adhered to is often unknown, posing

an additional challenge. Based on current state legislation, the vulnerability of private wells lies in maintaining the integrity of the well and ensuring safe water quality. This information contributes to the need for more data to better inform well owners, their supporting agencies, and future research.

5. Conclusion and Recommendations

In conclusion, states vary in the extent and nature of their private well regulations. This policy heterogeneity may leave consumers of private well water differentially vulnerable to water contamination and associated health hazards. Steps in developing more uniform policies by addressing the legislative gaps in each state and establishing a single program to monitor compliance and provide additional support for well owners may help address these vulnerabilities. While policy differences between states remain, the potential relevance of these policy differences for geographic health disparities merits further investigation.

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26. The Bluebook. 19th ed. Cambridge, Massachusetts: The Harvard Law Review Association; 2010.

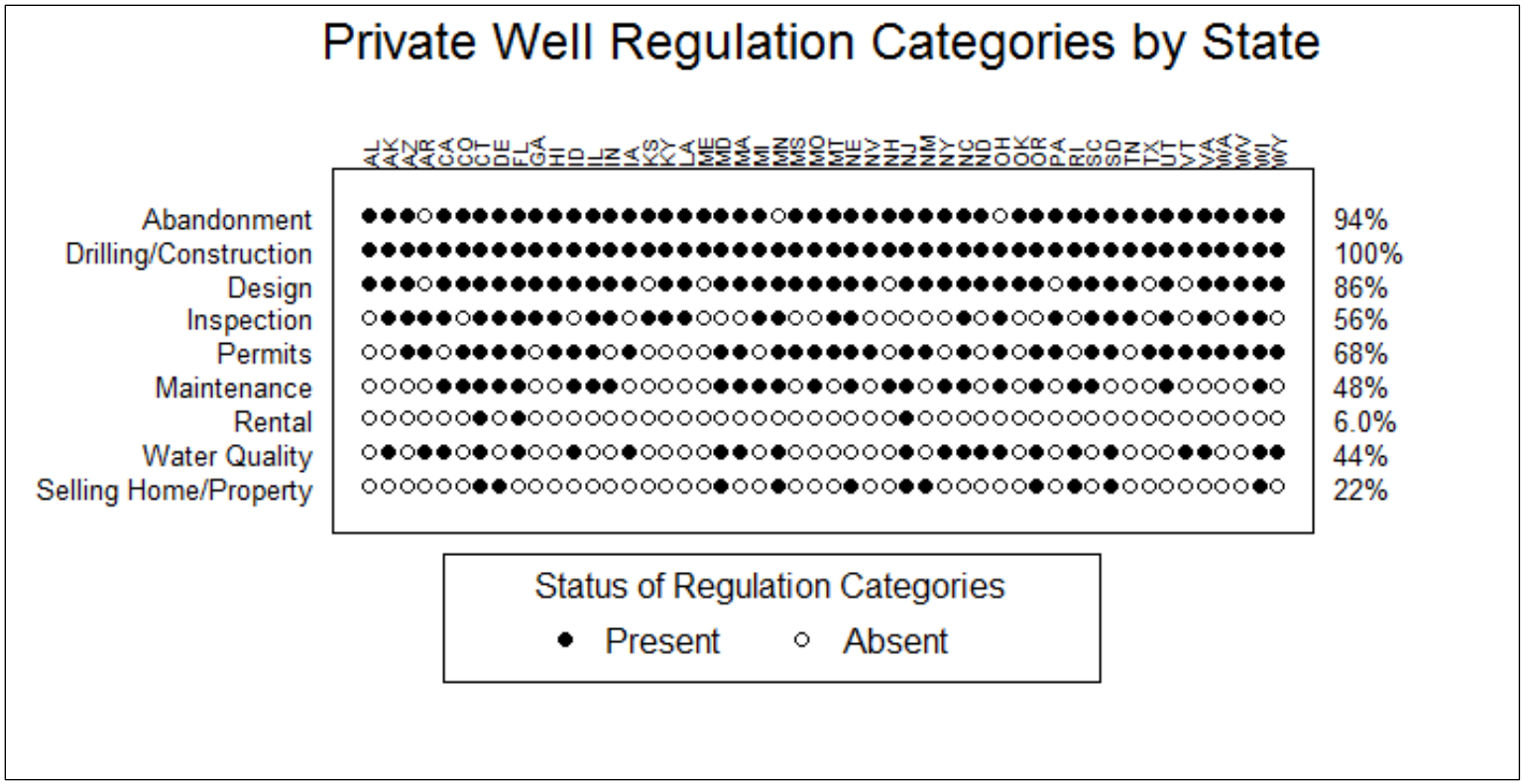


Figure 1. *Presence and absence of regulation categories for private wells by state.* A hollow circle represents the absence of a given regulation category. A filled circle indicates one or more statutes address the given category for a particular state. The percentage of categories present across states is indicated on the right.

Table 1*. The total number and percent of categories in state private well policies.*

Regulation Category	Total Number of Categories	Percentage of Regulation Categories in State Policies
Abandonment	63	17.7%
Drilling/Construction	77	21.6%
Design	50	14.0%
Inspection	35	9.8%
Permits	57	16.0%
Maintenance	28	7.9%
Rental	3	0.8%
Water Quality	28	7.9%
Selling Home/Property	15	4.2%
Total number of statutes across all states in all categories	374	

Figure 2. *A score plot of the two principal components by state.* Together, these two components accounted for the most variation, 50.1%. PC1 is labeled as more vs. less regulation, and PC2 is labeled establishment or closure vs. testing regulations. Florida and Connecticut statutes cover more categories for private well regulations than the remaining states.

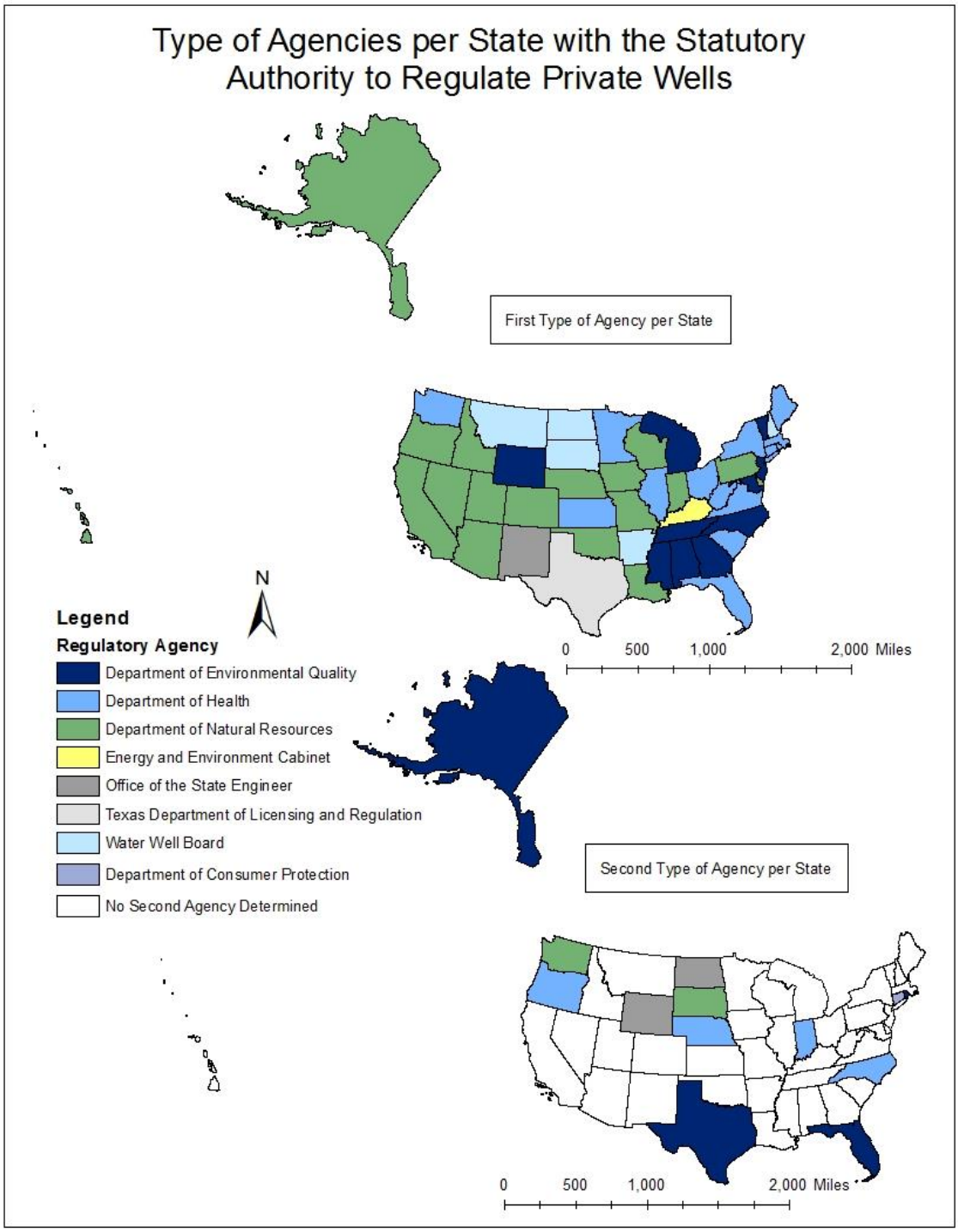
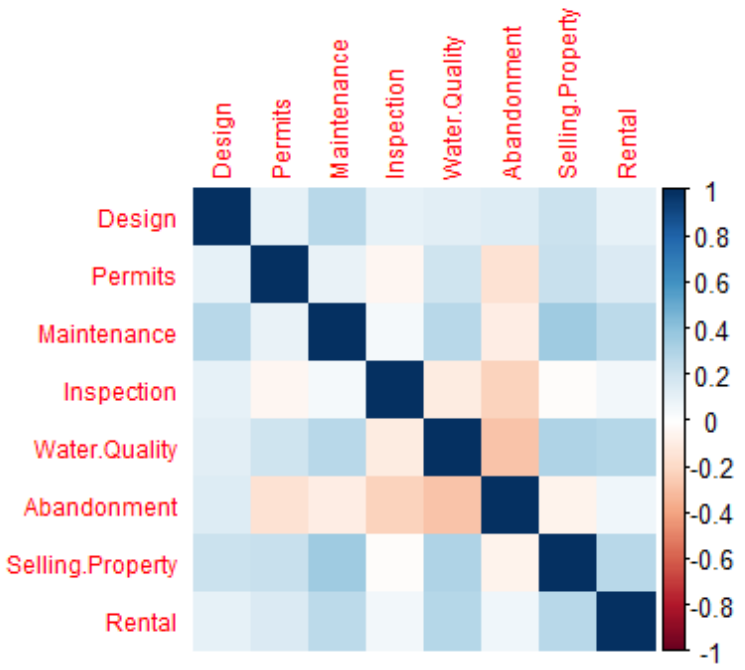


Figure 3*. Chloropleth map of the type of state agencies responsible for private well regulations.* Texas is the only state to have three different responsible agencies (Texas Department of Licensing and Regulation, Texas Alliance of Groundwater Districts, and Texas Commission on Environmental Quality). The Department of Natural Resources includes the Department of Water Resources, Department of Land and Natural Resources, Water Resources Commission, Department of Conservation and Natural Resources, Department of Environment and Natural Resources, and the Department of Ecology. The Department of Health includes the Department

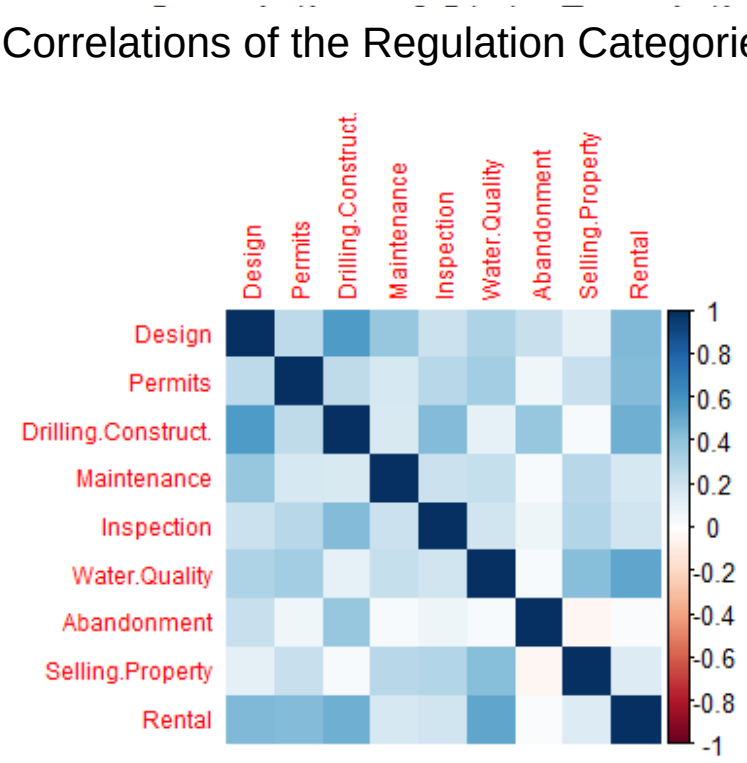
of Public Health, Board of Health, Department of Health and Environmental Control, Bureau for Public Health, Department of Health and Human Services, and the Oregon Health Authority. The Department of Environmental Quality encompasses the Department of Environmental Management, Department of Environmental Protection, Department of the Environment, Department of Environment and Conservation, Department of Environmental Conservation, and the Texas Commission on Environmental Quality. The Water Well Board includes the Water Well Construction Commission, Board of Water Well Contractors, and the Water Management Board.

Supplemental Table A. *A principal components analysis: loadings, eigenvalues, and percent of variance explained.*

Variable	Component 1	Component 2	Component 3
Abandonment	0.15	0.52	0.20
Drilling/ Construction	0.39	0.47	0.03
Design	0.41	0.25	-0.00
Inspection	0.31	0.00	0.44
Permits	0.35	-0.15	-0.28
Maintenance	0.28	-0.15	0.47
Rental	0.42	-0.02	-0.52
Water Quality	0.36	-0.38	-0.25
Selling Home/Property	0.25	-0.50	0.37
Eigenvalue	3.10	1.44	1.01
Percent Explained (%)	34.1	16.0	11.3
Cumulative (%)	34.1	50.1	61.4



Supplemental Figure A. *Tetrachoric correlations were used to summarize the relationship of the presence of state regulation categories across state policies (see Figure 1).* Drilling/construction was excluded from this figure because it contains no variability. Overall, state policies are less similar to each other based on the regulation categories.



Supplemental Figure B. *Spearman correlations were used to summarize the relationship of state regulation categories across state policies.* Overall, there are weak correlations among the state policies based on the regulation categories.

Supplemental Table B. *State statutes and policies included in this analysis, cited using the Bluebook (26).*

ALA. ADMIN. CODE r. 335-7-5 (2016)	IOWA ADMIN. CODE r. 567-38 (2008)
ALA. ADMIN. CODE r. 335-9-1 (1988)	IOWA ADMIN. CODE r. 567-39 (2008)
ALASKA ADMIN. CODE tit. 11, §93.140 (2004)	IOWA ADMIN. CODE r. 567-49 (2008)
ALASKA ADMIN. CODE tit. 18, §80.015 (2015)	IOWA ADMIN. CODE r. 567-82 (2008)
ARIZ. ADMIN. CODE § 12-15-8 (2007)	KAN. STAT. ANN § 82a-1201 (2014)
ARIZ. ADMIN. CODE § 12-15-13 (2006)	KAN. ADMIN. REGS. § 28-30 (2013)
Arkansas Water Well Construction Act. tit. 17, §50 (2010)	KY. REV. STAT. ANN. § 223.400
AWWCC § 096.00 (2016)	401 KY. ADMIN. REGS. 6:320 (2008)
CAL. WATER § 1, 7 (2016)	401 KY. ADMIN. REGS. 6:310 (2008)
CAL. HEALTH & SAFETY § 104 (2016)	LA. ADMIN. CODE. tit. 56 (2010)
Cal. Bulletin 74-90: California Well Standards (June 1991)	LA. ADMIN. CODE. tit. 43 (2011)
Cal. Bulletin 74-81: Water Well Standards (December 1981)	ME. REV. STAT. tit. 38, § 480B (2011)
COLO. CODE REGS. §402-2 (2016)	144 C.M.R. § 232 (1994)
COLO. CODE REGS. §402-6 (1986)	MD. CODE ANN., ENVIRONMENT § 26-4 (2008)
COLO. CODE REGS. §402-7 (1986)	310 C.M.R. 46.00 (2010)
CONN. AGENCIES REGS. § 19-13-B (1997)	MICH. ADMIN. CODE R. 325.1600 (1994)
CONN. AGENCIES REGS. § 25-126 (2015)	MINN. STAT. § 1031 (2016)
CONN. AGENCIES REGS. § 25-128, 129 (2015)	MINN. STAT. § 4725 (2016)
CONN. GEN. STAT. § 19a-36, 37 (2015)	Mississippi Licensing of Water Well Contractors Regulation § 51-5 (2015)
DEL. ADMIN. C. 7 §7301 (1997)	MO. REV. STAT. § 256.600 (2015)
Fla. Admin. Code R. 62-520 (2009)	10 C.S.R. 23-1-6 (2013)
Fla. Admin. Code R. 62-521 (2014)	36 M.C.A. § 21 (2013)
Fla. Admin. Code R. 62-524 (1996)	36 M.C.A. § 12 (2014)
Fla. Admin. Code R. 62-532 (2012)	37 M.C.A. § 43 (2015)
Fla. Admin. Code R. 64E-8 (2008)	85 M.C.A. § 2-302 (2015)
Fla. Admin. Code R. §§ 373.012-373.813 (2016)	178 NEB. ADMIN. CODE § 10 (2011)
O.C.G.A. 12-5-120 (2012)	178 NEB. ADMIN. CODE § 12 (2014)
HAW. REV. STAT. § 174C (2009)	NEB. REV. STAT. § 46-602 (2007)
HAW. CODE R. § 13-168 (1988)	NEB. REV. STAT. § 46-1201 (2011)
Hawaii Well Construction & Pump Installation Standards (2004)	NEB. REV. STAT. § 46-701 (2011)
IDAHO ADMIN. CODE r. 37-3-9 (2009)	NEV. ADMIN. CODE § 534.010-534.450 (2014)
IDAHO ADMIN. CODE r. 42-227 (1998)	N.H. CODE ADMIN. R. ANN. WE 100-1000 (2008)
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