

Increasing Awareness of Water Treatment Careers

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This image was taken with permission at the Fairhaven Water Pollution Control Facility at Fairhaven, MA

Abstract

Water treatment operators ensure the quality of public drinking water and protect the environment by cleaning wastewater. The United States is currently facing a shortage of water treatment operators. Moreover, $\frac{1}{3}$ of current operators are eligible for retirement within the next 10 years. Facing such a serious shortage puts both public health and the environment at risk. For our project, we worked with the Massachusetts Department of Environmental Protection to identify the causes of the operator shortage and develop recommendations to increase awareness and recruitment for the water treatment field. To achieve this goal, we conducted 18 interviews with municipal officials and private corporations and collected 206 survey responses from vocational high school and community college students.

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Water Treatment Industry and System Operator Shortage

Trouble in Water Treatment Operator Recruitment

For 90% of Americans, their drinking water is provided by one of the 148,000 United States Environmental Protection Agency (USEPA)-regulated public water systems (U.S. Environmental Protection Agency, 2015). However, the laws and regulations would be little more than the paper they were written on without water treatment operators. Water treatment operators ensure the safety of our drinking water resources and are the first and last responders to human or nature-derived water contaminations (Elledge et al., 2007). Historically, the operator-managed water treatment process has helped prevent disease outbreaks. In 1908, the United States adopted chlorine disinfection treatments. Between 1900 to 1950, communal efforts in establishing specialty water treatment plants and performing chlorination treatment nationally curbed typhoid infection death rates from 36 per 100,000 people to 0.1 per 100,000 people (Symons, 2006). The passage of the 1974 Safe Water Drinking Act (SWDA) continued this progress by imposing stricter safety standards for drinking water. As a result, water treatment plants and water treatment operators had a framework to significantly improve the quality of drinking water nationwide (Cotruvo, 2012). However, despite the importance of this job sector, there have been few new operators entering the industry.

Interestingly, while average employment opportunities in the United States is predicted to increase by 8 percent between 2020 and 2030, the water and wastewater treatment industry is projected to have a net loss of employment: a drop of

three percent or 3100 out of the 122,100 national operators (U.S. Bureau of Labor Statistics, 2020). In addition, we are in danger of losing nearly one-third of all qualified drinking water and wastewater operators in the next 10 years due to retirement eligibility without enough sufficiently qualified employees to take their place (U.S. Environmental Protection Agency, 2020). Moreover, as of 2018, only one percent of water and wastewater operators are 24 years old or younger (David, 2019). This shortage of new qualified operators will leave treatment plants under-resourced and at risk of jeopardizing public health (Boepple-Swider, 2008).

Water Treatment Plants

Water Treatment plants fall into two categories, Drinking Water Treatment Plants (DWTP) and Wastewater Treatment Plants (WWTP). In this section we discuss the differences between water and wastewater treatment plants and their importance.

Drinking Water Treatment Plants and Human Health

Freshwater supplies can contain numerous types of organic matter, bacteria, viruses, and toxins which affect the quality of water and can lead to health hazards.

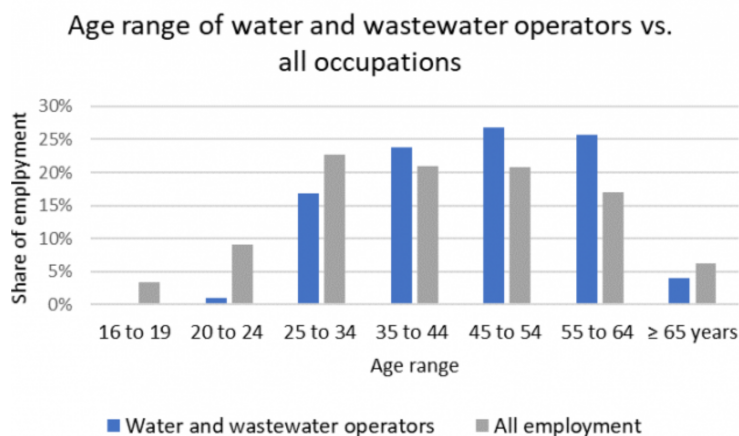


Figure 1: National Average Age Range Distribution for Water and Wastewater Operators Compared to All National Employments (U.S. Bureau of Labor Statistics, 2018)

Drinking Water Treatment Plants are necessary to remove disease-causing agents from drinking water sources to protect human health. There are several processes for treating drinking water. The most common processes are Coagulation, Sedimentation, Filtration and Disinfection (Centers for Disease Control and Prevention, 2015). The processes are arduous and require expertise and close monitoring to ensure purity in water and safety for the community. A simplified version of the water treatment processes is illustrated in Figure 2 below.

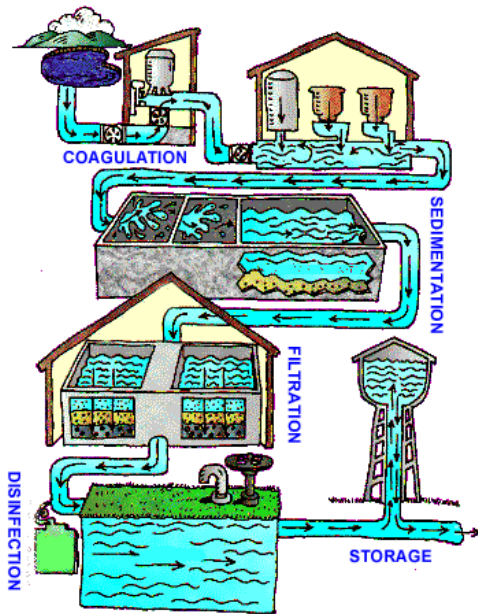


Figure 2: Water Treatment Process (EPA, 2009)

Between 1961 and 1970 there were numerous waterborne illnesses. These include: 14 outbreaks (22048 cases) of Gastroenteritis; eight outbreaks (239 cases) of Hepatitis; three outbreaks (737 cases) of Shigellosis; five outbreaks (16610 cases) of Salmonellosis; two outbreaks (157 cases) of Giardiasis; and one outbreak (25 cases) of Amebiasis. **Within the span of nine years, approximately 95% of epidemic outbreaks in the United States were caused by insufficiently treated water (Masschelein, 1992).**

One of the contaminants found in fresh water sources is Natural Organic Matters (NOM). Natural organic matter is a complex matrix of organic factors that is omnipresent in waters, sediments, and soils.

All natural drinking water sources are known to contain NOM (T. Sillanpää, 2015). NOM affects potable water quality by carrying metals and hydrophobic organic chemicals which contribute to undesirable color, taste, and odor problems (Gheraout, 2020). The coagulations process alone can remove up to 80% of the organic carbon and hydrophobic and molecules with high molecular weight contained in water (Ivančev-Tumbas, 2014).

American Drinking Water Sources

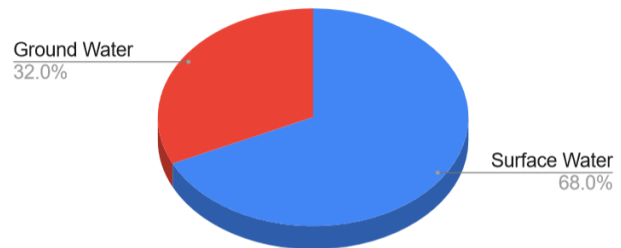


Figure 3: Pie Chart of American Drinking Water Sources (United States Environmental Protection Agency, 2008)

Environmental Benefits of Wastewater Treatment Plants

In urban environments, there are four sources of wastewater: Residential, Commercial, Infiltration/inflow and Industrial (Ding, 2017). The flow chart in figure 4 shows the types of wastewater and illustrates their path.

Beside eliminating potential health risks, Wastewater Treatment Plants also play a crucial role in helping protect the quality of water bodies. Operation of these treatment plants ensures that local bodies of water, such as lakes, streams, and the ocean, remain suitable for human and wildlife use. Wastewater contains numerous toxins, disease-causing agents, both organic and inorganic matters (Ding, 2017). If discharged without treatment, wastewater poses a serious threat to the natural environment and human health (Djukic, 2016).

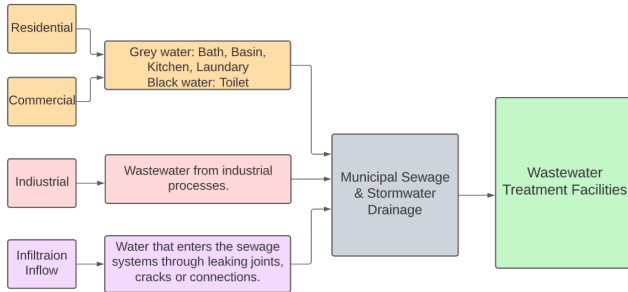


Figure 4: Origin of Wastewater in an Urban Environment (Ding, 2017)

A 2018 study by the U.S. Geological Survey detailed the various forms of life that depend on shorelines, beaches and marshes (U.S. Geological Survey, 2018). These areas are critical habitats for hundreds of species of fish and other aquatic life. Migratory water birds use the areas for resting and feeding (U.S. Geological Survey, 2018). The untreated wastewater contains contaminants that cause gastroenteritis, liver damage, nervous system impairment, skin irritation and liver cancer in animals over chronic exposure (Akpoy, 2013).

The Wastewater Treatment Plants have various effects on a healthy environment for both human and wildlife. Given the importance of drinking and wastewater treatment plants, it is critical to have qualified operators entering the water treatment industry.



Figure 5: Wastewater Treatment Operator Collecting Treatment Sample for Testing (Fairhaven Water Pollution Control Facility, 2022)

Water Treatment Operators

Both drinking water and wastewater treatment consist of complex and lengthy processes that requires operators with knowledge and experience to ensure smooth operations and high-quality water. Certified water operator are critical components of a safe water supply (American Water Works Association, 2022). In this section, we discuss the different grading and qualifications for American water treatment operators. Each state in the United States has different grading system and requirements for water treatment operators. Water treatment operators are graded based on level of examination, training program and years of experience. Coexisting with municipal plants are private owned water companies. Private water systems are for-profit systems owned by investors or shareholders. Public drinking water and wastewater systems often partner with private systems for financial or expertise reasons. Operators of both publicly operated and privately operated systems must be certified by the state board of certification (Joca, 2016).

In most careers, additional education or years of experience help employees move up their occupational ladder. In Figure 6, below, shows the ladder model and

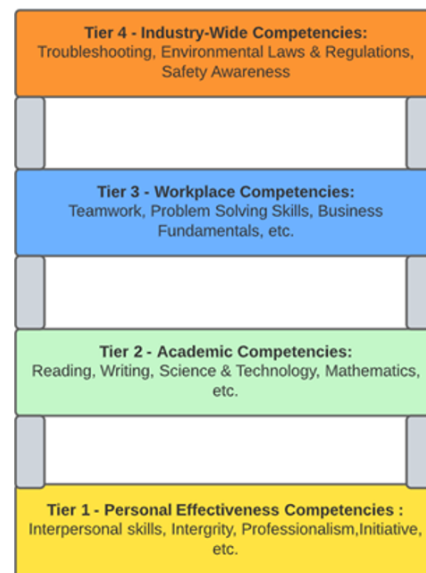


Figure 6: Water and Wastewater Competency Model (US Department of Labor, 2018)

represents the increased skills an operator must obtain in order to get promoted. Tiers 1-4 are divided into blocks representing the knowledge, skills, and abilities essential for successful performance in the water and wastewater sector (US Department of Labor, 2018).

According to John Murphy, Wastewater engineer in charge of Operator Certification and Training for MassDEP, water treatment operators need more than simply science and technological knowledge. They are expected to have strong communication, writing and reading skills. Although computer skills are essential, water treatment cannot be completed solely on computers, operators must work with almost all of their five senses (Personal Communication, February 2022).

Massachusetts Operators Certification System

In Massachusetts, there are seven level of wastewater treatment operators. For drinking water treatment operators there are four grades of certification, and the requirements are identical in wastewater treatment facilities. All levels of water treatment are required to pass the examination corresponding with the grade certification (New England Water Environment Association, 2018). Entry-level water treatment or wastewater treatment operator positions often require a high school diploma or its equivalency. Operators must be mechanically inclined and should be competent in basic mathematics, chemistry, and biology. As water treatment operations become more complex, the educational requirements increase (Spellman, 2020). In Table 1, we show additional details of the correlation between education, experience

and grade.

The Benefits and Challenges of Being a Water Treatment Operator

Becoming a water treatment operator requires years of training and experience because they are expected to be Jacks or Jills of all trades. Treatment operators are responsible for operating chemical-feeding devices and other equipment, obtaining water/wastewater samples, analyzing samples and adjusting the amount of chemicals, such as chlorine, in the water/waste stream. In addition to treatment processing, operators are expected to perform landscaping duties and other assorted functions at the facilities (Spellman, 2020). In this section we explain some of the challenges and benefits that come with being a water treatment operator.

Challenges

Upon entering the field, water treatment operators are threatened with physical dangers and financial unsustainability. In 2017, the annual cost of living in Worcester, Massachusetts was \$97,143 for a family of four (Economic Policy Institute, 2017). In 2020, water treatment operators made a median salary of \$49,090 per year or \$23.60 per hour nationally (U.S. Bureau of Labor Statistics, 2020). A similar operator in Massachusetts can expect a mean pay between \$57,170 to \$75,570 (U.S. Bureau of Labor Statistics, 2020). Even with a greater pay range in Massachusetts, the salary for operators is insufficient for supporting an average family. In addition to low salaries, plants often lack the capacity to manage employees, leading to the neglect in

Water Treatment Operator Grade	Education	Equivalent years of experience on the job.
Grade I	High School Diploma or its equivalent	2 years
Grade II	Associates Degree in science or Wastewater Treatment Technology	3 years
Grade II	Bachelor's Degree in any fields	3 years
Grade III	Bachelor's Degree (Civil, Environmental, etc.)	4 years
Grade IV	Master's Degree	5 years

Table 1. Education and Experience Equivalent (New England Water Environment Association, 2018)

planning and establishing recruitment and retention plans needed to sustain a healthy employee population (Boepple-Swider, 2008). The increasing public expectation for water quality has also outworn traditional workforce development approaches, such as word of mouth knowledge, from being sufficient for running a plant that meets current regulations (Davis et al., 2009).

Wastewater treatment workers are exposed to various hazards, such as bioaerosols and chemicals. Endotoxin exposure may have significant effects on the respiratory health of sewage treatment workers, including the development of respiratory symptoms and decreased lung function (Muzaini, 2021).

These combinations of problems have resulted in substandard work environments that burden operators with low pay, lack of support, and lack of professional development (Boepple-Swider, 2008). While being a water treatment operator can be challenging, the position also comes with various benefits and rewards.

Benefits

Becoming a water treatment operator can be a valuable opportunity, sporting various personal benefits. The first benefit for water treatment operators is job security. Same as all other jobs that government offered, there is very little chance that any government employee will lose his job. Especially at present with the shortage of operators all over the country, existing operators will hardly lose their jobs. Based on the data provided by United States Department of Labor there will be about 10,500 jobs open for people who want to work for water and wastewater treatment plant yearly, on average, over the decade (U.S. Bureau of Labor Statistics, 2020). It also means that once the requirements are met, you can easily get this job.

The second benefit is that this job may increase your sense of pride. A water treatment operators' job is to make sure drinking water is safe to drink and that wastewater is safely discharged into nature (U.S. Bureau of Labor Statistics, 2020). This job not only protects residents' safety, but

also helps protect the environment. Thus, this position is a public service to the community and can be a source of pride for operators.

However, despite the importance of water treatment operators, the job security, and the public service pride, there is a dearth of new operators. Massachusetts' Department of Environmental Protection (MassDEP) is an agency under Massachusetts' Executive Office of Energy and Environmental Affairs (EEA) that seeks to protect, preserve, and enhance Massachusetts' natural resources and the health, safety, and welfare of the community through regulation legislation and reinforcement. In order to protect local drinking water supplies, MassDEP has developed interest in counteracting the growing shortage of water treatment and wastewater treatment plant operators. For this purpose, MassDEP has reached out to Worcester Polytechnic Institute's Water Resource Outreach Center to devise explanations for the growing shortage of qualified water treatment facility candidates. As so, our team is partnering up with MassDEP to research the effectiveness of current advertisement methods among younger student and recent graduates in Massachusetts and develop methods for increasing public awareness and interests in the water treatment field recruitment.



Figure 7: Wastewater Treatment Operators From Fairhaven, MA (Fairhaven Water Pollution Control Facility, 2022)

Methodology

Between 2020 and 2030, the Water and Wastewater Treatment Industry employment is projected to decrease by 3 percent, equivalent to the loss of 3100 out of the 122,100 national operators (U.S. Bureau of Labor Statistics, 2020). In addition, one-third of certified operators will be eligible to retire, stressing current plants' ability to suitably serve the community. Working with the Massachusetts Department of Environmental Protection (MassDEP), we identified the causes of the declining workforce and developed methods for increasing awareness of water treatment positions. To accomplish this goal, we developed four objectives. In Figure 8, we offer a graphic representation of our methodological approach.

Objective 1: Gain an understanding of the benefits and challenges in the water treatment industry.

To gain an understanding of the water treatment positions, operators' challenges and benefits, and operator job satisfaction, we interviewed people that work in the water treatment field and toured water treatment plants.

To begin, we interviewed Andrea Briggs, the Deputy Regional Director for the Massachusetts Department of Environmental Protection (MassDEP) and John Murphy, the Wastewater Engineer/Operator Certification and Training from MassDEP (See Appendix A for Interview Questions). We also interviewed Michelle Jenkins, Information Officer with the New England Interstate Water Pollution

Control Commission (NEIWPCC), Evan Karsberg, and Jennifer Lichtensteiger, both Environmental Analysts with NEIWPCC (See Appendix B for Interview Questions). We've also conducted structured interviews with 14 municipal water plants superintendents and water treatment operators in 14 regions in New England (See Appendix C for Interview Questions & Appendix I for Interviewees List). During these interviews, we asked questions about the level of water treatment operator positions and associated responsibilities. Through these interviews, we gained a better understanding of the various water treatment operator certification grades along with the occupation's benefits, challenges, and levels of satisfaction.

We chose to conduct interviews with MassDEP and NEIWPCC because of their involvement in water treatment operator training and education. NEIWPCC is the regional commission that focuses on providing training for operators and education programs to engage the public in the water treatment industry (NEIWPCC, 2022). While NEIWPCC is responsible for engaging and educating the public, the MassDEP functions as a regulator to ensure that NEIWPCC's training and programs meet the state legal requirements (John Murphy, Personal Communication, February 2022). We decided to conduct semi-structured interviews because they are well designed for the exploration of the perceptions and opinions of respondents regarding the current operator shortage. This method also offers respondents a chance to provide additional information (Louise, 1994). We conducted structure interviews with 14.

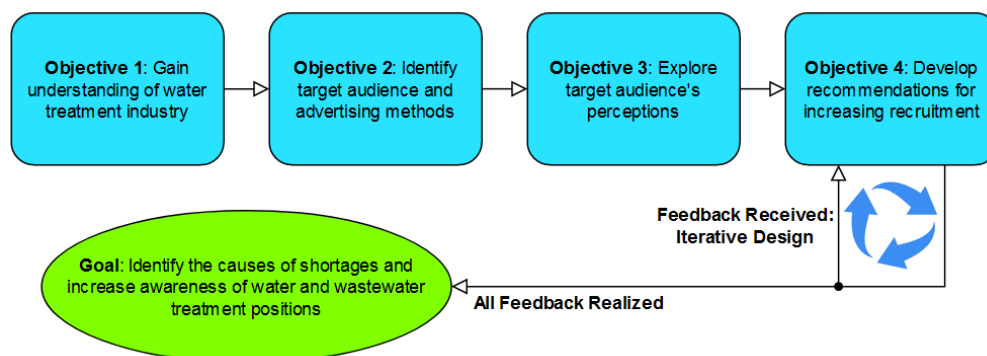


Figure 8: Methodology Flowchart

plant employees because we wanted to gain straightforward information and constructed interviews provide accurate and reliable data. Then we compiled all the interview data into comparative matrix to look for similarities between the different water facilities in Massachusetts. See Figure 9 for the comparative matrix we used for data analysis.

Name	Position/Organization	Operators' Job Satisfaction	Salary

Figure 9: Sample Comparative Matrix

The next step in achieving this objective was to visit water treatment plants. During the first week of our project, we visited the Worcester Water Filtration plant with Ms. Briggs from MassDEP. Using direct observation, we identified the responsibilities that correspond with the grade of each operator. We learned about the work environment and their day-to-day duties at the plants. We chose direct observation because it is the most appropriate data collection method to ascertain the functions performed by the water operators (Kumar, 2011). Our intention for this visit was to observe and compare the information we received from our interviews with the actual operations of the plant.

Since we only had seven weeks to achieve our goal, we completed the tasks associated with Objective 1 within the first week. In Appendix G, we provide a timeline for this project.

Objective 2: Determine how water treatment positions are currently advertised and the target audience for these positions

To determine the current target audience, advertising methods, and hiring challenges for water treatment plant positions, we conducted interviews with the municipal water plant superintendents in

Massachusetts, private water treatment providers, continuing education instructors, and members of NEIWPC.

We achieved this objective by interviewing 14 drinking and wastewater treatment plant supervisors and superintendents in 14 towns in New England. During these interviews, we asked questions about where they post jobs, challenges in recruitment, and which avenue receives the most traction from potential employees (See Appendix C for Interview Questions). We chose the plant superintendents and supervisors because they are currently involved in hiring new water treatment operators for publicly owned water treatment plants. Along with municipal officials, we chose to interview recruiters of private water companies to compare their experience in attracting potential employees to the municipal departments' experience. Our team then compared the data we collected from these interviews to identify any similarities or differences in their hiring processes and respective success.

Through the interviews with the plant supervisor and operators, we obtained information regarding training programs and how they came to be involved in this field. It was crucial to know how these operators learned about the water industry, so we could determine the effectiveness of current advertising methods.

During the semi-structured interview with the NEIWPC, described in objective 1, we asked about their current methods for advertising open positions and who the organization sees as their target audience. We chose semi-structured interviews because it allows the participants to explore ideas or aspects of current advertising methods that they consider to be important (Longhurst, 2016).

Objective 3: Explore what target audiences want from a job and their understanding of the water treatment field.

To assess what potential target populations may want from a job and their understanding of the water treatment field, we designed and conducted a pre-outreach

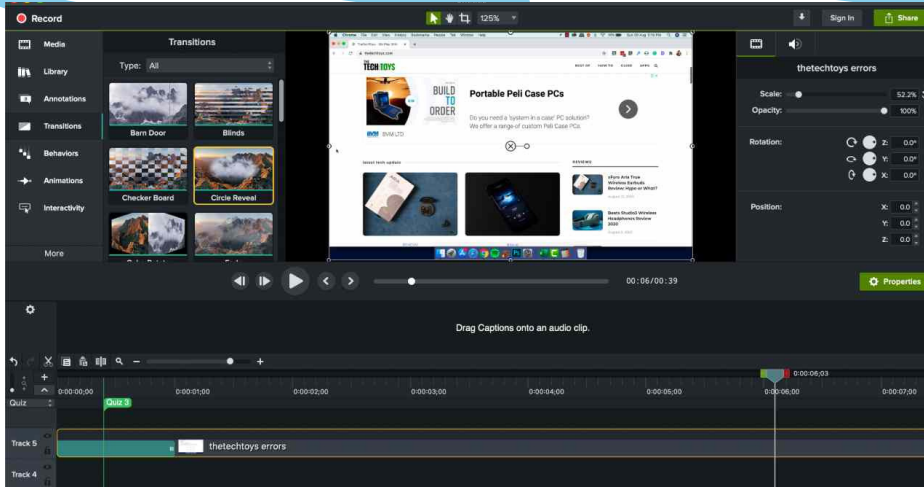


Figure 10: The TechSmith Camtasia User Interface, Our Chosen Video Editing Software (The Tech Toys, 2020)

survey for groups prioritized for recruitment by the water plant superintendents.

The survey consisted of 11 questions seeking to identify the respondents wants in a job, social media usage and knowledge of water treatment occupations. The goal of this survey was to obtain structured data on the targeted group’s knowledge and perspectives on employment in the water treatment field as. This survey also provided us with the popular social media platforms among the younger generations and the frequency of their usage. We compiled the survey results into a quantitative matrix to ease our analysis of the data (See Appendix E for the survey). The survey’s preamble can be found on Appendix D and the opt-in result form can be found on Appendix H.

As one of the target audiences includes high school students under 18 years of age, we have taken extra precautions of informing parents or guardians of our research and its purpose. We distributed consent forms to the parents or guardians in advance of surveying the students (See Appendix F for the Parental Consent Form). The vocational schools collected and stored the consent forms to protect student anonymity.

Objective 4: Develop recommendations for increased recruitment.

After gathering information on the water treatment operator field, current recruitment methods, and perspectives of operators and the target audience for potential operators, we developed recommendations and supplementary deliverables for additional avenues of outreach to develop awareness of the operator position.

To develop recommendations, we analyzed the interview data, survey data, and direct observation notes. We analyzed survey results and interview answers through quantitative generalization to find any common patterns or distinctions between operator and target audience responses in the field. The results can be treated as probable inferences of the general perspective of candidates and workers in the field (Flick, 2010).

Taking in the information from the survey data about the popular social networks that our targeted audience might use, we developed a supplementary deliverable in the form of a informational video for increasing awareness of the water treatment processes and operator field.

Using an iterative design process, we presented the recommendations to our project sponsors, Andrea Briggs and John Murphy. After receiving their feedback, we revised the recommendations and developed an action plan to share with them.

Findings

Water and wastewater treatment play an important role in protecting human and environmental health. Currently, water treatment plants are troubled with finding suitable new and young operators. To understand the issues and create effective recommendations, we interviewed superintendents and other water treatment experts and surveyed our targeted audiences. After analyzing all of the data we collected, we identified 11 findings. We organized these findings into three themes: Benefits and Challenges, Potential Target Audience, and Recruitment Methods.

The benefits and challenges in the water treatment industry

The public's lack of knowledge of the water treatment field has contributed to the operator shortage (Finding 1). We've interviewed 17 employees of municipal water treatment facilities and one private water sector employee in New England. During the interviews, we asked interviewees about the current operator shortage. All 18 agreed that the public's lack of knowledge of the field is the primary cause of the water operator shortage (see appendix I for complete interviewees list). Vincent Furtado, Director of Public Works in Fairhaven MA stated that "People have no idea where water comes from, nobody thinks about it" (Vincent Furtado, Personal Communication on March 23 2022). Similarly, Judy Bruenjes, a Senior Environmental Engineer from the Maine Department of Environmental Protection (MaineDEP), shared that being a water treatment operator is a "thankless job" because it's "a secret, invisible to the public's eyes" (Judy Bruenjes, Personal Communication, March 17 2022). The results of our survey show a similar story. Based on a survey of 206 students at Bay Path Regional Vocational Technical High School, Worcester Technical High School, and Middlesex Community College in Massachusetts, about 65% of students have no idea where their town's drinking water comes from.

Target Audiences' Knowledge of Water treatment

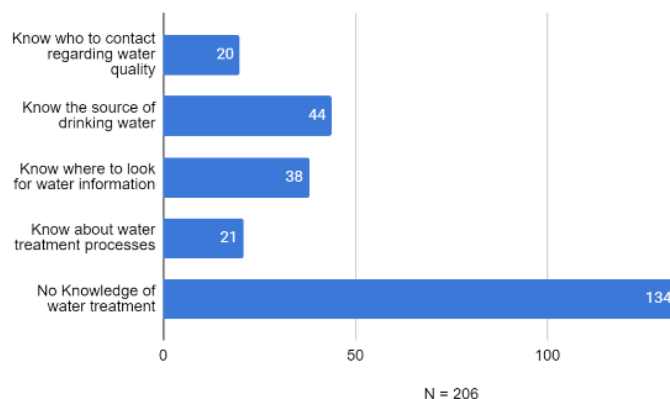


Figure 11: Target Audiences' Understanding of Water Treatment

Additionally, about 39% of students don't know where their homes' wastewater goes. Figure 11 demonstrates the numbers of respondents and their understanding of drinking water treatment. Figure 12 shows the respondents' understanding of wastewater treatment. Moreover, around 60% of students didn't know that the country is facing an operator shortage issue, and about 87% of students don't know if their local drinking and wastewater treatment facilities are currently hiring water treatment operators (see Appendix K for survey results). Not only do people have limited knowledge of the water treatment job, what they think they know is often incorrect.

Do you know where wastewater go?

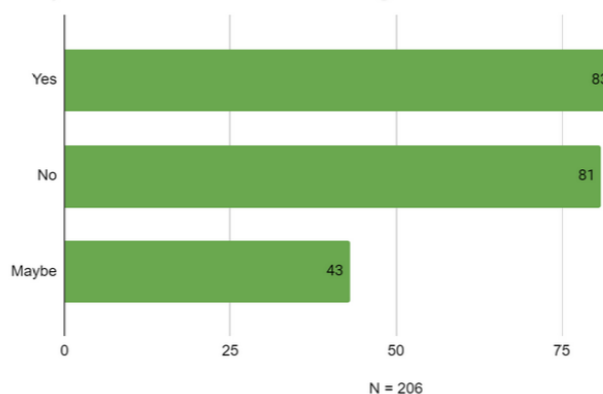


Figure 12: Target Audiences' Understanding of Wastewater Treatment

Wastewater treatment operation jobs may not be appealing to the public because of misconception of what the job entails (Finding 2). The majority of people don't acknowledge the existence of the field and those that are aware, have misconceptions about the operators' responsibilities. Twelve of the 18 interviewees, all current and former wastewater treatment operators who, based on their experience, believe that people don't want to enter the field because they view wastewater treatment as a dirty job. When asked why wastewater treatment facilities are facing such a serious shortage, Chris Welch, a Wastewater Operations Supervisor in Uxbridge of Massachusetts answered "People think it's disgusting" (Chris Welch, Personal Communication, March 22 2022). In a different interview, Arthur Simonian, Executive Director of the Mattabassett Sewer District in Connecticut agrees, " People are afraid to come into the industry. People don't want to deal with human waste" (Arthur Simonian, Personal Communication, April 6 2022). People misunderstand and assume that operators only deal with human waste. In fact, wastewater operators do technical and mechanical work. Wastewater operators have an understanding of science, machine maintenance, and computer skills. The lack of knowledge of the treatment field focuses people on the unpleasant elements of the job causing them to miss the bigger picture.

"People are afraid to come into the industry. People don't want to deal with human waste"
- Arthur Simonian (April 6, 2022)

Despite some people's misconceptions, wastewater and water treatment operators in Massachusetts are both proud of and satisfied with their jobs (Finding 3). Out of the 18 operators we interviewed, 12 stated that they're proud of their job. In fact, Kristin Dee, a grade seven combined licensed Supervisor with the Massachusetts Water Resources Authority (MWRA)

was proud to share that as an operator she "provide(s) treatment of wastewater that has helped to clean up Boston Harbor and protect wildlife" (Kristin Dee, Personal Communication, April 6 2022). Jennifer Lichtensteiger, an Environmental Analyst from NEIWPC offered a similar sentiment, "operators are proud of providing clean water". In addition to taking pride in their work, operators are said to be satisfied with their occupation.

Thirteen interviewees expressly stated that operators have high job satisfaction. Interviewees gave a variety of answers for why they are satisfied with their jobs, including job security, good health insurance, and a pension plan. All 18 interviewees from both municipal and private water facilities agreed that all operators receive extensive healthcare benefits. Twelve of the 17 municipal employees explained that the pension rate for operators ranges between 60 percent to 80 percent of their three years of salary. When asked what motivates operators to remain at their treatment plant, Paula Lomas, a Chief Operator at Worcester water filtration plant answered "Pension". The same question was asked to Jeff Kalmes, a Wastewater Superintendent in Billerica Massachusetts, he answered "Benefits". In addition to health insurance and pension, operators also receive job security, paid sick time, and vacation time. According to all eight of Massachusetts water operators, their vacation time parallels their years of employment. Jeff Kalmes stated in the interview that he receives "up to four weeks of vacation time after 15 years' ". Kristen Dee also explained that she receives one month of vacation time.

Benefits	
Insurance	Healthcare Dental care
Retirement	60% - 80% Pension 403B Plan
Sick Time	Unlimited
Vacation Time	Maximum 4 weeks (parallels years of employment)
Salary Increment	Guaranteed

Table 2: Water Treatment Operators' Benefits

However, operators cannot bring their vacation time if they transfer to a different plant, said Paula Lomas. Beside pride, operators are motivated to stay at their jobs because of the great work benefits. Table 2 shows the work benefits that operators receive.

Although the operators are said to be satisfied with their job, management thinks that the average salary for Massachusetts entry level water treatment operators is not an appealing and comparable pay rate (Finding 4). Six out of eight drinking and wastewater treatment operators and superintendents from Massachusetts explained that the entry level salary for a water treatment operator is \$24-\$27/hr and each of these six interviewees agree that this salary is not appealing (see Figure 13 for hourly salary). Guy Campinha, Director of Water Pollution Control in Wareham of Massachusetts stated that operators from grade four and five receive up to 27 dollars per hour. Campinha mentioned that this pay rate cannot compete with private water companies that pay 30 dollars or more for entry level operators (Guy Campinha, Personal Communication, March 28 2022). When asked to share his opinions on the salary range, Arthur Simonian stated “Competition with private companies is hard” (Arthur Simonian, Personal Communication, April 6 2022). All eight operators and Massachusetts DPW superintendents stated that operators' jobs are part of the union and salary increase is guaranteed. Although salary increase is guaranteed, operators' salary is based on years of experience rather than performance.

	Salary in Different Towns (\$/hour)
Fall River, MA	SSSSSSSSS - 20
Uxbridge, MA	SSSSSSSSSS - 24
Fairhaven, MA	SSSSSSSSSSSS - 25
MWRA	SSSSSSSSSSSSS - 26.76
Wareham, MA	SSSSSSSSSSSSSS - 27
Billerica, MA	SSSSSSSSSSSSSS - 26.29
Private Companies	SSSSSSSSSSSSSSSS ~30
Mattabassett, CT	SSSSSSSSSSSSSSSS ~ 30

Figure 13. Salary for Entry Level Operators in New England

Target audience and what they want in a career

Vocational school and high school students are a target audience for recruitment to the water treatment field (Finding 5). Each of our 18 interviewees have positive reception for the idea of water treatment training programs being available in every local vocational high school. During a meeting with Worcester Technical High School principal and guidance counselor, we learned that municipal and private water treatment groups regularly visiting the school to promote operator careers (Heather Courtney, Personal Communication, April 1 2022). Community college students are also considered a target group by our interviewees: 5 out of 18 interviewees recommended or have already started promoting water treatment positions to community colleges and vocational high schools through job fairs, advertisements, or tours. Kristen Dee, a wastewater Supervisor with the MWRA and Evan Karsberg, an environmental analyst from NEIWPC, both agree that identified veterans and ex-inmates are good target candidates as well. After we identified the target audience, we sent out a survey to determine post graduation plans and job perspectives from the target audience.

A significant portion of the target audience are most likely to look for jobs after finishing their education (Finding 6). The survey collected 200 students from Bay Path Regional Vocational Technical High School and Worcester Technical High School and 6 students from Middlesex Community College. After we collected and analyzed the survey results from vocational high school and community college students, we discovered that 34.5% of vocational schools students and 2/6 community college respondents wanted to secure a full time job post-graduation.

Target Audiences Survey Data

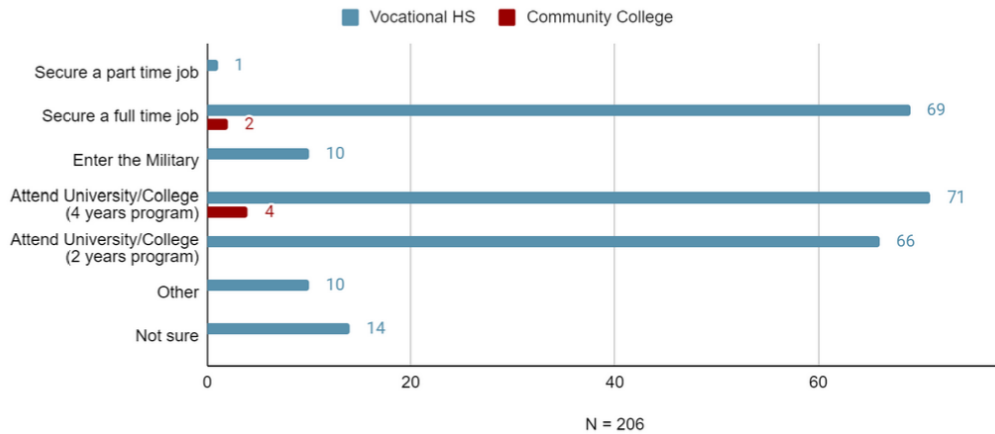


Figure 14. Target Audiences’ post graduation plans

Salary, level of job security, flexibility, and work environment of a water treatment operator matches the employment desires of the target audience (Finding 7). Based on the survey results from the three schools, with the yearly salary and the top three factors that students are looking for, the field’s job provisions fit the majority of students’ expectations. According to survey results, 54/206 people chose \$41000 - 50000/year, and 44/206 people considered that \$30000 - 40000/year fits their expectations. On average, entry-level water treatment operators in Massachusetts make \$24/hour, equivalent to \$49,920/year (40-hour work weeks), so survey respondent expectations align with water treatment operator salary (see Appendix K for survey results). Furthermore, there are about 54.3% students chose job security as the top three factors that they were most concerned about, 43.2% students chose working environment, and 51% chose flexibility. Since the water and wastewater operators' jobs provide great job security, various working environments, and flexibility, the field fits most participants’ perspective.

Recruitment Methods and Opportunities

Beside the future plans and job perspectives, we also questioned the students about their social media usage. We found that community college and

high school students spend upwards of three hours a day on Youtube, TikTok and Snapchat. While Facebook is found to be less popular among the younger generation (Finding 8). The survey results show that students, on average, spend 1-3 hours on Youtube, 1-3 hours on TikTok, less than 1 hour on Instagram, 1-3 hours on Snapchat, and less than 1 hour on Facebook. Students may use multiple social media platforms daily, possibly spending more time on social media platforms in total beyond our findings of 1-3 hours on each service. Students prefer to spend their time on Youtube, TikTok and Snapchat and less so on primarily Facebook. Therefore, we created a short video that could be played on these popular platforms and appeal to the target audience.

Municipal water treatment plants mostly use traditional insider services to inform others about job openings (Finding 9). According to 17 out of 18 interviewees, municipal water treatment plants post job opening on hotlines from specialized water treatment organizations and coalitions, such as NEWEA, MAWEA, or NEIWPPC. Private water treatment groups, on the other hand, seem to regularly use popular job posting sites, such as Indeed, Craigslist and LinkedIn, to find candidates. According to our interview with Julie Carreiro, a recruiter from Weston and Sampson, her company has the most recruitment success from Craigslist and Indeed (Julie Carreiro, Personal Communication, April 8 2022).

On the other hand, Arthur Simonian, the director of the sewer district in Mattabassett, Connecticut (Personal Communication, April 6 2022) and Scott Firmin, the director of wastewater services in Portland, Maine (Personal Communication, March 29 2022) provided an anecdote of the drawbacks for a municipality to advertise on major jobs sites. They illuminated the poor effectiveness of using major job sites in their districts, citing their lack of staffing to handle and sort through the resulting mass amounts of applications and the lack of quality in the applicants, who tend to share little interest and acknowledgement of the field.

Job postings are not a primary recruitment tool for the current group of operators from the plants we have interviewed (Finding 10). Often, operators in the field have either connections or expertise associated with the field. From the information of our 18 interviewees, 9 of our interviewees originally learned and eventually entered the water treatment field through word of mouth. Within our group of interviewees who have been water treatment operators in the past, some explain that their previous occupation in neighboring trades, such as construction or truck driving for pipeline maintenance group, got them in touch with staff in the field who informed them of water treatment career opportunities.

The target students showed interest in water treatment after learning about the field (Finding 11). From the three schools we surveyed, 3 students chose extremely likely and 10 chose the somewhat likely option of becoming operators. Water treatment plants need to provide conditions for such students to receive training. The survey also proved that seniors in high schools and college students are extremely unlikely to consider a career in water treatment because they already have a career path.

A Video to Promote Awareness

We found that vocational high school students are an appropriate and desired target audience for water treatment career outreach (see Finding 5). Moreover, we

Target Audience's Interest In The Water Industry

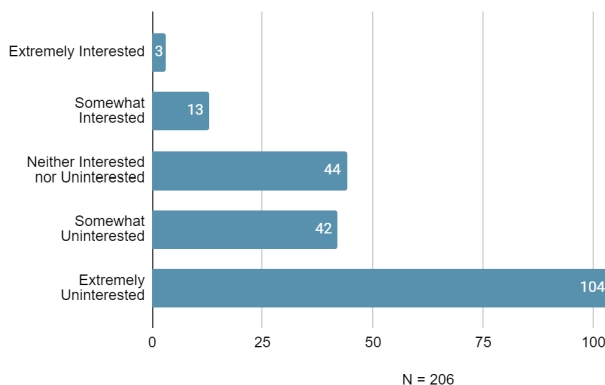


Figure 15. Target Audience's Interest In The Water Industry

found that vocational high school and community college students spend a lot of time on Tiktok, Snapchat and Instagram (see Finding 8). Based on these findings and after discussions with our sponsors, we developed a three-minute video for MassDEP and Massachusetts municipal water treatment plants to promote the array of benefits in the operator field to the target audience. The three minutes long video addresses the importance of both drinking and wastewater treatment, attempts to address misconceptions in the work involved (see Finding 2), and provides information on the current operator shortage. People from the water treatment field can customize the application of this video and post it on their website, Youtube, or TikTok as an informational tool and recruiting advertisement for local treatment plants. To view this video, please look over our project deliverables on the WPI Massachusetts Water Resource Outreach Center Website or Appendix L for the link to video.



Figure 16. Our Video Editing Process

Recommendations

Utilizing the eleven findings, we developed four recommendations for the Massachusetts Department of Environmental Protection (MassDEP), New England Interstate Water Pollution Control Commission (NEIWPCC), and other water treatment facilities in Massachusetts.

Recommendation 1: Educate high school students, middle school students and community college students about the water treatment field

In order to increase interest in the water treatment field, it is essential to make people aware of the field. Therefore, we recommend that MassDEP, NEIWPCC, NEWWA, or other organizations related to the water treatment field offer annual information sections, and attend career fairs for students in high schools, middle school and at community colleges.

We also recommend MassDEP, NEIWPCC, and NEWWA to meet with guidance counselors at these institutions every other year. For future studies, we recommend sending surveys to high school freshman, high school sophomore, and younger middle school students, asking about their career path and knowledge about the water treatment field.

Recommendation 2: Provide training program for high school students and community college students

All of our interviewees expressed interest in this idea. While we found that a great portion of students from vocational high school or community college are highly unlikely to go to the water treatment field because they already settled on a career path (see Finding 11), the starting salary of the water treatment field fits well above the expectations of prospective candidates (see Finding 7). If MassDEP provides supporting programs for potentially passionate students early on during their process of building their career path, it would help create a stronger recruitment pipeline.

Recommendation 3: Use Instagram, Snapchat, Tiktok and Youtube for water treatment outreach

We found that the younger generations are not active on Facebook, don't actively read job listing ads in a newspaper, and if they aren't aware of the field, will not be checking trade or trade journals for employment ads (see Findings 8 and 9). Therefore, we recommend municipalities use different, more youth-friendly social media platforms such as Instagram, Tiktok, or Snapchat as outreach tools. Facilities can have an Instagram page that posts job openings, contact information, information about the field, information sessions, training programs, and certification guidance. This Instagram page should have links to the facility's website where they post openings, this moneasy access for people who are interested in the jobs. They should start advertising on Instagram or Tiktok, because these apps have excellent algorithms for targeting the residents of a certain area. We recommend that MassDEP and NEIWPCC publish the video we created on their social media pages. They can also distribute the link for their Instagram page to high schools or middle schools, allowing students to watch the video in their science classes. Different water treatment facilities can also utilize clips of this video as advertisement for their position openings.

For future research, we recommend creating more videos to post on the facilities' social media pages. We also recommend the future research teams to continue exploring these media pages to find one that works best for spreading awareness.

Recommendation 4: Post job openings of Indeed, Craigslist and Monster

Municipal treatment facilities mainly post their job opportunities on insider websites that cannot be easily navigated by people outside of the water industry. We suggest that water treatment facilities should post openings on Indeed, Craigslist, and Monster. These are common job searching websites that are known by the public. These recruitment tools commonly have excellent algorithms that allow applicants to filter jobs based on level of expertise, salary range, and distance. Julie Carreiro, a recruiter from Weston and Sampson shared that “Indeed and Craigslist are our number one recruitment tools” (Julie Carreiro, Personal Communication, April 2022).

Conclusion

In collaboration with the Massachusetts Department of Environmental Protection, we created a video for MassDEP and local water facilities. The purpose of the video is for use as an advertising method that water treatment associations can post on social media to increase people’s awareness of the water operator shortage issue and recruit qualified people at the same time. In our early research, we discovered that focusing advertising on the correct target audiences, social media, and advertising methods were the key to increasing awareness of and recruitment to the water treatment field goal. We hope our work will help the MassDEP, municipal treatment plants, and water treatment organizations address the operator shortage and help protect the water quality in Massachusetts.

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Additional resources and references are included within our supplemental materials booklet.

