The Human Capital Resource Challenge: Recognizing and Overcoming Small Utility Workforce Obstacles

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Does the availability of an educated workforce in a utility's labor market affect that utility's ability to carry out its mission? This study analyzes US Safe Drinking Water Act (SDWA) compliance to show how levels of human capital (i.e., collective education) in utilities' labor markets affect their performance. Results indicate that utility scale correlates positively with SDWA monitoring and reporting requirements. Both scale and human capital in a utility's labor market significantly predict compliance with SDWA water quality standards; where a utility has the size and resources to take advantage of human capital resources in its labor pool, SDWA health compliance improves. After identifying these patterns, a comparative case study analysis of two small utilities is used to identify workforce strategies by which utilities might overcome limited access to human capital. Extensive cross-training of personnel emerges as a potentially useful management strategy for smaller utilities in regions where educated workers are scarce.

Keywords: *human capital, regulatory compliance, training workforce*

A utility's performance depends to a great degree on the availability of financial and environmental resources. Where these resources are plentiful, a utility has a greater ability to meet its community's health and environmental needs. Where environmental and financial resources are scarce, a utility faces greater difficulties. Is the same true of its workforce? More than a collection of physical assets, a utility is an organization that depends on effective workers and leaders. Does the availability of an educated workforce similarly affect a utility's ability to carry out its mission?

The AWWA Workforce Strategies Committee proposed to address this question through a study funded by AWWA's Technical & Educational Council in 2015. The resulting study explored this issue with an analysis of the relationship between utility compliance with the US Safe Drinking Water Act (SDWA) and levels of human capital (i.e., collective education) in utilities' labor markets. Two small utilities were also analyzed to identify management strategies by which utilities with limited access to human capital can nonetheless consistently attain high levels of SDWA compliance. This article describes key findings from the study and explores the relationship between the availability of an educated workforce in a utility's labor market and that utility's ability to carry out its mission.

Regulatory compliance with the SDWA is a useful way to evaluate performance across thousands of drinking water utilities for a number of reasons. First, while many goals are ambiguous or inconsistent across utilities, regulatory compliance is universally regarded as a goal for utilities. Whatever their opinions of the regulations themselves, utility managers will almost certainly regard compliance with existing regulations as necessary. Further, all utilities are tasked with relatively similar regulatory requirements under the SDWA, regardless of organizational or environmental characteristics. Since utilities face comparable requirements, it is possible to explore the impact of labor market quality on performance in a fairly general way. The authors do not claim that SDWA compliance is the best or only way to assess utility performance; water utilities pursue multiple goals, and their performance can be gauged in many ways. However, SDWA compliance is clearly an important, broadly applicable, and validly comparable means of evaluating performance.

This article begins by reporting a statistical analysis of SDWA compliance by utilities nationwide. The statistical analysis provides a point of departure for a comparative case study of two small utilities operating in a region with limited human capital. The findings show that scale affects utility compliance with the SDWA's monitoring and reporting requirements (i.e., larger utilities are more compliant), but access to human capital does not. However, both scale and human capital in a utility's labor market significantly predict compliance with SDWA water quality standards. Where a utility from the study had the size and resources to take advantage of human capital resources in its labor pool, compliance with the SDWA health regulations improved.

In the comparative case study, the research team analyzed a pair of similar small utilities. Even though they both had limited access to human capital, one had a strong SDWA compliance record and the other had a weaker one. While the two utilities

share many financial, organizational, and environmental similarities, one significant difference in human capital management strategies was identified between them; the utility with the better regulatory compliance record applied extensive cross-training for its staff, while the other did not.

This article concludes with a summary of main findings and identifies directions for development of utility workforce strategies to overcome the challenge of limited human capital for smaller utilities in isolated regions.

STATISTICAL ANALYSIS: SCALE, HUMAN CAPITAL, AND SDWA COMPLIANCE

The first step in the project was to use statistical analysis to evaluate utility compliance with the SDWA as a function of utility size and labor market human capital availability across thousands of US water utilities.

Data. Data were drawn from a number of sources. Water utility and compliance data were gathered from the Safe Drinking Water Information System database (USEPA 2014). The analysis evaluated compliance in the years 2010–2013. A total of 8,962 municipal water systems were analyzed, representing all United States municipalities that own water utilities and serve populations of 500 or more. Investor-owned utilities and utilities operated by federal, state, county, or special district government were excluded from the analysis in order to maintain valid data comparability across organizations. Data from the 2012 Census of Governments (COG) dataset (USCB 2013a) were used to identify employment data for the sampled utilities. Demographic, economic, and educational attainment data were taken from the 2012 American Community Survey (ACS) five-year estimates (USCB 2013b).

SDWA compliance. The present analysis predicts utility compliance with the SDWA. The authors identified a utility as compliant if it had no violations of the SDWA over the four years observed. Violations were grouped into two categories. The health violations category relates to a utility's abilities to control the levels of contaminants in its water supply. Included in this category are maximum contaminant limit violations, which occur when the utility's water contains contaminants above limits set by the state and US Environmental Protection Agency (USEPA), and treatment technique violations, which occur when a utility fails to follow mandated treatment methods. Second, the SDWA requires utilities to follow certain protocols for testing water, filing reports, and communicating with the public; violations of these requirements were labeled management violations. These include what the USEPA calls "monitoring and reporting" violations and "other" violations; the precise requirements can differ depending on the size of the utility and the source of its water supply. Compliance with these regulations does not require specialized, advanced training, but instead requires fulfilling procedural tasks in a timely manner. SDWA procedural requirements include taking water samples and sending them for laboratory testing, issuing boil-water notices, or publishing annual water quality reports.

It was expected that labor market human capital would correlate differently with health and management violations. Previous research on the effect of human capital in business management suggests that human capital has a larger effect on performance for tasks that are more complex (Acs et al. 2007). Regulatory requirements relating to water quality tend to be more technically complex to accomplish than those related to monitoring and reporting, so labor market human capital would be expected to have a larger effect on health compliance than management compliance.

Study authors coded health compliance as "1" if a utility had no health violations from 2010 to 2013, and "0" if it had one or more. Management compliance was coded similarly. Descriptive statistics for management and health compliance, along with the independent and control variables, are reported in Table 1. Management violations (an average of 2.4) were more common than health violations (0.83) over the four-year period. Management compliance (i.e., committed no management violations) was measured at 55.04% of utilities, while 78.02% were fully compliant with health regulations during the same period. Health and management violations are poorly correlated (pairwise correlation of .07), indicating that different factors drive each type of violation. While the effect of labor market human capital was expected to be related to the type of violation, it may also depend on utility size. Larger organizations typically have more resources available (Hanford & Sokolow 1987), and therefore enjoy economies of scale in searching for, training, and retaining the human capital available to them (Donahue et al. 2000).

For this study, utility size was measured as the number of full-time equivalent (FTE) employees (also referred to as FTEs) employed by each municipality in the areas of water and wastewater utilities, according to the 2012 COG (USEPA 2014). In many municipalities that operate both water and sewer utilities, the same personnel are assigned to both functions (i.e., a single employee might work on the water system sometimes and the sewer system at other times). As a result of differences in reporting personnel, many cities that operate water utilities report zero FTEs allocated to the water utility, but a large number of personnel for the sewer utility (or vice versa). Investigation of selected cases revealed that water personnel had been assigned to the sewer utility for COG reporting purposes. In order to avoid underestimating the number of water employees, the authors counted all water and sewer FTEs in the measure of organizational scale. Unsurprisingly, US water utilities range widely in scale: many of the smallest utilities had only one FTE, while the largest utilities employed thousands of FTEs (New York City is the largest with 3,870 FTEs). For this study, it is more appropriate to use a measure of the actual size of the organization as absolute scale rather than a population-adjusted measure. For example, San Diego Public Utilities in California has approximately 1.16 FTEs per thousand residents, while in Laurelville, Ohio, a town of 570 people, has 5.22 FTEs per thousand. It would be erroneous to infer that Laurelville's water utility has greater organizational capacity than San Diego's water utility.

Because the primary interest of this investigation was in how human capital in its labor market affected utility performance, ACS data (USCB 2013b) were used to measure human capital in the labor force within metropolitan statistical areas, which more accurately represents the level of human capital available to the cities than human capital levels within city limits (Hoyman & Faricy

2009, Acs et al. 2007, Simon 1998, Rauch 1993). City boundaries do not fully represent economic boundaries because labor pools may extend beyond city limits, and therefore human capital within the city labor pool alone may not fully capture the effect of human capital on compliance. Following Hoyman and Faricy (2009), human capital was measured as a percentage of the working-age population with a bachelor's degree or higher, which measures the level of education desirable for compliance with SDWA regulations better than would percentage of the population with a high school degree. Even though many utility operator and management positions do not require college degrees, higher-level operator certification (to say nothing of actual performance) requires greater mathematical, scientific, and language acumen than is typical of high school graduates. Indeed, at larger utilities, many positions require college degrees or the completion of certificate programs. Certificate examinations often have readability indexes that exceed high school levels. For this reason, it is useful to think of percentage of adult population with a college degree as a proxy measure of the general level of human capital in a labor market. This article's claim is not that access to people with college degrees directly affects regulatory compliance, but rather that, in general, a more educated labor market provides a higher-quality pool of potential employees from which a utility can draw.

The analysis included a number of control variables for utility characteristics to account for confounding causes of SDWA compliance. A control for whether a utility's major source of water supply is groundwater or surface water was included—coded as 1 for groundwater and 0 for surface water. Groundwater tends to have fewer contaminants than surface water, so utilities that use surface water are expected to be more likely to commit health violations (Wallsten & Kosec 2008). Similarly, it is expected that utilities that purchase their wholesale water supplies will have fewer health violations, because the wholesale provider is responsible for the source quality and treatment processes (Teodoro 2014, Wallsten & Kosec 2008). The analysis also included a variable for the size of the population served by the utility.

In addition to data on education, the analysis included a number of demographic control variables from the ACS (USCB 2013b). Compliance with US environmental regulation has been linked to the ethnic, racial, and socioeconomic composition of community populations (Konisky & Schario 2010). Thus, the analysis accounts for median household income, percentage population below poverty, as well as the percentage of the municipality's population that is black, and the percentage of the municipality's population that is Hispanic. Finally, regulation of the SDWA is jointly administered by the USEPA and state governments, and regulatory requirements can vary across states. For this reason, state dummy variables were included in all of the models estimated in order to control for state-level differences in regulatory regimes.

Because the measures of compliance were coded as either 1 or 0, logistic regression models were estimated. With logistic regression, it is possible to estimate the effect of the independent variables on the likelihood that a utility is compliant over the four years analyzed here. Additionally, the measure of scale was transformed using a natural log transformation in order to more fully represent the effects. Because it is reasonable to expect diminishing returns to increases in employment, a nonlinear relationship

TABLE 1 Descriptive statistics for management and health compliance

	Percentage	Mean	Standard Deviation	Minimum	Maximum
Human Capital Variables[a]					
Labor market with bachelor's degree—%		23.17	9	5.4	58
Number of utility FTE employees		17.79	86.31	1	3,870
Utility Variables					
Management compliance	55.04				
Health compliance	78.02				
Groundwater supply	59.32				
Purchased water supply	20.93				
Management violations		2.42	8.23	0	401
Health violations		0.83	4.30	0	232
Population served—*1,000s*		17.43	117.90	0.50	8,000
Community Variables					
Median income—*$1,000*		45.50	18.77	12.36	250
Below poverty—%		17.33	9.85	0	67.6
Hispanic—%		9.53	15.54	0	99.78
Black—%		9.21	17.19	0	99.71

Source: USEPA 2014; USCB 2013a, 2013b

FTE—full-time equivalent, SDWA—Safe Drinking Water Act

[a]Human capital was measured as a percentage of the working-age population with a bachelor's degree or higher, which measures the level of education desirable for compliance with SDWA regulations better than would percentage of the population with a high school degree.

TABLE 2 Logistic regression results predicting SDWA compliance

Variable	Management Compliance (1)		Health Compliance (2)	
	Coefficient	Standard Error	Coefficient	Standard Error
Human Capital Variables				
Labor market with bachelor's degree—%	–0.00	(0.00)	–0.02[a]	(0.01)
Logged employees	0.19[a]	(0.06)	–0.17[b]	(0.07)
Labor market with bachelor's degree—% *by logged employees interaction*	0.00	(0.00)	0.01[a]	(0.00)
Utility Variables				
Population served—*1,000s*	–0.00	(0.00)	–0.00	(0.00)
Groundwater supply	0.28[a]	(0.06)	0.69[a]	(0.07)
Purchased water supply	0.18[a]	(0.07)	0.57[a]	(0.08)
Community Variables				
Median income—*1,000s*	0.00	(0.00)	0.01[a]	(0.00)
Below poverty—%	–0.00	(0.00)	0.00	(0.00)
Hispanic—%	–0.00	(0.00)	–0.00	(0.00)
Black—%	–0.01[a]	(0.00)	–0.01[b]	(0.00)
Constant	–0.62[a]	(0.20)	0.65[a]	(0.24)
Observations	8,962		8,962	
AIC	10,935.70		8,736.87	
Log likelihood	–5,408.85		–4,309.43	

Source of labor market data: USCB 2013a

AIC—Akaike information criterion

Standard error is shown in parentheses. Models include state dummy variables.
Significance levels:

[a] <0.01
[b] <0.05

between scale and compliance was anticipated. For example, the difference between a utility with 25 and 50 FTEs was expected to be more significant than the difference between utilities with 1,475 and 1,500 FTEs.

Results. Regression results are shown in Table 2 and estimates are presented graphically in Figures 1–3. Figures 1 and 2 show probabilities of management and health compliance, respectively, for a small utility (15 employees) and a large utility (500 employees). The vertical axis gives the predicted probability of compliance with 95% confidence intervals, while the horizontal axis gives the percentage of the labor market with a bachelor's degree. The nearly flat slopes of the prediction lines in Figure 1 show that the level of human capital does not have a statistically significant impact on the probability of management compliance for utilities of any size.

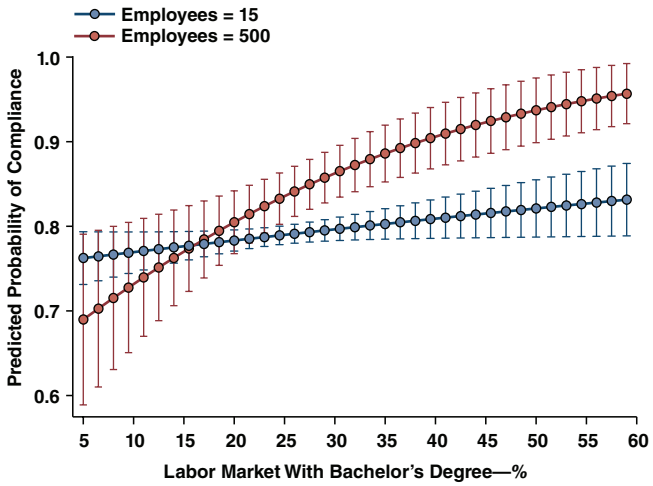
What does have a great impact on management compliance is the size of the utility; in a labor market with average human capital (23.2% with a bachelor's degree), a utility with 500 employees has a predicted 74.94% probability of compliance, while a utility with 15 employees only has a 59.74% chance of compliance. When it comes to management compliance, area human capital has little influence, but organizational scale has a large impact.

FIGURE 1 Predicted management compliance

Source of labor market data: USCB 2013a

The nearly flat slopes of the prediction lines show that the level of human capital does not have a statistically significant impact on the probability of management compliance for utilities of any size.

FIGURE 2 Predicted health compliance



Source of labor market data: USCB 2013a

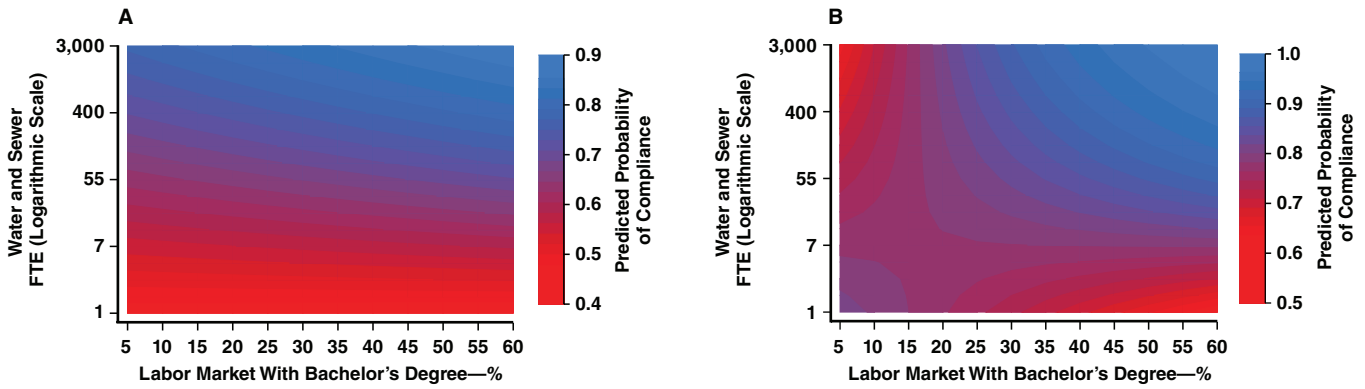
SDWA—Safe Drinking Water Act

Labor market human capital has a large effect on health compliance, although the size of this effect is conditional on utility size. The small (15 employees) and large (500 employees) utilities' probability of compliance with SDWA health requirements were statistically indistinguishable in low human capital labor markets, but larger utilities were predicted to comply at much higher rates in areas with high levels of human capital.

Larger utilities have a much higher probability of complying with the monitoring and reporting aspects of the SDWA than do smaller utilities. Moving to health compliance, Figure 2 shows the predicted probabilities of health compliance for a small and large utility across a range of labor market human capital. Once again, the predicted probability of compliance is on the vertical axis, while the percentage of labor market with a bachelor's degree is on the horizontal axis. Here labor market human capital has a large effect on health compliance, although the size of this effect is conditional on utility size. For larger utilities, being in a labor market with a highly educated workforce had a large and significant positive relationship with SDWA health compliance, while labor market education had little effect for small utilities. The small (15 employees) and large (500 employees) utilities' probability of compliance with SDWA health requirements were statistically indistinguishable in low human capital labor markets, but larger utilities were predicted to comply at much higher rates in areas with high levels of human capital.

Figure 3 presents the results of the models as a contour plot. The vertical axis is the number of water/sewer FTEs employed by the municipality, moving from only one employee to 3,000 on a logarithmic scale. The horizontal axis is the percentage of the labor market with a bachelor's degree. Red shading represents a relatively low predicted probability of compliance, while blue shading represents a high probability of compliance. The left-hand panel in Figure 3, part A, shows that SDWA management compliance is more correlated with utility size than labor market human capital; there is some change in compliance from left to

FIGURE 3 Predicted management compliance (A) and predicted health compliance (B)



Source of labor market data: USCB 2013a

FTE—full time equivalent, SDWA—Safe Drinking Water Act

Red shading represents a relatively low predicted probability of compliance, while blue shading represents a high probability of compliance.

(A) SDWA management compliance is more correlated with utility size than labor market human capital; there is some change in compliance from left to right, but most of the change in management compliance occurs along the vertical axis—the picture turns from red to blue as the number of FTEs increases from one to more than 1,000.

(B) Large utilities in high human capital areas have a high probability of health compliance, while small utilities and utilities located in low human capital areas are especially likely to violate the SDWA's health regulations. These findings suggest that larger utilities have the capacity to leverage available human capital more effectively than do smaller utilities.

right, but most of the change in management compliance occurs along the vertical axis—the picture turns from red to blue as the number of FTEs increases from one to more than 1,000.

The right-hand panel of Figure 3, part B, shows the results for health compliance in contour plot form. While most of the changes in the predicted probability of management compliance occurred along the y-axis, this figure tells a much more complicated story. Large utilities in areas with high human capital have a high probability of compliance, while small utilities and utilities located in areas with low human capital are especially likely to violate the SDWA health regulations. These findings suggest that larger utilities have the capacity to leverage available human capital more effectively than do smaller utilities.

MANAGING TO OVERCOME LIMITED HUMAN CAPITAL: A COMPARATIVE CASE STUDY

As can be seen from the statistical analysis, small utilities that are located in lower human capital areas are expected to perform poorly when it comes to compliance with the SDWA, and potentially in terms of other utility tasks, as well. These utilities have limited access to high-quality labor from which to draw and retain qualified employees, and they do not have abundant resources to put toward development of their human resources. Especially when it comes to the more complex tasks, it is expected that small utilities located in areas with relatively low education will struggle when compared with larger utilities.

Although smaller utilities that lack access to a well-educated labor force are expected to have a more difficult time complying with regulations, many small utilities have excellent compliance records nonetheless. Why and how these utilities are able to perform well despite organizational and labor market challenges are questions that are difficult to answer with statistical analysis alone. A case study approach is useful for uncovering management practices that may allow for small utilities to overcome the effects of limited human capital availability.

Case selection and recruitment. The research team sought to isolate the differences in workforce strategies that might account for differences in regulatory performance, and so compared similarly challenged utilities that had different regulatory outcomes.

Rather than just investigating high-performing utilities, this study looked at both high- and low-performing utilities to understand the differences between them.

In order to isolate management effects that account for differences in regulatory performance, two utilities were identified that were outwardly as similar as possible, except for compliance with the SDWA. In this way, differences in compliance could be more easily attributable to factors other than size, wealth, organizational structure, or state regulatory regimes. After identifying these two utilities that met these needs, the authors contacted the general managers from each respective utility to request their participation in the study.

Participants were promised confidentiality and were protected under research protocols approved by the Texas A&M University Institutional Review Board. Consequently, the names of utilities, their managers, and their personnel are not reported here. The two utilities are labeled "utility A" (the utility with a stronger SDWA compliance record) and "utility B" (the utility with a poorer compliance record).

The two utilities are remarkably similar (Table 3). They are both relatively small utilities in the same state and are located approximately 30 mi apart. The state in which the two utilities are located is a "right to work" state, so both utilities' workforces were non-unionized. Utility A serves a population of around 15,000 and has 25 FTEs, while utility B serves a population of about 10,000 and has 27 FTEs. The demographics of the two municipalities served by the utilities are very similar. Both municipalities were around 60 to 65% white and 30% black, with a 2% Hispanic population. Both municipalities had relatively low median household incomes, ~$30,000/year. Data from the 2012 COG revealed that the average water/sewer employee salaries at each utility were just over $30,000, indicating that they offered similar compensation for workers. Utility A serves a municipality with a higher rate of poverty, with about 30% of the population below the poverty line compared with 17% for utility B.

Importantly, the levels of human capital in the respective labor markets are similar, as well. Utility A is located in an area where 22% of the labor market has a bachelor's degree, and utility B is located in an area where 13% of the labor market has a bachelor's degree. Our investigation reveals very similar challenges in terms of the labor market with both utilities. Beyond the education level of the utilities, the workforces of the two municipalities were similar in terms of unemployment, each with unemployment rates of 8 to 9%.

Initial water quality may be a driving factor in SDWA compliance, but that is not of concern here. Both utilities use surface water as their primary source of water, drawing supply from the same river. Potential negative downriver effects are not a concern either, as utility B is located upriver from utility A. The

TABLE 3 Similarities observed in utility A and utility B

	Utility A	Utility B
Human Capital Variables		
Labor market with bachelor's degree—%	22	13
Utility FTE employees	25	27
Utility Variables		
Average salary—$	32,000	33,000
Population served	15,000	10,000
Community Variables		
White—%	65	60
Black—%	30	30
Hispanic—%	2	2
Median income—$	28,315	32,478
Below poverty line—%	30	17
Unemployment rate—%	8	9

Source of labor market data: USCB 2013a

FTE—full time equivalent

utilities have similar institutional histories, as well. Both used to operate under water–sewer commissions relatively independent from the city government, but the commissions were abolished 15 to 20 years ago, and the utilities were both placed under direct city management.

Utility B has a newer treatment facility, built about 10 years ago. As will be discussed, the transition to this new treatment plant put a major strain on some of the employees of the organization. Comparatively, utility A has a much older treatment plant. However, the plants are of similar capacity and use, and both utilities provide service to areas outside of their municipalities.

Case study methodology. After securing participation by the selected utilities, the research team gathered a variety of information about their respective approaches to workforce quality challenges. Data collection began with media and official archival sources. The research team identified any information that might explain the utilities' SDWA compliance patterns, including governance, organizational structure, service-area economic conditions, demographic profiles, and major recent news events.

Archival review was followed by on-site visits to the two utilities, where the research team conducted interviews with utility managers and personnel, and also observed utility operations at treatment facilities. The overall focus of interviews was on policies, practices, and decisions related to workforce. Participants were asked to describe their specific actions and experiences in securing and retaining workforce quality, rather than about their attitudes toward recruitment or workforce development in abstract ways. The researchers avoided asking directly about the quality of the workforce in the local labor market; instead, open-ended interview questions allowed respondents to bring up workforce issues unprompted. This action-focused approach allowed the researchers to draw inferences about specific management practices that distinguish the high-compliance utility from its low-compliance counterpart. After gathering data from both participating utilities, the authors analyzed similarities and differences in workforce management that could help account for differences in regulatory compliance performance.

Findings. The utilities were quite similar in their main human resource practices. Both utilities had extraordinary longevity among their employees, with numerous employees working 10 or more years at the utility compared with the US average of 4.6 years (Bureau of Labor Statistics 2014). The general manager of utility A had worked there for 40 years, and the general manager at utility B had worked there for 17 years. In addition to the longevity of the managers, many of the superintendents and other employees at the utilities had exceptional longevity as well. Both the field and treatment plant superintendents at utility A had been working there for 15 years, while the treatment and wastewater superintendents at utility B were hired more than 20 years ago. These types of long-term careers were common at both utilities.

Managers and employees at both utilities mentioned some difficulty in finding qualified employees. While they would receive around 20 applicants for advertised jobs, managers mentioned that many of the applicants were not qualified. This was especially the case for operator openings, where the required mathematical ability proved prohibitive for many candidates. Both managers mentioned that these jobs were more difficult to fill than others in the utility. This was especially true at utility B, where the manager mentioned that adequate mathematical ability was the hardest thing to find in applicants: even when a candidate had a good work ethic and physical ability, if he or she was not able to do the math required, the applicant would not be a strong candidate. Some of the greater difficulty in finding qualified candidates at utility B was due to certification requirements; utility B required Class 4 treatment certification, while utility A required only Class 3 certification.

Despite the utilities' broad similarities, field investigations revealed a few differences that offer clues as to why one had a better compliance record than the other. The biggest management difference between the utilities was in their approaches to training. Training was emphasized in both utilities, and both managers mentioned the many opportunities their employees have to receive training from the state health department and AWWA. However, one major management practice that was repeatedly brought up by both the manager and employees of utility A, but not utility B, was cross-training.

At utility A, employees at all levels of the organization mentioned how important cross-training was to their organizational success. Employees received training in all phases of water and wastewater treatment and operations, and this practice extended to all parts of the organization. While the goal at utility A was that the employees would work toward certification across multiple areas through training, the management expectation was that employees receive sufficient training to help cover for others or supplement existing staff in short-term situations. In this way, cross-training as discussed here can mean licensing across multiple operations, but it can also mean training to the point of basic competence. While cross-training may mean formal certification across functions—especially depending on state regulatory requirements—what was important at utility A was that individuals were able to work competently in multiple parts of the utility. Treatment plant operators learned all phases of treatment, as well as all operational aspects of the distribution system. Indeed, utility A's general manager mentioned that even the front office staff—whose primary duties involve billing, customer service, and financial functions—had both water and wastewater training. Although she had worked her way up in the organization through front office positions only, utility A's general manager also had water and wastewater licenses.

The divisions between the different parts of the department were more rigid at utility B. Utility B's general manager mentioned that new employees were usually assigned to water treatment, water distribution, or wastewater. While utility B employees sometimes moved between these areas, such transfers occurred when employees expressed a desire for a move. There were no obvious legal or structural barriers to cross-training in utility B.

Large utilities that have access to a highly educated workforce can maintain a long roster of well-trained employees in every area of the organization. Essentially cross-training may allow a smaller utility to have a flexible group of employees capable of filling in when necessary. In this way, cross-training overcomes the structural disadvantages that smaller utilities in economically challenged regions face.

It is even possible that cross-training could have helped alleviate some of the strain on the organizational resources for utility B that came during the transition to the new water treatment plant. Just before the transition to the new plant, the utility received a number of citations from the state's department of health, and as a part of a resulting settlement had to keep the new treatment plant compliant for a year. During the transition from the old plant to the new one, the current manager (then the plant superintendent) and the current plant superintendent (then an operator) essentially had to operate two treatment plants at once, since they had to make sure that the new one would be compliant before switching over. While they were able to accomplish the goal of compliance for a year, this was a difficult period for the utility and required many hours of overtime from the two employees. Cross-training may have helped to ease the transition between the plants. Rather than have two employees essentially running two plants at the same time, if employees working in areas other than treatment were cross-trained, then the utility would have been able to move a few employees over to help work the old plant while the current operators learned the new plant. Having a group of flexible employees trained in treatment to help at the old plant would have reduced the strain that was placed on the superintendent and operator.

Utility A's successful cross-training program does not take place in a vacuum. Integral to their ability to cross-train is the longevity of their employees. Utility A's general manager and supervisors estimated that it takes about five years for an employee to be fully licensed through cross-training. This case suggests that cross-training only helps a small utility overcome human capital constraints if two conditions are met. First, the employee being cross-trained must be at the utility long enough to undergo full training. If the utility experiences high levels of turnover, its managers cannot expect employees to be around long enough to fully cross-train them. Second, the utility must have enough well-trained employees so that when additional, advanced outside training opportunities are readily available, they are able to cover the work of others. Indeed, employees mentioned that full cross-training takes a long time specifically because it sometimes is difficult to cover for the worker that would be missed. If already-trained employees are not available to cover, cross-training is difficult to impossible to achieve. Of course, a larger utility with more resources may be able to devote more time to cross-training its employees, but such a utility would have less need to cross-train. Utility A's general manager recognized the key relationship between longevity and training, noting that she targeted job candidates who would be expected to stay in the long term, specifically because she didn't want the utility to be a training ground with a revolving door.

The ability of employees to work in multiple functional areas of a utility is frequently governed by regulatory and legal requirements. In many cases, employees must be certified separately by their respective state agencies in treatment, distribution, backflow and cross connection, or other functions.

CONCLUSION

Just as a utility must find a source of water supply and financial resources, it also must have a source of high-quality workers in order to succeed. This study has demonstrated a strong correlation between utility scale, the availability of human capital in a labor market, and mission-critical performance as measured by SDWA compliance. Statistical analysis indicates that SDWA management compliance is strongly correlated with utility size. More importantly, utility compliance with SDWA health regulations also is strongly correlated with the availability of human capital in the utility's labor market. These statistical relationships hold even after controlling for supply source, income, and a host of other demographic variables. The relationship between compliance and availability of human capital is especially acute in smaller utilities, where limited organizational capacity means that organizations may struggle to attract and retain talented labor. Utility success in these economically and/or socially challenged regions may require special workforce strategies.

As an initial step toward identifying management strategies that might help overcome limited human capital availability, this study analyzed staffing and management in a pair of very similar utilities that operate in regions with low human capital, but have experienced varying degrees of SDWA compliance over the past few years. Careful review of management practices revealed broad similarity in management strategy across the two utilities, but one key difference may help explain their differences in SDWA performance—cross-training. Training all utility staff—including field, plant, customer service, and front office personnel—on all phases of utility operation appears to provide smaller utilities in a limited human capital region a degree of resilience and proficiency beyond ordinary organizational capacity. The flexibility offered by cross-training might also help organizations weather the storm of massive retirements now beginning to sweep across water utilities. A significant corollary to this finding about cross-training is that low turnover/long tenure among employees is much more significant for utilities in human capital-scarce regions. It would be premature to make broad, industry-wide management recommendations on the basis of this limited study. Also, utility managers should check with their individual regulatory authorities prior to deploying cross-trained employees. Nonetheless, the initial findings here suggest that cross-training might be a workforce and human capital management strategy that is worth exploring.

Implications for AWWA workforce strategies. At least three key implications follow from the findings reported here. The first is a clear finding based on rigorous and exhaustive statistical analysis. The remaining two are less definitive but point the way to potentially significant advances in workforce development for water utilities.

- Limited human capital is a significant challenge for water utilities. Workforce issues are important for utilities everywhere, but statistical analysis of SDWA compliance firmly demonstrates that workforce challenges are especially acute for utilities in regions with limited access to human capital.
- Smaller utilities are particularly vulnerable to human capital scarcity, owing to their limited capacity to cultivate their own human resources. Thus, to maximize impact, AWWA's workforce efforts should give special attention to smaller, geographically isolated utilities. Efforts aimed at connecting

military veterans with jobs in the water industry may be fruitful in such efforts, since military personnel hail disproportionately from rural areas (Kane 2005) and may seek employment near their former homes upon discharge.

- Smaller utilities might be able to mitigate limited access to human capital through extensive staff cross-training. The initial paired case study suggests that cross-training in multiple functions can provide smaller utilities with greater flexibility and resilience. Cross-training allows smaller utilities to maintain high levels of technical knowledge in a rapidly advancing field and provides capacity to handle extreme events and crises. As with boxing, cross-training may help smaller utilities "punch above their weight." Such extensive cross-training is possible only for organizations in which turnover is low. In light of the findings of this study, AWWA should investigate more thoroughly the promise of cross-training in utilities—that is, the human dimension of Total Water Solutions®—particularly in smaller or medium-sized organizations. More extensive study should be undertaken to affirm, falsify, or refine the apparent connection between cross-training and performance in small utilities that operate in labor markets with low human capital. In a similar vein, regulators should explore potential regulatory incentives for and barriers to cross-training.

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