# Addressing Workforce Attrition, Retention, Absenteeism, and Recruitment in the Rural Alaska Water Sector

Michaela LaPatin, P.E., S.M.ASCE[1], Nikki Ritsch, S.M.ASCE [2], Daniel Armanios, Ph.D.[3], Leif Albertson[4], Lynn Katz, Ph.D.[5], Kasey M. Faust, Ph.D., A.M.ASCE[6]

[1] Dept. of Civil, Architectural and Environmental Engineering, Univ. of Texas at Austin, ORCID: https://orcid.org/0000-0001-6304-7592. Email: mlapatin@utexas.edu
[2] Dept. of Engineering and Public Policy, Carnegie Mellon University, ORCID: https://orcid.org/0000-0002-3936-443X. Email: nritsch@andrew.cmu.edu
[3] Professor, Saïd Business School, University of Oxford, Oxford, UK; ORCID: https://orcid.org/0000-0001-7100-2861. Email: daniel.armanios@sbs.ox.ac.uk
[4] Natural Resources and Extension, University of Alaska Fairbanks, Email: leifalbertson@gmail.com
[5] Professor, Dept. of Civil, Architectural and Environmental Engineering, Univ. of Texas at Austin, ORCID: https://orcid.org/0000-0002-4244-334X. Email: lynnkatz@mail.utexas.edu
[6] Associate Professor, Dept. of Civil, Architectural and Env. Engineering, Univ. of Texas at Austin. ORCID: https://orcid.org/0000-0001-7986-4757. Email: faustk@utexas.edu (corresponding author)

## ABSTRACT

Rural water utilities often struggle to retain a reliable, skilled workforce. In the Yukon-Kuskokwim (YK) Delta of Alaska, this challenge is exacerbated by communities' remoteness, small populations, and limited economies. Workforce attrition leaves utilities understaffed and unable to provide sufficient water services to their community. In this study, we evaluate interviews with seven YK Delta water sector professionals, including environmental health officers, water plant operators, and water haulers. Through a hybrid qualitative content analysis and cognitive mapping, we seek to better understand the relationships between workforce attrition and interdependent system factors. For instance, we identify that overworking can lead to attrition, which can lead to service disruptions. Preliminary results indicate that a major concern for water sector professionals is the excessive hours of work, which leads to worker burnout, attrition, and absenteeism. We further identify that increased wages for water sector workers can improve retention and recruitment, likely leading to long-term improvements in water provision.

## INTRODUCTION

The built environment requires a sizable skilled workforce for construction, operation, and maintenance of essential services. Unfortunately, the number of skilled trade workers has decreased in recent years, placing a strain on the industry. In fact, according to the U.S. Chamber of Commerce, the U.S. had a shortage of 407,000 construction workers in August 2022 (U.S. Chamber of Commerce 2023). The Associated Builders and Contractors projected in early 2022 that the industry needed to recruit 605,000 construction workers to meet demands for the year (Reichle 2022). Further, in their 2022 Workforce Survey, Associated General Contractors found that 91 percent of firms had trouble filling positions in the year, and 66 percent of firms reported project delays due to workforce attrition (i.e., people leaving their job roles; Associated General Contractors and Autodesk 2022). This challenge is not limited to new construction—rather, the operations, maintenance, and management (OMM) of essential infrastructure is impacted by this shortage. Utility management relies on skilled workers to ensure safe and consistent delivery of services. In 2022, the State of the Water Industry Report, prepared by the American Water Works Association, included workforce concerns in the list of the top 20 issues facing the water sector.

Over 3,500 water professionals participated in their survey, ranking "aging workforce/anticipated retirements" at number 4 and "talent attraction and retention" at number 11 (American Water Works Association 2022). Both of these issues moved up in rankings from the previous year (from numbers 8 and 14, respectively), indicating a growing concern in the industry.

Water utilities in rural, low-income communities face additional workforce challenges, where populations are smaller and infrastructure systems are sprawling. Communities in rural Alaska, specifically, face significant challenges due to their remoteness (Hickel et al. 2018), limited economy (Hickel et al. 2018; Penn, Loring, and Schnabel 2017; Sohns et al. 2021), and extreme Arctic climate (Cozzetto et al. 2013; Marino et al. 2009; Melvin et al. 2017; Thomas, Hickel, and Heavener 2016). The workforce in these communities must be able to address frozen pipe systems, wind-damaged structures, and interrupted services, all while maintaining EPA drinking water standards. Further, the impacts of climate change cause erosion and subsidence, necessitating additional infrastructure repair, replacement, or relocation (Brown et al. 2022). In this study, we focus on the rural communities in the Yukon-Kuskokwim (YK) Delta of Alaska, where utilities often struggle to recruit and retain a water system workforce. The YK Delta is home to about 26,000 people, 85% of which identify as Alaska Native (AK DOT 2018). The region spans 59,000 square miles (AK DOT 2018) without a road system between communities. Water utilities must operate almost autonomously, with water plant operators, administrators, and maintenance workers living and working within the community. While there is a group of essential workers in this region called Remote Maintenance Workers, these individuals are dedicated to traveling between villages to assist with repairs and training, rather than supporting daily operations (Division of Water 2023). Filling the daily operations roles with skilled, consistent workers can be challenging with small populations, which range from 25 to 1,000 people in villages outside of the Bethel hub city (AK DOT 2018). In 2022, the unemployment rate in the Bethel Census Area was 8.8%, compared to 3.7% for the State of Alaska and 3.5% for the United States as a whole (Department of Labor and Workforce Development 2023).

There are three distinct water delivery methods in rural Alaska communities, including piped water systems, hauled water systems, and traditional water collection methods. Many communities use a combination of these methods to meet consumers' water demands. In a piped water system, pipes transport water from a water treatment plant to homes, with pipes often placed above the ground surface to avoid interference from shifting permafrost. These pipes require a skilled workforce who can perform preventative maintenance, as well as repair pipe damage due to freezing temperatures, permafrost heave, and damage from vehicles (Rosen 2021). In a hauled water system, water is treated at a water treatment plant, just like the piped system. However, this water is then transported to homes via truck or ATV, and stored in tanks inside the home (Hickel et al. 2018). Water can be transported by a utility employee or by the community members themselves. Finally, some community members choose to collect water from natural sources, including frozen ice, snow, or rainwater (Mattos and Blanco-Quiroga 2020).

In this study, we focus on two critical water utility roles: the water plant operators (for piped and hauled systems) and the water haulers (for hauled systems). We analyze interviews with seven key water sector stakeholders in the YK Delta to evaluate the causes and effects of workforce attrition and retention. These professionals, including environmental health officers, water truck drivers, and others, shared their experiences working with water systems in rural Alaska communities. We use these interviews to answer the following research question: *What is*

*perceived to contribute to workforce attrition and retention in rural Alaska water infrastructure systems?*

## METHODS

### Data Collection

To understand the water sector workforce in the YK Delta, we conduct seven semi-structured interviews with water sector stakeholders to collect data on workforce challenges. We then analyze the interviews using a hybrid qualitative content analysis. Interview participants include environmental health officers, water truck drivers, and engineers. These interviews were conducted remotely between November 2021 and April 2022. Interview questions were directed toward understanding the unique challenges to water service operations in the YK Delta. While we focus on workforce here, interview questions covered broader topics as well. Interviews began with background information about the interviewee, asking about their community, their family, and their career. Interview questions then moved to their experiences with water as an individual (e.g., what type of water system they used at home). Next, interviewees were asked about their work in the water sector, including daily tasks and training experiences. Finally, interviewees were asked to discuss their experiences within their community and how they believed water systems could be improved. Indicative questions that led to discussions of workforce were those such as, "Can you walk us through a typical workday in your role?", "How have water systems changed over time?", and "What workforce challenges do you face when operating your water system?"

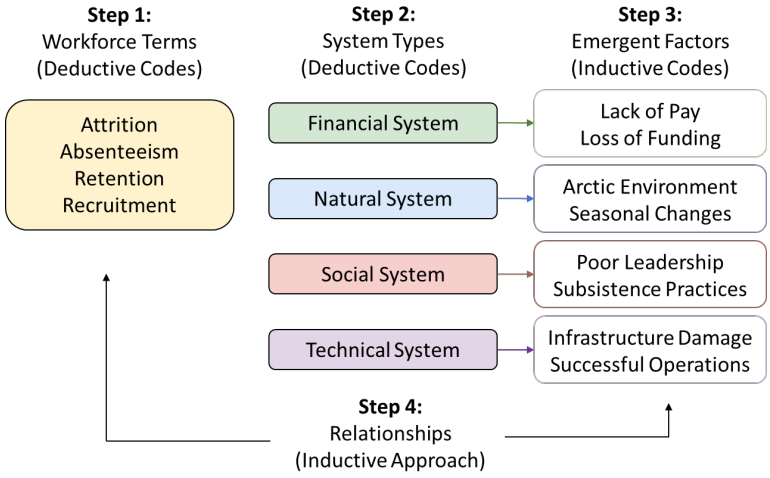


**Figure 1. Coding process used in the qualitative content analysis. The emergent factors shown here are examples and not all-inclusive.**

### Qualitative Content Analysis

We used a hybrid deductive-inductive qualitative content analysis approach (Saldaña 2013; Spearing, Bakchan, et al. 2022) to provide insights into stakeholders' experiences with water utilities and their perceptions of workforce challenges. The analysis process is shown in Figure 1, and divided into four key steps: workforce terms, system types, emergent factors, and relationships. In compiling all of the relationships in Step 4, we create the cognitive maps shown in Figures 2 and 4. We include the codes from Steps 1, 2, and 3, connecting each via the relationships identified in Step 4. In these maps, the arrowheads indicate the directionality of the

relationships (i.e., A leads to B). Qualitative coding was performed using NVivo Software (QSR International Pty Ltd 2020). The coding was completed by one researcher and validated by a second researcher who coded a set of interviews independently.

## RESULTS AND DISCUSSION

The analysis revealed important findings regarding workforce retention and attrition in the rural Alaska water sector. The interviewees discussed attrition (i.e., people leaving their jobs) most frequently, as shown in Table 1, indicating that this may be a significant (if not critical) concern for stakeholders. This finding aligns with research and reports on the water sector workforce nationwide (Kane and Tomer 2018; Paxton, Anderson, and McDonald 2022; Ross 2020). Further analysis identifies reasons that attrition is especially concerning in rural Alaska. Interviewees discussed the social system causes and implications of workforce attrition most frequently, likely indicating that impacts on people in the community are the most salient concerns for stakeholders. We can further evaluate the relationships included in the cognitive maps to explore the emergent factors leading to these challenges.

**Table 1. Frequencies at which key workforce terms and system types were discussed in interviews. Note that excerpts could be assigned more than one code.**

| | Interviewees | Frequency | Rel Freq |
|---|---|---|---|
| **Workforce Term** | **7** | **53** | **100%** |
| Absenteeism | 5 | 8 | 15% |
| Attrition | 7 | 21 | 40% |
| Recruitment | 3 | 12 | 23% |
| Retention | 7 | 12 | 23% |
| **System** | **7** | **99** | **100%** |
| Financial | 5 | 18 | 18% |
| Natural | 4 | 9 | 9% |
| Social | 7 | 40 | 40% |
| Technical | 6 | 32 | 32% |

### Absenteeism and Attrition

Absenteeism was discussed in 15% of excerpts. The analysis indicates several factors that lead to absenteeism (i.e., people missing work for some period of time), as shown in Figure 2. Nationwide, absenteeism was a major concern in the water sector workforce in the first several years of the COVID-19 pandemic (AWWA 2021; Switzer, Wang, and Hirschvogel 2020). Yet, in rural Alaska, absenteeism persists as a major concern for reasons that are unique to these communities, including Arctic weather conditions, training requirements, and subsistence practices. As one interviewee explained, absenteeism is especially problematic due to the already low number of workers available. They stated, *"we have operators that will take subsistence leave, so sometimes summer times can be hard to find someone around to run the water plant."*

Extreme Arctic weather poses significant challenges for water haulers in the YK Delta, as they must navigate icy roads, low visibility, and freezing temperatures. Figure 2 shows that arctic weather can lead to worker injury or illness, resulting in absenteeism. As one participant explained about the haulers, "*They're constantly going in and out, so you're getting hot and cold, hot and cold, hot and cold. You're more susceptible to be getting sick because, you get inside the truck, you start sweating. You go outside, you get cold. […] So, we'd have drivers that get sick, and you'd*

*have to take time off to rest up."* The Arctic environment presents increased levels of health and safety risks for these water sector workers. Additionally, the water delivery role is rarely found in other parts of the United States and is fairly unique to rural Alaska communities. Therefore, the missed working days due to injury or illness are likely more significant for rural Alaska.

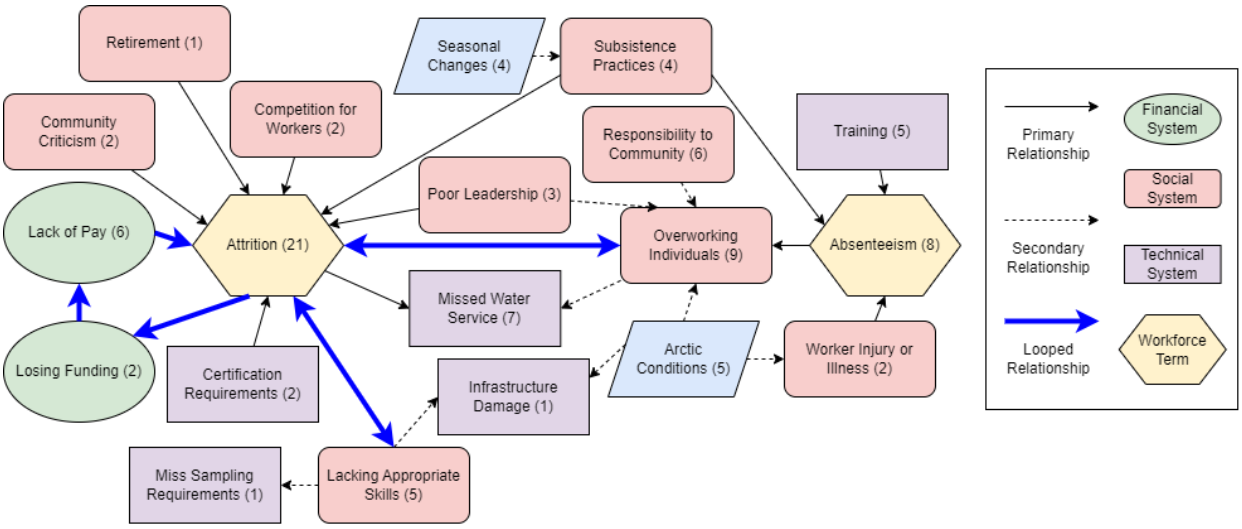


**Figure 2. Cognitive map showing factors associated with attrition and absenteeism. Numbers indicate frequencies at which each factor was included in interviews.**

Another factor leading to absenteeism is workforce training (Figure 2). Job training for water plant operators is both essential and disruptive. Water plant operators are required to attend trainings and testing to complete certifications, often for several cycles to obtain the appropriate level of certification (Department of Environmental Conservation 2016). In rural Alaska, training poses an additional challenge due to the remoteness of communities, which are not connected by road systems. Traveling to other communities for in-person training requires water plant operators to spend significant time away from their homes and water plants. While some training programs have implemented online course offerings, internet connectivity is often not reliable enough for operators to fully participate from remote communities. Even while the online training eliminates travel costs, it still requires several hours of an operator's time each day. As one interviewee stated, *"They don't have a whole crew of people that can fill in when someone comes to training for a week."* This is an additional hurdle for communities with small populations, where they cannot find a suitable replacement for operators during training. This absenteeism due to training responsibilities can leave some water systems without a reliable operator for that period of time.

In addition to absenteeism, attrition (i.e., workers leaving their roles) was discussed in 40% of the interview excerpts. Both absenteeism and attrition can result from challenges around subsistence practices in rural communities, as shown in Figure 2. Subsistence in this region includes hunting, fishing, and collecting berries, and is the primary method of obtaining food for Alaska Natives in the YK Delta (Ballew et al. 2006; Herman-Mercer et al. 2019; Johnson et al. 2009; West and Ross 2012). With roughly 85% of YK Delta residents identifying as Alaska Native (AK DOT 2018), subsistence practices are embedded into the culture of the community. An interview participant explained that *"what's really valuable [here] is hunting, and sharing your food, and subsistence, and family. And that's what makes the place so special."* Competing with this priority is the need for full-time water sector OMM. Water sector workers are often expected

to work full-time, with limited time off throughout the year, which does not align with traditional subsistence practices. If water plant operators or water haulers miss work due to subsistence needs, the utility must find other workers in the interim to fulfill the duties. In communities with small populations, where most people practice subsistence, this can be nearly impossible. The interviewee continued, *"So now you're asking these Native men and women to come drive [and] telling them, 'Nope, you can't moose hunt, I don't [have] enough guys. Nope, you can't go fishing.' That's a big issue."* This misalignment between Indigenous and Western practices often leads not just to absenteeism, but to attrition. Rather than compromising their traditional values and the needs of their family, some Alaska Native workers will choose to leave their roles in the water sector, instead prioritizing subsistence needs.

There are several instances of looped relationships, which have cyclical feedback, shown with thick blue arrows in Figure 2. One such loop shows that overworking individuals can lead to attrition, and that attrition can lead back to overworking individuals. As explained by interview participants, overworked individuals sometimes reach a point of burnout, leading them to leave their roles in search of a less-demanding job. However, as the workforce thins, more work is often thrust upon those workers who remain, which leads to overwork. This cycle can continue if there is not some intervention to address the issue. Even more, this cycle is exacerbated by absenteeism. Figure 3 shows the effects of attrition and absenteeism on water truck drivers, as explained by an interview participant. Scenario A is the "ideal" scenario—this is how the routes are supposed to be distributed, with each driver taking one route and working roughly 8-10 hours each day. Scenario B is the more "typical" scenario, where one of the routes will be split up amongst drivers in addition to their regularly assigned route. This often occurs due to attrition, and drivers are expected to work 10-12 hours each day because there are not enough drivers to cover the routes. Scenario C is the most "difficult" scenario, which still happens fairly often due to absenteeism. Drivers are expected to share the missed routes, leading to 12–14-hour workdays.

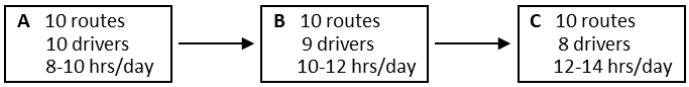


**Figure 3. Scenarios for water delivery truck drivers given attrition and absenteeism**

These looped relationships occur in the financial system as well, shown in three thick blue arrows in Figure 2. In this loop, workers choose to leave their roles due to insufficient pay. Several interview participants explained that there are some job opportunities that the low wages did not compensate enough for the long hours and Arctic conditions. Unfortunately, that attrition can lead to further financial problems, as state and federal funding is often contingent upon a utility demonstrating that they can fill roles. Without sufficient funding, small rural communities often cannot afford to pay their workers. As one interviewee explained, one community had to let go of their water plant operator due to lack of funds, at the same time that their system needed repairs. Another scenario includes bringing workers from outside of the community to fill roles when attrition is high. However, contract workers such as these tend to cost the utility more money in wages and accommodations, further draining their financial means, and perpetuating this cycle. This looped relationship between financial challenges and attrition can be detrimental for a small community, where economic activity is limited or non-existent.

### Recruitment and Retention

Workforce retention and recruitment were each included in 23% of the coded excerpts. Participants

identified actions that can lead to retention and recruitment in the water sector, such as increased wages and changes to certification requirements, as shown in Figure 4. Nationwide, recruitment and retention is a major topic of discussion and research, as industry leaders search for solutions to the shrinking workforce (Bigelow et al. 2019; Kane and Tomer 2018). Some of this research focuses on apprenticeship programs as a tool to improve recruitment (Bilginsoy 2003; Kappia, Dainty, and Price 2007; Wagner and Kulwiec 2022). Others identify certification requirements as a barrier to retention in the water sector (Hickel et al. 2018; Sohns et al. 2021; Spearing, Mehendale, et al. 2022). Understanding water sector recruitment and retention is particularly important in rural Alaska due to the small populations, remote locations, and limited economies.

Interview participants identified worker morale as a key component of workforce recruitment and retention. Several factors shown in Figure 4 can positively impact worker morale, including better pay, community support, and supportive leadership. This finding is supported by psychology, business, and construction literature, which shows that worker morale impacts retention (Edmondson and Bransby 2023; Nkomo, Thwala, and Aigbavboa 2018; Shan et al. 2017). In rural Alaska, community support is particularly important due to the small populations and limited work opportunities. Several interviewees discussed these actions, emphasizing that workers need to feel valued and be treated in such a way that shows the importance of their work in the water sector. A participant explained that one way to improve morale is to pay higher wages, stating that *"if we could pay operators more, […] I think it would be a way to recognize their contributions, and it would be a way to hold on to them longer."* Increasing wages for water sector workers in rural Alaska would help demonstrate to the workers and to the community that they provide an essential service, on par with health care workers and other respected professions. As another participant explained, "w*ater and sewer people are public health professionals [..] and I think they should be treated as such. But I feel like culturally, we're not doing that right now."* With greater support from the community and from the water systems' leadership, workers might feel more valued in their roles, and stay in their positions longer.

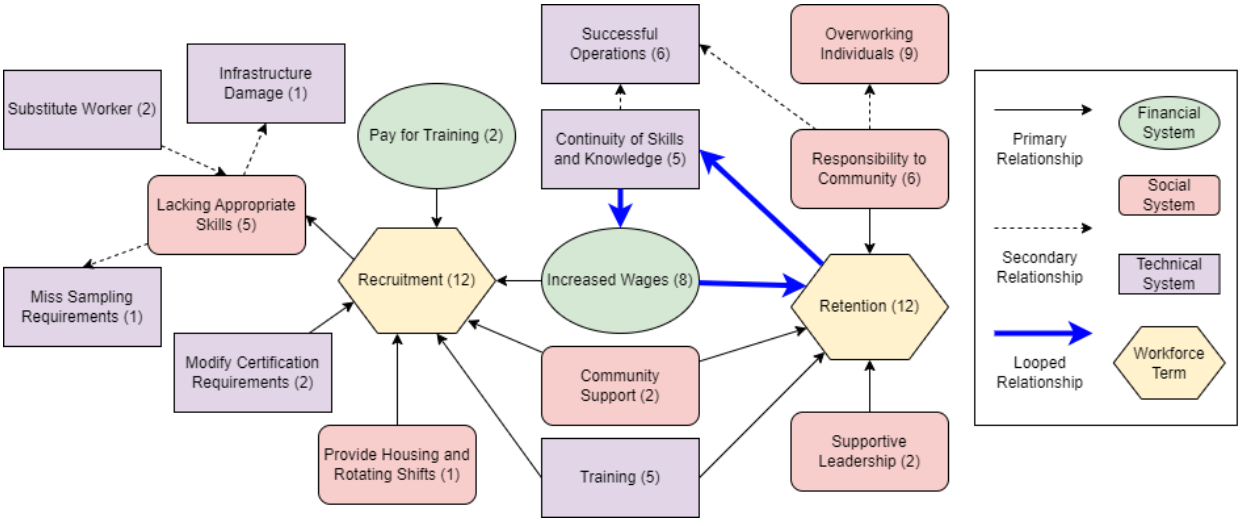


**Figure 4. Cognitive map showing factors associated with recruitment and retention. Numbers indicate frequencies at which each factor was included in interviews.**

A factor that was discussed by several stakeholders and was emphasized as being critical to the success of water systems in the YK Delta is the workers' sense of responsibility to their communities. Many water operators and haulers recognize the importance of their work, and they

take pride in providing the essential service to their community. This responsibility can lead to retention, incentivizing workers to stay in their roles despite the challenging conditions previously discussed. An interviewee discussed an encounter with a water truck driver, *"'You're still doing this? You should have been retired.' […] 'Yeah, I could have retired a while back, but I just love my job always helping people out.'"* This connection to their community is a critical piece of workforce retention. Water system owners can learn from this result, and encourage connections between the workforce and the community.

Participants discussed methods that could be used to improve recruitment, including making changes to the employment structure. A participant explained a workforce model that is commonly used in Alaska, where workers travel to the area, work long days for two weeks, and then travel home for two weeks. In this model, housing is typically provided for the work weeks. They explained, "*I believe that a bunkhouse and a two weeks rotational shift would be hugely beneficial."* Others further argued that changes to the training and certification requirements for water plant operators would improve recruitment and retention by minimizing barriers. Many states, including Alaska, have adopted operator certifications that allow operators to work in other states with their license. However, participants explained that the testing requirements for such certifications are unreasonable in the YK Delta, and instead should be modified to focus on the operation requirements for the local systems. Making these changes to the working and training models for rural Alaska water systems would improve recruitment and retention.

Several interview participants also warned about negative effects of rapid recruitment in the water sector. They explained that workers who are hired quickly to fill important roles are not always adequately trained. For instance, during seasonal changes, a new operator might "*not do something right and break something, that was kind of a norm. The first cold snap in some communities that the water plant operator wasn't up to snuff on, that was usually the problem."* These service disruptions can be inconvenient or even harmful if community members cannot receive treated water as expected. Further, operators without adequate training might make mistakes or fail to complete required water sampling. Failing to properly complete water sampling can lead to regulatory implications for the utility.

## CONCLUSION

Here we evaluated interviews with seven water sector professionals in the Yukon-Kuskokwim Delta of Alaska to understand factors that contribute to workforce absenteeism, attrition, recruitment and retention. Water sector workforce attrition is a challenge nationwide, with an aging workforce and few apprentices joining the workforce each year. The workforce attrition in rural Alaska communities is particularly concerning due to their remote locations and small populations. Here we sought to better understand the challenges, as well as identify potential interventions for workforce improvement.

We identified several key factors that contribute to workforce attrition and absenteeism, including overworking and sickness. The harsh arctic weather poses challenges to water haulers, especially, who risk sickness and injury in the cold and dark winter. Additionally, while training is essential to water sector jobs, it is also disruptive, often requiring travel away from remote communities. As these factors lead to absenteeism and attrition, they exacerbate the challenge of overwork—when there are fewer workers available, the remaining workers are forced to work longer days, leading to burnout. As we develop an understanding of the factors contributing to

workforce absenteeism and attrition, we can also identify the interventions that may improve retention and recruitment. For instance, many interview participants indicated that worker morale is essential—community respect, supportive leadership, and a sense of responsibility to one's community all contribute to worker retention. Additionally, modifications to the current working model, such as rotational shifts and worker housing, may improve recruitment efforts. Water utility owners and decision-makers can use these findings to consider changes to their working models, improving working conditions, worker morale, and overall performance of the water utility.

## ACKNOWLEDGEMENTS

This work is supported by the National Science Foundation Awards #2127353/ 2127354.

## REFERENCES

AK DOT. 2018. "Yukon-Kuskokwim Delta Transportation Plan 2018." *AK Dept. of Transp. and Public Facilities*. https://dot.alaska.gov/stwdplng/areaplans/area_regional/ykd.shtml.

American Water Works Association. 2022. "State of the Water Industry: Executive Summary."

Associated General Contractors and Autodesk. 2022. "2022 Workforce Survey Analysis."

AWWA. 2021. "COVID Water Sector Impact Survey 5." American Water Works Association.

Ballew, Tzilkowski, Hamrick, and Nobmann. 2006. "The Contribution of Subsistence Foods to the Total Diet of Alaska Natives in 13 Rural Communities." *Ecology of Food and Nutrition* 45 (1): 1–26. https://doi.org/10.1080/03670240500408302.

Bigelow, Zarate, Soto, Arenas, and Perrenoud. 2019. "Attracting and Retaining Tradespeople, an Eval. of Influencers on Constr. Workers in Two Different Trades in Texas." *Intl. J. of Const. Educ. and Res.* 15 (3): 163–78. https://doi.org/10.1080/15578771.2017.1280103.

Bilginsoy. 2003. "The Hazards of Training: Attrition and Retention in Construction Industry Apprenticeship Programs." *Industrial and Labor Relations Review* 57 (1): 54–67.

Brown, Spearing, Roy, Kaminsky, and Faust. 2022. "Drivers of Declining Water Access in Alaska." *ACS ES&T Water* 2 (8): 1411–21. https://doi.org/10.1021/acsestwater.2c00167.

Cozzetto, Chief, Dittmer, Brubaker, Gough, Souza, Ettawageshik, et al. 2013. "Climate Change Impacts on the Water Resources of American Indians and Alaska Natives in the U.S." *Climatic Change* 120 (3): 569–84. https://doi.org/10.1007/s10584-013-0852-y.

Dept. of Environmental Conservation. 2016. "Water and Wastewater Operators Certification and Training." State of AK. https://dec.alaska.gov/media/ikmdy5mz/18-aac-74.pdf.

Dept. of Labor and Workforce Development. 2023. "Labor Force Area Data." https://live.laborstats.alaska.gov/data-pages/labor-force-area-data?s=6&a=0.

Division of Water. 2023. "Remote Maintenance Work Program." Alaska Department of Environmental Conservation. 2023. https://dec.alaska.gov/water/remote-maintenance/.

Edmondson, and Bransby. 2023. "Psychological Safety Comes of Age: Observed Themes in an Established Literature." *Annual Review of Org. Psych. and Org. Behavior* 10 (1): 55–78. https://doi.org/10.1146/annurev-orgpsych-120920-055217.

Herman-Mercer, Laituri, Massey, Matkin, Toohey, Elder, Schuster, and Mutter. 2019. "Vulnerability of Subsistence Systems Due to Social and Env. Change: A Case Study in the YK Delta, Alaska." *ARCTIC* 72 (3): 258–72. https://doi.org/10.14430/arctic68867.

Hickel, Dotson, Thomas, Heavener, Hébert, and Warren. 2018. "The Search for an Alternative to Piped Water and Sewer Systems in the Alaskan Arctic." *Env. Science and Pollution Research* 25 (33). https://doi.org/10.1007/s11356-017-8815-x.

Johnson, Nobmann, Asay, and Lanier. 2009. "Dietary Intake of Alaska Native People in Two Regions and Implications for Health: The Alaska Native Dietary and Subsistence Food Assessment Project." *Intl. Journal of Circumpolar Health* 68 (2): 109–22.
Kane, and Tomer. 2018. "Renewing the Water Workforce."
Kappia, Dainty, Price. 2007. "Prioritising Career Development in Relation to Recruitment and Retention: A Trade and Craft Perspective." *Constr. Mgmt. and Econ.* 25 (3): 239–53.
Marino, White, Schweitzer, Chambers, Wisniewski. 2009. "Drinking Water in NW AK: Using or Not Using Centralized Water Systems in Two Rural Communities." *Arctic* 62 (1): 75–82.
Mattos, and Blanco-Quiroga. 2020. "Water Infrastructure Brief: Opportunities and Challenges for Washeterias in Unpiped Alaska Communities."
Melvin, Larsen, Boehlert, Neumann, Chinowsky, Espinet, Martinich, et al. 2017. "Climate Change Damages to AK Public Infr. and the Econ. of Proactive Adaptation." *Proc. of the Natl. Acad. of Sciences of the United States of America* 114 (2): E122–31.
Nkomo, Didibhuku Thwala, and Ohis Aigbavboa. 2018. "HR Mgmt. and Effects of Mentoring on Retention of Employees in the Constr. Sector…" Springer International Publishing.
Paxton, Anderson, and McDonald. 2022. "The Water Sector Industry Workforce: A Quantitative Case Study, Tennessee, USA." *Utilities Policy* 76: 101356.
Penn, Loring, and Schnabel. 2017. "Diagnosing Water Security in the Rural North with an Environmental Security Framework." *Journal of Env. Mgmt.* 199 (September): 91–98.
QSR International Pty Ltd. 2020. "NVivo." https://www.qsrinternational.com/
Reichle. 2022. "ABC: Construction Industry Faces Workforce Shortage of 650,000 in 2022." *Associated Builders and Contractors*, 2022.
Rosen. 2021. "For Some Alaska Villages, the Lack of Modern Water and Sewer Service Means More Health Risks." *Arctic Today*, 2021.
Ross. 2020. "America's Water Sector Workforce Initiative: A Call to Action." U.S. EPA.
Saldaña. 2013. *The Coding Manual for Qualitative Researchers*. Second. SAGE Publications.
Shan, Imran, Lewis, and Zhai. 2017. "Investigating the Latent Factors of Quality of Work-Life Affecting Constr. Craft Worker Job Satisfaction." *J. of Const. Engr. and Mgmt.* 143 (5).
Sohns, Ford, Adamowski, and Robinson. 2021. "Participatory Modeling of Water Vulnerability in Remote AK Households Using Causal Loop Diagrams." *Env. Mgmt.* 67 (1): 26–42.
Spearing, Bakchan, Hamlet, Stephens, Kaminsky, and Faust. 2022. "Comparing Qualitative Analysis Techniques for Construction Engineering and Management Research: The Case of Arctic Water Infrastructure." *J. of Const. Engr. and Mgmt.* 148 (7): 1–12.
Spearing, Mehendale, Albertson, Kaminsky, and Faust. 2022. "What Impacts Water Services in Rural Alaska? Identifying Vulnerabilities at the Intersection of Technical, Natural, Human, and Financial Systems." *J. of Cleaner Production* 379 (December): 1–12.
Switzer, Wang, and Hirschvogel. 2020. "Municipal Utilities and COVID-19: Challenges, Responses, and Collaboration." *The American Review of Public Administration* 50 (6–7).
Thomas, Hickel, and Heavener. 2016. "Extreme Water Conservation in Alaska: Limitations in Access to Water and Consequences to Health." *Public Health* 137 (August): 59–61.
U.S. Chamber of Commerce. 2023. "U.S. Chamber of Commerce." *America Works Data Center*.
Wagner, and Kulwiec. 2022. "Expanding Pre-Apprenticeship Training Programs as a Model to Improve Recruitment and Retention of Building Construction Tradeswomen." *International Journal of Construction Education and Research.* 18 (1): 3–16.
West and Ross. 2012. "Local Institutions for Subsistence Harvesting in Western AK: Assessing Their Adaptive Role in the Context of Global Change." *J. of Ecol. Anthr.* 15 (1): 22–40.