

# Promoting Entry to Career Pathways in the Drinking Water and Wastewater Sector

A Report by  
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**“Maintaining a well-trained, high caliber workforce is essential but no small challenge in the era of tight budgets, increasingly sophisticated facilities, under-appreciation of the industry and profession, and graying of staff.”**

—New England Interstate Water Pollution Control Commission, special edition, *Keeping the Plants in Good Hands*, Interstate Water Report, January 2005

**“Everyone’s time and resources are limited, but if each of us “does our part” in our professional spheres of influence, we can recruit, develop and retain a competent, motivated, professional workforce to ensure a bright future for the drinking water and wastewater professions.”**

—Chip Mackey, New Hampshire Department of Environmental Services, former Chair of NEWWA’s Operator Certification Committee, and Incoming President of the Association of Boards of Certification

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## Executive Summary

*Promoting Entry to Career Pathways in the Drinking Water and Wastewater Sector* was a research planning project designed to identify opportunities and obstacles for lower skilled, low-income populations to enter the drinking water and wastewater sector and progress through a career ladder.

After a huge expansion in water infrastructure in the late 1970s and early 1980s, we are faced with an aging physical infrastructure as well as an aging workforce. Nationally, industry estimates are that 30-50% of the current water workforce will be eligible to retire in the next five to ten years. Concern about these retirements and the associated “brain drain” or loss of expertise and experience is shared by environmental regulators and national, regional and state professional associations.

While crucial for our public health, environmental and economic well-being, this sector and the people who work in it are not well known and are often not respected. Jobs at these facilities include licensed operators but also maintenance workers, laborers, distribution workers, lab technicians and office support. The U.S. Bureau of Labor Statistics projects employment of operators to grow by 20% between 2008 and 2018, with “excellent” job opportunities in the field. Our initial assessment is that there are 2,400 potential retirements in Massachusetts over the next 10 years, but it is not clear if all these positions will be filled or at what levels.

While estimating possible job opportunities in this sector is not simple, water sector jobs are, and will remain, local by their very nature. They will not be closed for business or out-sourced to another country.

This sector has traditionally been very friendly to lower skilled workers and has a culture of identifying, investing and mentoring those who start at the entry level. The field, however, is changing. Complex regulatory requirements, advancing technology, and the professionalization of the field may mean that it will become less welcoming of lower skilled workers. Obstacles to entry into this sector may include lack of: awareness of the sector, education and skills, training and licensure, networks and mentors.

It is difficult to determine the scope of the possibilities for employment without further study. The complexity of the water infrastructure and its different types of systems, the lack of a good count of the complete spectrum of workers currently in the Massachusetts water workforce, the shifts in types and numbers of workers required to run the systems, and the economic realities that are shifting retirement patterns, all combine to point toward the need for an in-depth labor market study.

Career ladders are well articulated for portions of this industry. There are several models for outreach into new populations and for fostering a pipeline for new workers. There is deep commitment and pride amongst leaders in this sector. They are invested in shepherding a new group of workers into this field.



*This sector has traditionally been very friendly to lower skilled workers and has a culture of identifying, investing and mentoring entry level workers. The field, however, is changing.*

# I. Introduction

*Promoting Entry to Career Pathways in the Drinking Water and Wastewater Sector* was a research planning project designed to address the following questions:

- What employment opportunities exist in the drinking water and wastewater sector?
- What are the challenges and obstacles in (a) entering into this sector and (b) moving along a certification career pathway?
- What are the number and types of jobs that will be opening up to lower-skilled workers?
- What initial and continuing training and education will be required to support workers in entering this sector and moving along a career pathway?
- What are potential career pathways within the drinking water and wastewater industries?

The project focused on jobs at drinking water and wastewater facilities (e.g., operators, maintenance workers and laborers). It did not focus on the myriad of jobs that design, build and service those facilities. The project was also not designed or intended to be a detailed labor market study. It was an initial assessment with a focus on opportunities for low-income communities in order to determine if a full scale labor study is merited. The following report provides:

- an overview of this sector from a workforce development perspective,
- a summary of the approach taken in this research project,
- what we found, and
- conclusions and recommendations.

## **Massachusetts Overview**

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250 Municipal Drinking Water Utilities

120 Municipal Wastewater Utilities

2260 Operator jobs

Average Annual MA Operator Salary: \$48,000

Data from: MassDEP; U.S. Department of Labor, Bureau of Labor Statistics, *Occupational Employment and Wages, May 2010 Occupational Profile*, U.S. Department of Labor, CareerOneStop

## II. Overview of Issues

### Aging Infrastructure and Workers

The infrastructure assets (sewers, pipes) were designed to last 80–120 years. By the 1970s most of the assets had reached the extent of their life expectancy. In response to concerns about these assets and the safety of public water supplies and quality of the nation's rivers and lakes, the federal Safe Drinking Water Act and Clean Water Act were enacted. These statutes greatly increased regulatory requirements for drinking water systems and wastewater facilities.

The availability of large federal grants for municipal wastewater treatment in the late 1970s and early 1980s spurred a huge expansion of wastewater treatment facilities as did the federal mandate in the early 1990s for the treatment of drinking water surface supplies. To staff the new wastewater treatment plants as well as public water supplies, there was a correlated increase in the number of people newly hired in this sector during this period.

Thirty to forty years later, we are faced with an aging physical infrastructure as well as an aging workforce. This issue has been a growing concern since a 2005 published report by the American Water Workers Association (AWWA) titled, *Succession Planning for a Vital Workforce in the Information Age*, projected that 37% of water utility workers and 32% of wastewater utility workers would be eligible for retirement within the next decade.<sup>1</sup> Follow-up research conducted by the Water Research Foundation and the AWWA in 2010, the Water Sector Workforce Sustainability Initiative, place the anticipated loss of current utility employees at between 30 and 50% within the next 10 years.<sup>2</sup>

In addition, a 2005 labor market survey by the New England Interstate Water Pollution Control Commission showed that 31% of employees in New England were over 51 years old and 43% were between 41 and 50 years of age. This could indicate that the wave of coming retirements could be relatively long, or may have a second peak.

All told, awareness of the coming wave of retirements is high in this sector and anxiety about that potential knowledge loss is higher. In a 2010 study of concerns facing the US water industry, "Workforce" was the fifth most cited issue for the second year in a row, and the New England Region, Region 1, showed above average concern about this issue.<sup>3</sup>



*"This could be a train wreck when people retire... it's important to have people who know what they're doing, skilled knowledgeable people."*

*"We need to make sure that as people retire there are people that can step in and take over."*

—Staff of regulatory agencies

1 Ritchie, Ed. *The Workforce Gap in Water Efficiency*. January-February 2011. <http://www.waterefficiency.net/WE/Articles/12949.aspx>

2 Water Environment Federation. *Water Sector Workforce Sustainability Initiative*. 2010. <http://www.waterrf.org/ProjectsReports/PublicReportLibrary/4206.pdf>

3 Mann, John and Jon Runge. *State of the Industry Report 2010*. Journal AWWA. October 2010.



*“People don’t understand what it takes to deliver water and wastewater. People don’t get that there are jobs.”*

—Water Operator

## Protecting Public Health, the Environment, and a Public Works Investment

Billions of dollars have been invested in drinking water and wastewater infrastructure. Since 1993, the Massachusetts Water Pollution Abatement Trust, through the State Revolving Fund Program, has financed \$1.1 billion in drinking water and \$4.3 billion in clean water projects.

Protecting both the value of this public investment of funds, as well as the public health, is of paramount concern. The water industry understands that in order “to reap the benefits, plants must be in good hands. A competent, reliable workforce must be attained and maintained.”<sup>4</sup> Federal and state regulators, as well as drinking water and wastewater professionals, are concerned about the impending loss of knowledge and expertise in how to run drinking water and wastewater operations safely and in compliance as workers in the field retire.

## Sector Invisibility

Ironically, the success of the massive federal and state public works and environmental programs means that most Americans take safe drinking water and good water quality in our lakes and rivers for granted. Wastewater and drinking water facilities, and the people who work in them, are “invisible” to most residents and businesses unless something goes wrong. The result is that this sector, while crucial for our public health, environmental and economic well-being, is not well known and often not respected.

Associations of drinking water and water quality professionals, the Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection (Mass DEP) are trying different ways to increase awareness of jobs and professions in the water sector. They are experimenting with ways to attract interest in the sector and to reach and train people to be able to start up the career ladder for certified operators. Efforts include creating internship and mentoring opportunities as well as outreach to vocational and technical high schools. Please see pages 20-23 for more details.

## Existing Jobs

Nationally, water and wastewater treatment plant and system operators held about 113,400 jobs in 2008. In 2010, Massachusetts estimates were that 2,260 people held operator jobs. Employers typically provide financial support for workers to study and sit for the required certification exams, as well as encouragement for employees to move up the certification ladder.<sup>5</sup>

4 Stephen Hochbrunn, *Keeping the Plants In Good Hands*, New England Interstate Water Pollution Control Commission, Special Edition Interstate Water Report, January, 2005.

[http://www.neiwpcc.org/neiwpcc\\_docs/iwr\\_special\\_jan05.pdf](http://www.neiwpcc.org/neiwpcc_docs/iwr_special_jan05.pdf)

5 US Bureau of Labor Statistics. <http://www.bls.gov/oes/current/oes518031.htm>

In small water systems the operator works during the day, but is on call for nights and weekends. During emergencies people are expected to come in—for example when storm surges cause large amounts of stormwater and wastewater to flow into sewers exceeding the plant’s capacity, or during plant malfunctions. Larger plants may require overnight shifts or multiple operators on several shifts. Similarly, weekend and holiday work is required in larger systems and/or people are on call.

The work is often physically demanding, and working in wastewater facilities can be unappealing. It is often performed in locations that are difficult to access or unclean. Workers must pay close attention to safety procedures because of the presence of hazardous conditions, such as slippery walkways, dangerous gases, and malfunctioning equipment. Opportunities are best for people with mechanical aptitude, problem solving skills, an interest in science and better math skills.

Although local governments are the largest employers of water and wastewater treatment plant and system operators, municipalities often hire private contractors (e.g. Veolia, AECOM, Aquarion, United Water) for the staffing and/or management of all, or part, of their plants.

In addition, a “public water system” is defined as a drinking water system that serves at least 25 people for at least 60 days of the year. That means many restaurants, office complexes, summer camps, motels, schools, day care centers, gas stations that serve coffee, and other small facilities that provide their own drinking water to people are classified as public water systems and need to have a certified operator either on staff or under contract. In total there are 1748 public water systems in Massachusetts. This number includes a subset of approximately 530 “community systems,” which are defined as those that serve their own water to residential customers.<sup>6</sup> Community systems include large municipal systems, as well as many apartment complexes, condominiums, prisons, and nursing homes. Of the community systems in Massachusetts, 250 are water departments or water districts. So the universe of systems that requires water operators is quite diverse.

But drinking water and wastewater facilities employ more than just operators. Maintenance workers—both inside and outside the treatment plants—laborers, distribution workers, lab technicians and office support staff round out the industry. Wages range for these positions, as do the entry level skills required.<sup>7</sup> (See Table 1 for details.) It is not unusual for people in maintenance or laborer jobs to become an operator, and they often are encouraged to make that transition. Like the operators, many of these workers are reaching retirement age as well.

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<sup>6</sup> Email correspondence with Liz Kotowski, MassDEP, 12/30/11.

<sup>7</sup> Note that overtime pay (e.g., for wet weather events) is not included in the information in Table 1

**Table 1: Partial Range of Job Titles, Growth and Wages in the Water Industry**

Titles	SOC CODE	Projected National Growth from 2008-2018	National Median wage/Salary and
			Massachusetts Median wage/Salary
<b>Water and Liquid Waste Treatment Plant and System Operators</b>	51-8031.00	20%	\$19.60 hr./ \$40,800 in 2010
			<b>\$23.57 hr./ \$48,200 in 2010</b>
<b>Plumbers</b> • Plumbers • Pipelayers • Pipefitters & Steamfitters	47-2152.02 47-2151.00 47-2152.01		\$21.15 hr. in utility system construction in 2008.
<b>Helpers</b> (pipelayers, plumbers, pipefitters, Steamfitters)	47-3015		\$14.31 hr. \$ 29,760 for utility System Construction in 2010
<b>Maintenance Workers, Machinery</b> (Maintenance Technician, Mechanic, Maintenance Mechanic, Machine Repairer, Maintainer, Maintenance Worker, Industrial Maintenance Millwright, Oiler, Maintenance Electrician, Maintenance Machinist)	49-9043.00	5%	\$18.49 hr./\$38,000 per year in 2010
		<b>3% in MA</b>	<b>\$18.92 hr./ \$39,400 in 2010</b>
<b>Grounds maintenance workers</b> • First-line supervisors/managers of landscaping, lawn service, and groundskeeping workers • Grounds maintenance workers • Landscaping and groundskeeping workers • Pesticide handlers, sprayers, and applicators, vegetation • Tree trimmers and pruners • Grounds maintenance workers, all other	37-1012 37-3000 37-3011 37-3012 37-3013 37-3019	Average of 18% growth.	Overall average was \$12.50 an hour in 2008 \$20.72 for Supervisors and managers \$14.41 for tree trimmers/pruners

**Sources:**

Water and wastewater treatment plant operators: U.S. Department of Labor Occupational Outlook and Occupation Profile

National Data Source: U.S. Department of Labor Occupational Employment Statistics Survey

State Data Source: Massachusetts Wage Information

Pipelayers, Pipefitters, and Steamfitters: U.S. Department of Labor Bureau of Labor Statistics Occupational Outlook

“Helpers” to plumbers, pipefitters, pipelayers, and steamfitters:

U.S. Department of Labor Occupational Employment Statistics

Maintenance Workers/Technicians: U.S. Department of Labor Occupational Outlook

National Data Source: Bureau of Labor Statistics, Office of Occupational Statistics and Employment Projections

State Data Source: Massachusetts Executive Office of Labor and Workforce Development

Grounds Maintenance: U.S. Department of Labor Occupational Outlook

## Jobs Forecast

In many ways, with their focus on protecting both the environment and the public health, jobs in the water industry are the original “green” jobs. And with their increasing focus on clean energy and energy efficiency, these jobs are becoming greener still. But in contrast to other sectors projecting growth in green jobs, water industry positions are not based on theoretical increases in demand. The demand and the jobs currently exist.

The Bureau of Labor Statistics projects that employment of drinking water and wastewater operators is expected to grow by 20% between 2008 and 2018, which is much faster than the average for all occupations. Job opportunities are projected to be excellent, both because of the expected much faster than average employment growth and because the retirement of the baby-boomer generation will require that many operators be replaced.<sup>8</sup>

But estimating possible job opportunities in this sector is not simple. The mixture of public and private employers makes for a complex system that is hard to quantify. The sector is becoming more dependent on computer systems [e.g., Supervisory Control and Data Acquisition (SCADA)] and this may decrease the number of operators needed to run drinking water and wastewater plants or it may mean that preferred qualifications for job candidates will include familiarity with in monitoring and using SCADA systems.

The policy environment in the water industry is also becoming more complex, and that may mean that there will be a need for more workers with expertise in GIS mapping, regulations, and community relations. Climate change pressures and increasing focus on energy efficiency may also change the needed skill profile for water industry jobs.

However, water sector jobs are, and will remain, local by their very nature. They will not be closed for business or out-sourced to another country.

## Education and Skills

All operator positions, as well as positions in the lab, usually require a high school diploma or GED. An interest in science and the environment is typical. Math skills are needed at the level of basic algebra.

For the Water Sector Competency Model developed by AWWA, EPA and the Water Environment Federation, please see Appendix G or <http://www.careeronestop.org/competencymodel/pyramid.aspx?WS=Y>

A high school diploma or GED was required for many maintenance positions. We did not find codified skills or education universally required for entry into laborer

*“Everyone I work with comes from different backgrounds. My supervisor was a pool guy and a butcher before this. Another guy I work with was an electrical engineer. I was a plumber and a cable technician. We have a guy with mechanic background. So we all come from different backgrounds.”*

—Plant Operator

<sup>8</sup> Occupational Outlook Handbook, 2010-2011 Edition. US Bureau of Labor Statistics <http://www.bls.gov/oco/ocos229.htm>



*"I look for someone who shows up, is reliable—dependable, a good worker... with the willingness to learn."*

—Executive Director of a regional wastewater treatment facility

positions. We repeatedly heard that the most highly prized soft skill was stability, followed by the willingness and ability to learn. As a Chief Operator stated, "I need people who care about the job, realize the consequence of doing the job well and what happens if they don't. ...[in the past] people did not see an opportunity here. Whereas I think there is opportunity here now. Now people see that you need a skill—many skills—to run a treatment plant." People with a steady character were targeted for encouragement and educational investment toward an eventual promotion even if they did not yet have the skills required for that next position.

## Clear Career Pathways

Licensed drinking water and wastewater operators have very clear career pathways moving from operators-in-training to fully licensed chief operators up a graded scale. Factors include experience, education and the passing of certification examinations. See Appendix C for requirements for drinking water operators and Appendix D for wastewater operators.

The Massachusetts Board of Registration of Operators of Drinking Water Supply Facilities regulates and licenses all operators of water distribution and treatment facilities. Significant changes went into effect on January 1, 2012, that affect the training requirements to sit for exams and the sequence in which exams may be taken.<sup>9</sup> While applicants for entry level certification have no new training requirements, applicants for higher level exams must first satisfactorily complete specified training courses before being allowed to sit for exams. Where applicants used to be able to take any level of exam, they must now take all exams sequentially (i.e., an applicant must first take and pass a grade 1 exam in treatment or distribution before taking grade 2 and so on). An exemption does exist for those who hold an Operator-in-Training license or full license to take the next higher level exam without repeating a lower-level exam. The impact of these more stringent requirements on people entering the drinking water certification licensing pathway is not yet known.

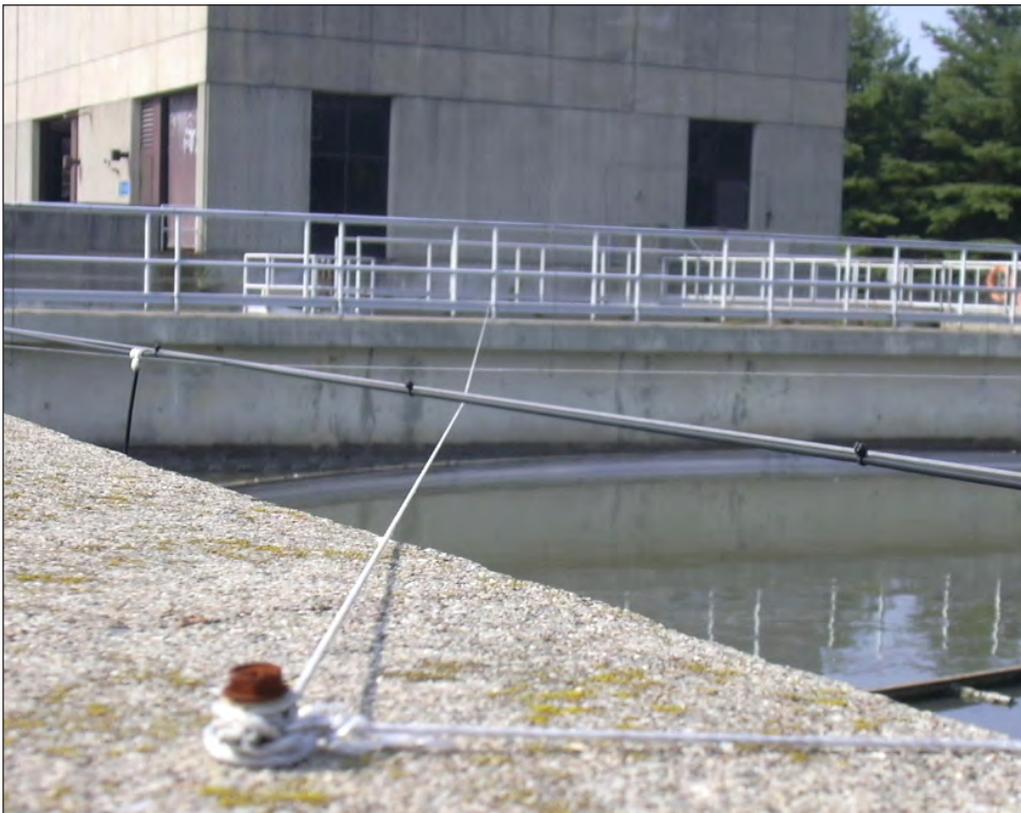
Due to state budget cuts in Massachusetts, MassDEP shifted its wastewater operator certification and training program to a new consortium of training organizations, led by the New England Interstate Water Pollution Control Commission (NEIWPCC). Since July 2005, the operator training, certification exams, and renewals have been fully coordinated by NEIWPCC. In addition to NEIWPCC, the consortium includes the New England Water Environment Association (NEWEA), Massachusetts Water Pollution Control Association (MWPCA), Massachusetts Rural Water Association (MRWA), MA DEP, US EPA - New England, Massachusetts Board of Operator Certification, and the Upper Blackstone Water Pollution Abatement District. Representatives of these organizations have formed a Training Advisory Committee that steers the direction of the wastewater operator training program.<sup>10</sup>

<sup>9</sup> Niman, Paul S. *Board Makes Changes to Exam Policies*. In *The Main*, January 2011.

<sup>10</sup> Training and Renewals. <http://www.neiwpcc.org/training/mwot.asp>

Lab analysts also have education and experience requirements and may participate in a voluntary Laboratory Analyst Certification Program. Positions such as laborer and maintenance worker have traditionally had lower barriers to entry. However, plant maintenance is becoming more complex and professionalized, and the anecdotal evidence that we found indicates the requirements for these types of positions may be increasing in the near future. Currently there is no formal training or certification for maintenance workers that we found. We did not hear that requirements for laborers would be increasing.

**In summary, the drinking water and wastewater industry is comprised of good but challenging jobs with advancement potential, clear career pathways and supervisors who support education and training for those pathways. Industry leaders are committed to their employees, profession and mission to protect public health and the environment.**



*“I took a course on wastewater in high school. I got my operator license before I got my driver’s license.”*

—Executive Director of a regional wastewater treatment facility

### III. Approach

Given the potential for work opportunities emerging in the water sector described above, our project, “Promoting Entry to Career Pathways in the Drinking Water and Wastewater Sector,” posed the following questions:

- What employment opportunities currently exist in the drinking water and wastewater sector?
- What are the challenges and obstacles in both (a) entering the water and wastewater sector, and (b) moving along a certification career pathway?
- What number and types of jobs will open up to lower-skilled workers?
- What initial training and education is required for entering the sector, and what continuing training and education supports progression along a career pathway?
- What potential career pathways exist in drinking water and wastewater?

In order to answer the above questions we conducted:

#### 1. Individual interviews with:

- a. Sixteen drinking water or wastewater operators in person and on the phone.
- b. Six interns and alums from programs designed to encourage operator certification and interest in the water and wastewater field.
- c. Four Workforce Investment Board directors on the telephone (Brockton, Lowell, Central Massachusetts, and Boston).
- d. The Director of the Massachusetts Water Works Association (MWWA).
- e. The Training Coordinator for the New England Interstate Water Pollution Control Commission

#### 2. Meetings with environmental regulatory agencies:

- a. The Massachusetts Department of Environmental Protection (MassDEP) and the Environmental Protection Agency (EPA) about trends in the drinking water and wastewater sector, their concerns with the anticipated rate of retirements of certified operators, and their efforts to encourage young people’s interest in drinking water and wastewater careers.
- b. DEP’s Central Regional Office and the City of Worcester’s Department of Public Works about training, outreach and internship programs.

- 3) **Discussions at meetings of drinking water and wastewater operators** organized by EPA and DEP:
  - a. Three *Energy Management Roundtable Meetings* in Massachusetts (1/14/11, 3/15/11 and 11/1/11)
  - b. One *Energy Management Roundtable Meeting* in Maine (5/24/11)
  - c. One meeting on *Opportunities for Energy Improvements at Contract-Operated Water and Wastewater Utilities* (9/22/11)
  - d. One meeting of the *Operator Certification Committee* of the New England Water Works Association (NEWWA) (12/9/11)
- 4) Search for and review of **existing information** on labor trends in the sector.
- 5) Review of **certification requirements** for drinking water and wastewater operators, including recent changes in the requirements for licensing of drinking water operators.
- 6) An **electronic survey** to 130 drinking water or wastewater operators to collect information on anticipated retirements, job classification trends and other insights or recommendations about the labor force in their own utilities.

See Appendix A for a list of people and organizations we interviewed or met with, Appendix B for a list of references, links and resources, Appendix C and D for certification requirements, Appendix E for questions used in interviews, and Appendix F for the electronic survey. Appendix G is a Water Sector Competency Model. Appendix H is *The Drinking Water Workforce Crisis on the Horizon*, a publication by New England Water Works Association about strategies to recruit and develop future operators.



## IV. What We Found



*“Are we concerned about it? Yes we are. We have a challenge hiring people. We’ve been very successful, but with every search we need to target someone and convince them to come our way. So it’s difficult.”*

—Plant Operator

### Sector Awareness, Concern, and Commitment

Concern in the drinking water and wastewater sector about upcoming retirements and “brain drain” is high. National professional associations such as the American Water Works Association and the Water Environment Federation have held conferences and published numerous articles about workforce development and looming retirements.<sup>11</sup> The New England Water Works Association’s committee on operator certification has developed strategies for utilities, states, associations, public officials, and the EPA to recruit and develop future operators.<sup>12</sup> These strategies include making this sector more visible in communities, placement of interns, and outreach to youth. (See Appendix H for more details.) State, regional and national organizations are focusing time and energy on bringing new people to the profession as well as on developing existing employees to take on more responsibility and management duties.

### Anecdotal Information on Upcoming Retirements

We gathered anecdotal information showing that the retirement “wave” is happening and will continue, although, as one chief operator said, “the rate of retirement was slowed by the economic situation.”

The Massachusetts Water Resources Authority (MWRA) employees 1200 people with an average age of 52. While the MWRA is the largest system in Massachusetts, it is one of the youngest, being created in 1985, and thus may be having fewer retirements in the near term. The MWRA currently see 5-6 retirements a year but anticipate 10+ a year from 2013 on when a “great number” will consider retiring because of age or number of service years.<sup>13</sup>

### Estimates of Retirements and Job Availability

There is broad consensus that a large proportion of the water workforce is nearing retirement. However, data varies at the national, regional and state levels.

In addition, although there are good estimates for the total number of drinking water and wastewater operators in Massachusetts, there currently are no equivalent discreet numbers for all the other job titles that comprise workers in water and wastewater utilities. Many of these other job titles represent the best entry level opportunities for lower-skilled workers, and many of these workers are also approaching retirement. Thus, this is a significant knowledge gap in assessing the potential job opportunity for low-income populations. And finally, as mentioned earlier, there is a much broader spectrum of need for water operators for public water systems than are just employed

11 Brookhart, J. Douglas. *Crisis in the Making: Mass Exodus = Brain Drain*. Water Environment Federation, 2008.

12 *The Drinking Water Workforce Crisis on the Horizon: What Can Be Done to Recruit and Develop Future Operators and Who Can Do It?* New England Water Works Association, 2011.

13 Robert Donnolly, Director of Human Resources, Massachusetts Water Resource Authority.

in treatment plants. However, given these difficulties, below are several ways of looking at the range of potential retirements in Massachusetts in the next 10 to 20 years.

We know that there were approximately 2,300 water and wastewater operators in Massachusetts in 2010.<sup>14</sup> The on-line survey we conducted for SkillWorks indicated that approximately half the anticipated retirees were not operators. If we assume that this represents a standard proportion (50% operators/50% other workers) working in these plants, then there would be approximately 2,300 other employees currently working at water and wastewater utilities. Thus, for the purposes of the below estimates, **we will use the number of 4,600 total water and wastewater utility workers currently in Massachusetts.**

### Retirement Estimates Using National Numbers

The 2010 study by the Water Research Foundation and the AWWA anticipated losing between 30% and 50% of total utility employees within the next 10 years.<sup>15</sup> Using these percentages and our estimate of total employees above, that represents **between 1,380 and 2,300 anticipated water workforce retirements** in Massachusetts over the next 10 years.

### Estimates Using Regional Numbers

Findings from a survey by the New England Interstate Water Pollution Control Commission (NEIWPCC) presented at the 2006 Annual Conference of the New England Water Environment Association (NEWEA) showed that the 123 wastewater utilities that responded (10 of which were from MA) had 1177 employees. Slightly above the national average, or 31% of those 1177 employees were 51 or older, and 43% were 41-50. Using these percentages, we would anticipate **1,426 retirements before the year 2022 and an additional 1,976 retirements before 2032** in Massachusetts. Although there were not a huge number of current vacancies (26% of respondents replied that they had vacancies), 63% said they would need to replace staff in the next five years.<sup>16</sup>

### Estimates Using Massachusetts Numbers

There are 120 wastewater and 250 municipal drinking water utilities in MA. We surveyed 130 of those utilities and got 13 responses or a 10% response rate. Those 13 utilities anticipated 84 retirements in the next 5-10 years. While not a large sample number, the respondents represented a wide variety of water and wastewater systems

<sup>14</sup> US Bureau of Labor Statistics. <http://www.bls.gov/oes/current/oes518031.htm>

<sup>15</sup> Water Environment Federation. Water Sector Workforce Sustainability Initiative. 2010. <http://www.waterrf.org/ProjectsReports/PublicReportLibrary/4206.pdf>

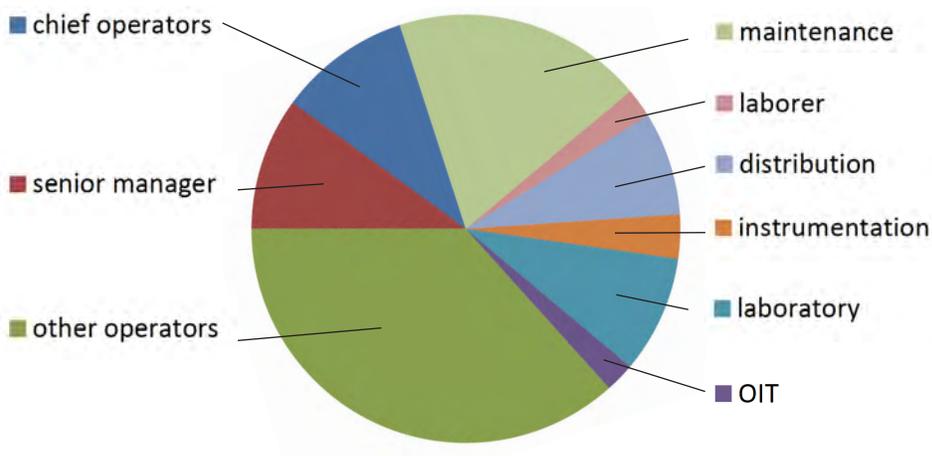
<sup>16</sup> New England Interstate Water Pollution Control Commission. *Northeast WWTF Labor Market Questionnaire. News Brief*, December 2005. [www.neiwpcc.org/neiwpcc\\_docs/wwtf\\_results\\_dec05.pdf](http://www.neiwpcc.org/neiwpcc_docs/wwtf_results_dec05.pdf)

in terms of size, type of facility, and geographic location, and we feel this warrants looking at the data for insight into trends. If the proportion of retirements is true across the board in Massachusetts, (i.e., 84 retirements from 13 utilities translates to X retirements from 370 utilities), that would mean we could anticipate **2,400 potential retirements over the next 10 years.**

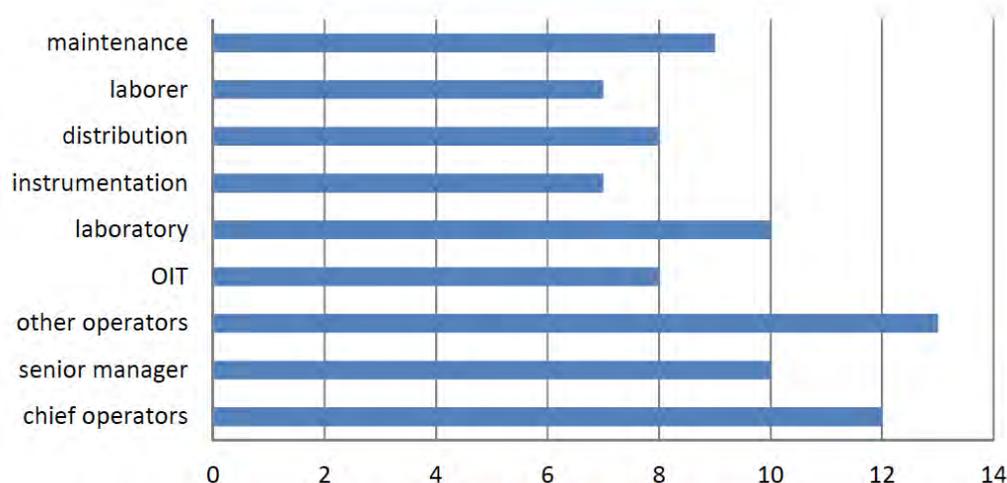
If the Massachusetts workforce follows the New England trend above, we are likely to see a second wave of retirements in the decade between 2022 and 2032 as well, and training programs should anticipate longer horizon of demand for their services.

Table 2 below shows the type of jobs anticipated to be vacant as a result of retirements in the next 5 to 10 years. Note that approximately half will be operators and a third maintenance and lower level positions. It should be noted that positions that become open through retirements are not guaranteed to be filled with the same type or level of position.

**Table 2: Job Distribution of Anticipated Retirees in the SkillWorks Survey**



**Table 3: Types and Numbers of Positions in Facilities**



Results from an on-line survey of 130 Massachusetts water and wastewater utilities, *Career Pathways in Drinking Water and Wastewater*, 2011.

### Lower Level Positions as Traditional Entry Points

“Employees are two types—either came in at entry level position and moved up ranks ... Have a bunch of employees who were laid off as their company dissolved and had wastewater licenses and came up through the ranks here. I also have a graduate from Minutemen Tech and he’s worked his way up.” –Chief Operator

Most of the licensed operators, and other employees approaching retirement, started when the industry was young and worked their way up to their current positions. People traditionally started in lower level positions and, in the case of operators, worked themselves up the certification ladder by preparing for and taking tests to become certified operators at different levels. Training and education were usually subsidized or paid for as it was in the interest of the plants to have qualified and certified operators. See Table 3 for positions considered to be entry level by the respondents to the electronic survey we conducted.



*“Study, take the exams, listen, mentor and learn from others.”*

—Words of advice to aspiring operators from a Chief Operator who started as a laborer

### **How did you get into this field?**

“I took a bike ride past a plant just being built and knew I wanted to work there. “

“I went on a tour of a plant when I was Girl Scout.”

“My roommate told me about a job; I had a 2 year degree and went back to school.”

“I had a master’s in geology, was mapping pipes and applied for a field position.”

“It was an accident—I was in criminal justice and saw an ad.”

“I was hired to dig sand for a summer, was kept on and worked up to Chief Operator.”

“I was an electrical engineer, went back to school in environmental management.”

“I was a chemical engineer, then to food service and then as a lab assistant.”

“I was lucky because they were seriously desperate for someone for an Operator in Training.”

### **Importance of Networks**

One of the themes that evolved in the course of our research was the significant role that networks played in entry into this sector. People related how they learned of jobs through a friend, a relative, a professor, or saw a job posting when working in another municipal department. Networks also play an important role in training for advancement and in professional development. Networks are a powerful tool for all workers when trying to enter a field. However, the drinking water and wastewater sector seems especially dependent on personal networks to gain entry. The requirement that workers have direct experience for most positions intensifies the value of networks since it means that a new prospective employee may need an internship or apprenticeship. All of the recent entries into the field that we contacted spoke of the need for mentorship in making a successful transition into the water industry.

## Changing Nature of Jobs

A lot has changed in the science of both drinking water and wastewater treatment over the last few decades. As a result, jobs have also changed. As a former educator of wastewater operators stated, “it’s a completely different field—used to be primary treatment in the facility, then went to secondary treatment<sup>17</sup> so now we need more knowledge... chemistry, mechanics, understanding of the complexity of the modern wastewater treatment plant. Operators need to know how to interpret data. We need knowledgeable, trained operators.” As one Chief Operator put it, “They need to know how to problem solve, how to think.”

Many changes are the result of an increase in the number, complexity and stringency of regulations, the use of and reliance on computerized control systems, constrained budgets and rising costs. Most Massachusetts plants are now highly automated and computer literacy to work with SCADA systems (Supervisory Control and Data Acquisition) is a necessity. SCADA systems mean that fewer operators may be needed in general or on-site. MassDEP is getting requests to reduce staffing at facilities, presumably because of the use of SCADA systems.<sup>18</sup>

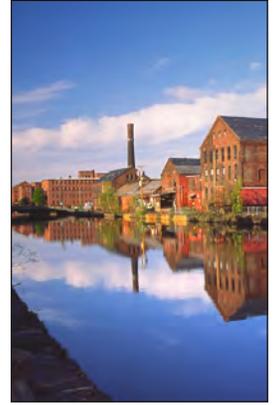
As the HR director of a major water/wastewater system said, “Skill sets are in a transition now that systems are more automated. It’s beyond math. Operator supervisors are at computer consoles. They need to analyze, review, respond to on-screen info. You used to have to be knowledgeable about how the operation runs. But now you have to use that knowledge through a computer screen.”

Others indicated that “even though it is getting more technologically focused, we still have a need for laborers” and that “plant maintenance is not going to shift substantially – you can have automation but you’re still going to have maintenance.”

Operators noted budget constraints and increasing costs as continuing challenges. Prospective employees with experience in energy management or energy auditing may have an edge in being hired in the future because energy costs typically comprise up to 30% of plants’ operating budgets.

Industry and job changes also bring changes in minimum qualifications, skills, and experience. As one Chief Operator said, “So much has changed—regs and operations. The bar has been raised—now you need more education, more in-depth training.” One Chief Operator whose laborer positions have been eliminated said, “I would like to hire more laborers—how are people going to grow?”

While this sector has been welcoming to lower skilled workers in the past, it is not clear if that trend will continue.



*“People do need more technology skills. But even with SCADA you still need to understand the process to make the right changes.”*

—Chief Operator

*“The biggest change I see is in the maintenance department. The plant is becoming very complex—fiber optics etc. In the future people will need more skills. I want more people in house to do the work; right now I have to sub out too much work.”*

—Chief Operator

<sup>17</sup> Primary treatment = removal of solids, oil and grease; secondary treatment= removal of dissolved and suspended biological matter.

<sup>18</sup> Meeting with David Terry, Mass DEP, 6/29/11.

*“In general, qualifications to work at a wastewater treatment plant are more stringent [than in past]. NPDES permits require report writing, telephone skills, understanding the regulations so high school is not enough.”*

—Chief Operator



SCADA System Screen Shot

## Obstacles to Entry

We have identified several issues that can be obstacles to entering the drinking water and wastewater sector. These include lack of (1) awareness of the sector; (2) education and skills; (3) training and licensure; and (4) networks and mentors. We did not do an analysis of potential CORI barriers as this did not come up in the course of our interviews. It clearly is an issue that warrants further research.

## Awareness of Sector

As previously discussed, the drinking water and wastewater field is mostly “invisible” to the public. While concern about the coming wave(s) of retirements is high in the sector, awareness in the workforce development community is quite low. We contacted 4 of the 16 Massachusetts Workforce Investment Boards (Boston, Worcester, Brockton and Lowell) and although two had heard that water jobs would become increasingly available (at the same Green Jobs conference) none had heard much about the sector’s upcoming retirements. Two cautioned that the prospect of an emerging opportunity should not be exaggerated. For the people working in workforce development, hard data about this issue, broken down by region, is of paramount importance.

In terms of raising sector awareness, Directors and Chief Operators of facilities spoke of the challenge in having to “compete with other professions” since salaries in the water industry are more modest despite having good benefits.

### Education and Skills

Many entry level positions in this sector do not require advanced education but, as a Chief Operator said, “A degree makes a difference” and “college students would have an advantage.” In addition more years of college education diminishes the time on the job it takes to be a full-fledged operator at different levels. On the other hand, a newly hired employee reiterated what we heard from many about the value placed on reliability/stability saying, “They care a lot about whether someone will stay. Because I have a college degree, they must have asked seven times if I was planning on staying in the sector.”

A recurring issue from operators and trainers was need for basic math skills, particularly in preparing for and passing operator examinations. Another Chief Operator said, “If you’re not good at math just concentrate on the process.” Training providers find that math reviews are needed in their programs.

### Training and Licensure

Training courses and exams cost money and can be an obstacle to entry. As one already in the field said, “If I was not in the field I’m not sure I’d have the resources to take a series of classes to get ready to take the test. It takes money and time.” For those already employed at a drinking water or wastewater facility, tuition and exam fees are traditionally paid for by their employer. Large systems like the MWRA “offer a strong offering of technical training so people will have the opportunity to succeed.”<sup>19</sup>

However, anecdotally we repeatedly heard that people are usually hired without a license and then encouraged and supported to get training and become licensed. Recent changes in the requirements needed to apply for drinking water operator certification exams may raise the bar for entry into the field.

### Networks and Mentors

As previously discussed, networks, advisors and mentors were very important in knowing about and getting jobs in this sector. Not having them is a barrier to entering this field.



#### CERTIFICATION LEVELS

##### Very Small Systems

##### Drinking Water

**Treatment: 1, 2, 3, 4**

**Distribution: 1, 2, 3, 4**

##### Wastewater Treatment

**Grade 1, 2, 3, 4, 5, 6, 7**

Sources:

<http://www.mass.gov/dep/water/drinking/opedex.htm>

<http://www.mass.gov/dep/water/approvals/surffms.htm#wwtocer>

<sup>19</sup> Telephone interview with Robert Donnelly, HR Director, MWRA.

*“Drinking water operations professionals learn in the classroom and hands-on laboratory, through mentoring by experienced co-workers in their utilities, and through career long professional development. Beginning with math, the basic sciences, hydraulics—through advanced water operations—skills developed in the classroom are honed via application in the field under the supervision and mentoring of trained professionals—the career long training and experience wheel within the wheel.”*

—Ted Kenney,  
Deputy Executive Director/  
Education Manager, NEWWA

## Established Training Programs

Courses for prospective wastewater operators are offered by The New England Interstate Water Pollution Control Commission (NEIWPCC) in conjunction with Mass DEP and the Massachusetts Water Pollution Control Association.

<http://www.neiwpcc.org/training/mwot.asp>

The Massachusetts Water Works Association (MWWA) offers two drinking water Operator Certification Review Courses per year, typically in spring and fall (<http://mwwa.memberclicks.net/education>).

Here is the calendar that tracks MA training classes for water classes:

[http://mwwa.memberclicks.net/index.php?option=com\\_mc&view=mc&mcid=8](http://mwwa.memberclicks.net/index.php?option=com_mc&view=mc&mcid=8)

## Reaching Out to the Next Generation

Given the industry concern about the coming wave of retirements, there have been various efforts to do outreach and develop a pipeline of new workers. Although there are established classes to prepare people to sit for operator certification exams, what has been needed are efforts to expose more people to the range of work in the water industry in order to get them interested in making the investment of time to embark on a career in water. Most of the work summarized below has either been a pilot program or is in a developmental phase. There are several promising models which warrant further study and sharing of results.



Solar Array at the Chelmsford Water District

**Youth in Environment Program** is an EPA program that focuses on introducing economically disadvantaged inner city and rural youth to career opportunities in the environmental field. This program promotes environmental education and provides high school students with increased awareness of protecting the environment and water quality within their own communities. EPA has partnered with New England Interstate Water Pollution Control Commission, EPA, the Lowell Career Center, and the Lowell Regional Wastewater Utility in placing 4-5 high school and college students at the Lowell Regional Wastewater Utility at several “stations” (e.g. laboratory, pretreatment, maintenance, process control, etc.) on a rotational basis so that they are exposed to some of the many facets involved with the proper operation of a wastewater treatment plant on an everyday basis. The students also participate in field trips related to science and water quality, along with college career counseling. See <http://www.epa.gov/owm/mab/smcomm/youth.htm> and <http://www.neiwpc.org/yep/>

**Water Boot Camp** is an EPA initiative to get more people into the water workforce. A two week course held in Bridgeport, Connecticut, during the summer of 2010, exposed 18 local high school students to potential careers within the water industry. At the end of the two weeks, students received a certificate from the EPA. The boot camp curriculum was based on a course called “Water and People” developed by the Connecticut arm of the American Water Works Association. There are plans to offer it in the Boston area in the near future. See <http://www.youtube.com/watch?v=4ggytAMlihg>

**Pre-Engineering Outreach.** The Greater Lowell Technical High School, New England Interstate Water Pollution Control Commission and others are partnering to encourage student engineering, including wastewater operations in a “Pre-Engineering Outreach” effort being developed.

**Green Jobs Training and Placement Partnership.** “In an effort to replace an aging and retiring workforce,” MassDEP developed a Green Jobs Training and Placement Partnership with EPA funds.<sup>20</sup> The initiative was designed to train future drinking water operators in a “hands on” fashion while building their scientific knowledge, skills and understanding of drinking water and the surrounding natural environment. The program’s components were designed to:

1. Train students at vocational and technical high schools in drinking water operations basics
2. Train students in community based “Night-Life (Adult)” education programs in the basics of drinking water operations and preparation for “Very Small System” operator examinations.



*“Internships are a part of green jobs—a bridge connecting environmental programs with the economy is a good thing. And if we can do it in an Environmental Justice area, it’s a blessing. A perfect fit.”*

—Jane Downing,  
EPA Region 1 New England

<sup>20</sup> Massachusetts Department of Environmental Protection. Green Jobs-Drinking Water Operator Training Initiative. July 2009. <http://www.mass.gov/dep/water/drinking/greenjob.htm>

*A graduate of DEP's Green Jobs Training and Placement program recently notified DEP that he was offered a job at a water treatment plant operated by a private contractor. This person, aged 50+, had been laid off for over a year and got his operator-in-training licenses as a result of his internship and training in DEP's program.*

3. Incorporate drinking water operator training classes into the community (state) college network. [Participants may receive college credits which they can apply to existing drinking water (or other environmental program) that is offered at the college.]
4. On-site field training—Internship Program that provided mentors and 24 paid internships at public water systems. This element reflects the importance of hands on training and experience as well as the importance of networking with people within the industry.

MassDEP worked with several partners (e.g. Massachusetts Community Colleges, Massachusetts Technical and Vocational High Schools, Massachusetts Water Works Association, New England Water Works Association, Community based Night-Life Programs and others) to provide drinking water operator training, examination preparation and review, career counseling and on-site field training (internships).

Many of the people taking the Very Small System courses passed their examinations and became certified. Several have gone on to get their Operator-in-Training Grade 1 licenses and get jobs in drinking water facilities. Several of the interns have also gone on to becoming employed in the drinking water profession. See the table on page 23 for a summary.

It should be noted that (1) many drinking water professionals offered their time in helping teach these classes and (2) utilities were very eager and willing to have interns placed in their facilities.

**The City of Worcester's Department of Public Works and Parks** provided interns in the City's Water Filtration Plant and water operations.

The University of Massachusetts Lowell used to offer wastewater certification programs but ceased doing so 9 years ago. In the past, Community Colleges have offered courses preparing people to take operator examinations. Recently, Roxbury Community College offered the Small Water Systems Operation operator class twice last year funded through a grant from MassDEP. They had 20 students in each class and are offering it again in January. Roxbury Community College is working with EPA and the Massachusetts Water Works Association (MWWA) to develop a pipeline for future water managers. MWWA is developing three new courses in water capacity building: basic distribution training, basic treatment training, and advanced treatment training. Roxbury Community College is also hosting a water awareness fair in July of 2012 in collaboration with Outward Bound and Sociedad Latina to target youth. The school is working to incorporate water management as a concentration for the Associates degree in environmental management as well.



*Carl Shaw, Pittsfield Wastewater Treatment Plant, received his certificate of completion of the Management Training Program from Tom Bienkiewicz, Mass DEP.*

The above strategies have been focused on getting new people interested in and joining this sector. But the sector is also concerned about the loss of managers and supervisors. In response to the upcoming loss of Chief Operators and directors of facilities, the New England Interstate Water Pollution Control Commission has partnered with the Water Pollution Control Association to offer a new **Massachusetts Wastewater Management Training Program**. The program is designed to provide basic training to develop candidates to management programs. Participants meet once a month for 12 months and learn about topics such as finance and budgeting, communications/public relations, advanced process control, working with consultants, and permitting and state regulations.<sup>21</sup>

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<sup>21</sup> New England Interstate Water Pollution Control Commission. Massachusetts Wastewater Management Training Program. <http://www.neiwppc.org/training/training-docs/MassachusettsManagementTrainingProgram.pdf>

### Summary of Outcomes of MassDEP's Courses in Preparation for Examination for Operators of Very Small Systems (VSS)

Session of VSS	# of Students who Completed the Course	# of Students who Passed the VSS Exam	# of Students Who Passed Exams						# of Interns Placed at Public Water Systems	# of Students with Full-Time Jobs as Operators
			Grade 1 Operator		Grade 2 Operator		Grade 3 Operator			
			Treatment 1	Distribution 1	Treatment 2	Distribution 2	Treatment 3	Distribution 3		
Worcester Night Life Spring 2009	17	6	1	0	3	1	1	0	5	3
Assabet After Dark Fall 2009	23	7	0	0	2	0	0	0	2	1
Worcester Night Life Spring 2010	24	3	2	1	1	1	0	0	5	1
Assabet After Dark Fall 2010	19	6	3	0	2	2	0	2	5	2
<b>VSS Course Totals</b>	<b>83</b>	<b>22</b>	<b>6</b>	<b>1</b>	<b>8</b>	<b>4</b>	<b>1</b>	<b>2</b>	<b>17</b>	<b>7</b>

Source: Elizabeth Kotowski, MassDEP, 1/10/12

## V. Conclusions

1. Water is a critical need and adequately staffing our drinking and wastewater facilities is important to our public health, the environment, and economy.
2. Jobs in the water industry will stay local by necessity. They will not be outsourced or sent to another country.
3. There will be jobs in the water industry across the state starting in about 5 years and lasting for about 20 years. The range is probably somewhere between 1200 and 2400 jobs opening in the water industry in the next 10 years. And there will be more job openings in the 10 years following.
4. The water industry is incredibly committed to the work and to the workers.
5. Because people routinely move from less skilled jobs, like laborer, into operator positions, and receive financial assistance to make that shift, it is important to focus on the entry level positions, like maintenance and laborers, to get lower skilled people into those positions.
6. Apprenticeship/internship models are highly successful at getting people into the field and necessary to help with the work experience requirements.
7. Certification is standard for operators. Pipeline programs to get into that certification process could have a standard curriculum, tailored to specific communities. Similarly, ancillary jobs, such as maintenance, could have targeted outreach and education on a rotating basis throughout the state in various venues. Community-based outreach will be critical to engaging lower skilled communities in recognizing and capitalizing on these opportunities.
8. The face of the field, and the field itself, is changing. There are more women entering the field and becoming managers. There is an understanding that this workforce has largely been white, and there are outreach efforts currently into other communities. There is a greater need for computer literacy, communication skills, emphasis on energy efficiency and a need to understand climate change and the regulatory environment.

## V. Recommendations

1. Given the complexity of the water industry in Massachusetts, the upcoming wave of retirements, and critical knowledge gaps, a full labor market study is needed to determine the full scope of the problem and opportunities, and to inform good planning. This study should include:
  - The full scope of potential opportunities (i.e. not just operators and not just in the municipal sector) in order to be useful to the workforce development community as a whole.
  - An assessment of how CORI impacts hiring in this sector.
  - The numbers of anticipated retirements and whether that will create vacancies in similar or less senior positions.
  - Questions about salaries.
  - Information broken out regionally.
  - Range of employer investments in training employees.
  - Implications about the increasing use of SCADA systems in terms of the expected skills and numbers of employees needed.
  - The potential need for incumbent training both to prepare new leadership and to gain advanced technical skills.
2. Increase awareness and understanding of this sector in the workforce development community, including federal and state departments of labor.
  - Present study findings at workforce development conferences and meetings.
  - Promulgate results to the range of coalitions and alliances that focus on workforce development.
  - Assess the potential role of social media and networking tools to increase awareness of and interest in this sector.
3. Fund, foster and study apprenticeship, internship and mentoring models in the water industry.
4. Survey educational institutions that have operator training embedded into their curricula for lessons learned.

5. Fund and study successful models for a longer time. Too frequently models lose funding just as they begin to get organized, and too soon to become institutionalized.
6. Hold a workshop/conference/working session with everyone involved in various aspects of this study, including leaders in the water and wastewater profession, MassDEP, EPA, professional associations, training providers and educational institutions, to share information, prepare for a full labor market study and ensure that information from this effort is used to the fullest extent possible.



## Appendix A: People and Organizations Contacted

### List of People and Organizations Contacted

Sector	Organization	Name
Water Utilities	Cambridge Water Department	Timothy MacDonald, Chief Operator
	Chelmsford Water District	Todd Melanson
	The Milford Water Company	David Condrey, Manager Brad Coughlin, Operator Steve Donovan (Whitewater, Inc.) Bernie Marshall, Operations Supervisor Jeff Papuga, Operator
	Spencer Water	Greg Karpowicz, Chief Water Operator
	City of Worcester Water Filtration Plant	Bob Hoyt, Plant Manager and Chief Operator
	Worcester Water Department	Kimberly Abraham, Water Operator
Water and Wastewater Utilities	Massachusetts Water Resources Authority	Robert Donnelly, Director of Human Resources
	<p><i>Massachusetts Energy Management Roundtable for Water and Wastewater Utilities:</i>  “Massachusetts Energy Leaders 2011”, Meeting #4, Fitchburg, MA, 3/15/11  “Massachusetts Energy Leaders 2012”, Meeting #1, North Chelmsford, MA, 1/14/11;  Meeting #2, Lenox, MA, 11/1/11.</p> <p><i>Maine Energy Management Roundtable for Water and Wastewater Utilities</i>, Meeting #3, Portland, Maine, 5/24/11.</p> <p><i>Opportunities for Energy Improvements at Contract-Operated Water and Wastewater Utilities</i>, Holden, MA, 9/22/11.</p> <p>Operator Certification Committee”, New England Water Works Association (NEWWA), Holliston, 12/9/11</p>	
Wastewater Utilities	Newburyport Wastewater Treatment Plant	Joe Dugan, Chief Operator Robert Bradbury, Assistant Chief Operator
	Pittsfield Wastewater Treatment Plant	Carl Shaw, Chief Operator
	Charles River Water Pollution Control District	Cheri Cousens, Chief Operator
	Greater Lawrence Sanitary District	Rick Weare, Capital Projects Manager
	Lowell Regional Wastewater Utility	Mark Young, Executive Director
Training Providers	New England Interstate Water Pollution Control Commission (NEIWPC)	Don Kennedy, Training Coordinator Tom Groves, Director of Wastewater and Onsite Programs
	New England Water Works Association (NEWWA)	Ted Kenney, Deputy Executive Director/ Education Manager, NEWWA NEWWA Operator Certification Committee
	Massachusetts Water Works Association (MWWA)	Jen Petersen, Executive Director

Sector	Organization	Name
<b>“Alums”/current student interns</b>	MassDEP’s VSS Drinking Water Operator Evening Class	Katherine Oreichuck John Viegas Greg Kimball
	Interns at Worcester Water Filtration Plant	Jason Ferreira Maria Proulx Shahira Thompson-Nisbett
<b>Colleges and Universities</b>	University of Massachusetts Lowell- Department of Engineering	Ken Lee, Assistant Professor, Civil Engineering, UMass Lowell
	Roxbury Community College	Freddy Gonzales, Director of Corporate and Community Education
	Middlesex Community College	Don Pottle, Adjunct Professor, Middlesex Community College; former Chair of the Engineering Technology Department at UMass Lowell.
<b>Government</b>	U.S. EPA Region 1 New England	Jane Downing, Associate Director of Drinking Water
		Katie (Connors) Marrese, Civil Engineer, Municipal Assistance Unit
	Massachusetts Department of Environmental Protection, Bureau of Resource Protection	Anita Wolovick, Environmental Analyst, Drinking Water Program
		Dave Terry, Director, Drinking Water Program
		Mike Maynard, Project Manager
		Tom Bienkiewicz, Central Regional Office, Massachusetts State Board of Certification of Operators of Wastewater Treatment Facilities
		Mike DiBara, Project Manager, Central Regional Office
		Yvette DePeiza, Division of Water Supply, Manager, Water Quality Assurance Section, Drinking Water Program
		Liz Kotowski, Training and Outreach Coordinator, Drinking Water Program,
		Paul Niman, Environmental Engineer, Division of Water Supply; Chairman of the Board of Operators of Drinking Water Facilities,
Dave Ferris, Northeast Regional Office, Director, Wastewater Management Program		
<b>Workforce Investment Boards (WIBs)</b>	Boston PIC	Alysia Ordway, Workforce Initiatives Director
	Central Massachusetts WIB	Jeffrey Turgeon, Executive Director
	Greater Lowell WIB	Barbara O’Neil, Director
	Brockton Area WIB	Sheila Sullivan-Jardim, Executive Director

## Appendix B: References, Links and Resources

### References

American Water Works Association. *State of the Industry Report 2010: How water professionals are meeting ongoing challenges and economic uncertainty*. October 2010.

American Water Works Association. Articles on Workforce Development.

*Journal of the American Water Works Association*.

[http://workforwater.org/resourceforwaterprofessionals/page\\_int.aspx?id=173](http://workforwater.org/resourceforwaterprofessionals/page_int.aspx?id=173)

Brookhart, J. Douglas. *Crisis in the Making: Mass Exodus = Brain Drain*. Water Environment Federation, 2008.

Hochbrun, Stephen. *Keeping the Plants in Good Hands*, New England Interstate Water Pollution Control Commission, Special Edition Interstate Water Report. January 2005.

[http://www.neiwpcc.org/neiwpcc\\_docs/iwr\\_special\\_jan05.pdf](http://www.neiwpcc.org/neiwpcc_docs/iwr_special_jan05.pdf)

Kotowski, Liz. *Adult Education VSS Course Expands the Number of New Operators*.

In The Main, January 2011.

Massachusetts Department of Environmental Protection. *Green Jobs-Drinking Water Operator Training Initiative*. July 2009.

<http://www.mass.gov/dep/water/drinking/greenjob.htm>

Massachusetts Department of Environmental Protection. *Will Your Utility Be Prepared When Your Licensed Operator Retires? New Jersey's Licensed Operator Internship Program 2011-2012*. In The Main, December 2011.

<http://www.mass.gov/dep/public/njopins.htm>

New England Interstate Water Pollution Control Commission, Massachusetts Wastewater Management Training Program.

<http://www.neiwpcc.org/training/training-docs/MassachusettsManagementTrainingProgram.pdf>

New England Interstate Water Pollution Control Commission, *Northeast WWTF Labor Market Questionnaire*. December 2005.

[http://www.neiwpcc.org/neiwpcc\\_docs/wwtf\\_results\\_dec05.pdf](http://www.neiwpcc.org/neiwpcc_docs/wwtf_results_dec05.pdf)

New England Water Works Association. *The Drinking Water Workforce Crisis on the Horizon: What Can be Done to Recruit and Develop Future Operators and Who Can Do It?* Appendix H

<http://newwa.org/PDF/DW%20Workforce%20Brochure-Revised%2012-9-2011%20Low%20Res.pdf>

New England Water Works Association. *Career Opportunities Reference Guide—Drinking Water and Wastewater Treatment Industries*. January 2008.

<http://www.newea.org/LinkClick.aspx?fileticket=3-BOW7Uwe4I%3d&tabid=299&mid=1139>

Ritchie, Ed. *The Workforce Gap in Water Efficiency*. January-February 2011.

<http://www.waterefficiency.net/WE/Articles/12949.aspx>

Mann, John and Jon Runge. *State of the Industry Report 2010*. Journal AWWA. October 2010.

Sykes, Richard. Workforce Development-Building Future Leaders in Operations and Maintenance. WEF/AWWA Joint Management 2006.  
[www.wef.org/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=3675](http://www.wef.org/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=3675)

US Bureau of Labor Statistics. <http://www.bls.gov/oes/current/oes518031.htm>

Water Environment Federation. *Water Sector Workforce Sustainability Initiative*. 2010.  
<http://www.waterrf.org/ProjectsReports/PublicReportLibrary/4206.pdf>

## **Links and Resources: Water Associations and Treatment Training/Internships**

### **Professional Associations:**

American Water Works Association  
[www.awwa.org/](http://www.awwa.org/)

MA Water Works Association  
[mwwa.memberclicks.net/](http://mwwa.memberclicks.net/)

MA Coalition for Small System Assistance  
[www.masmallwatersystem.org](http://www.masmallwatersystem.org)

New England Interstate Water Pollution Control Commission  
[www.neiwpcc.org](http://www.neiwpcc.org)

New England Water Environment Association  
[www.newea.org](http://www.newea.org)

New England Water Works Association  
[www.newwa.org/](http://www.newwa.org/)

Water Environment Federation  
[www.wef.org](http://www.wef.org)

**Training Links:**

[www.abccert.org/abc\\_certification\\_program/default.asp](http://www.abccert.org/abc_certification_program/default.asp)

[www.masmallwatersystem.org](http://www.masmallwatersystem.org)

[www.mwwa.memberclicks.net/education](http://www.mwwa.memberclicks.net/education)

[www.neiwpc.org/training/calendar.asp](http://www.neiwpc.org/training/calendar.asp)

[www.newwa.org/NetCode/courseDescList.aspx](http://www.newwa.org/NetCode/courseDescList.aspx)

[www.wef.org/onlineeducation/default.aspx](http://www.wef.org/onlineeducation/default.aspx)

[www.workforwater.org/resourceforwaterprofessionals/page\\_int.aspx?id=173](http://www.workforwater.org/resourceforwaterprofessionals/page_int.aspx?id=173)

[www.wef.org/onlineeducation/default.aspx](http://www.wef.org/onlineeducation/default.aspx)

**Certification Programs and Requirements:**

MA Wastewater Operator Training

<http://www.neiwpc.org/training/mwot.asp>

<http://www.mwpca.org/>

MA Board of Certification of Operators of Drinking Water Facilities

<http://www.mass.gov/ocabr/licensee/dpl-boards/dw/about-the-board.html>

Education and Experience Requirements Worksheet

<http://www.mass.gov/ocabr/docs/dpl/boards/dw/dwboiws.pdf>

## Appendix C: Certification Requirements for Drinking Water Operators

### Drinking Water Applicant Requirements

To become a full-fledged Drinking Water Operator in treatment or distribution **requires both education and experience** in the job. This chart describes the *combinations of education and experience required* for each operator license level to be fully valid.

Treatment or Distribution Operator Grade	Education Level Required	PLUS	Experience (in years) needed to be an operator at this level	OR	Experience (in years) needed to be an operator at this level <i>with previous certification</i>
Vending (VND)	HS/GED	PLUS	0.25	OR	NA
Very Small System (VSS)	HS/GED	PLUS	0.5	OR	NA
Grade 1 (Treatment/Distribution)	HS/GED	PLUS	2	OR	NA
	Training Certificate	PLUS	1	OR	NA
	College-1 year	PLUS	1	OR	NA
Grade 2 (Treatment/Distribution)	HS/GED	PLUS	3	OR	1
	Training Certificate	PLUS	2	OR	1
	College- 1 year	PLUS	2	OR	1
	College- 2 year	PLUS	1	OR	1
Grade 3 (Treatment/Distribution)	HS/GED	PLUS	5	OR	2
	Training Certificate	PLUS	4	OR	2
	College- 1 year	PLUS	4	OR	2
	College- 2 year	PLUS	3	OR	2
	College- 4 year	PLUS	1	OR	2
Grade 4 (Treatment/Distribution)	Training Certificate	PLUS	5	OR	1
	College- 1 year	PLUS	5	OR	1
	College- 2 year	PLUS	4	OR	1
	College- 4 year	PLUS	2	OR	1

### Notes

Often people take exams for the next level up, and then are considered operators in training (OIT) while they work to reach the time needed to be a full operator at the level they desire.

The years of experience required is not necessarily full-time work. Someone could work part-time for the year(s) required in order to earn the time needed to become the next level operator.

Treatment and Distribution require separate exams at each level.

There are new requirements for passing certain classes prior to taking exams starting at the Grade 2 level that go into effect 1/1/12. Please see <http://www.mass.gov/dep/public/trexams.htm> for details. In addition, after 1/1/12, all exams must be taken sequentially, with the exception of operators in training (OITs).

## Appendix D: Requirements for Wastewater Operators

### Certified Wastewater Operators: Required Experience and/or Education (257 CMR 2.12)

(Note that passing of examinations is also required)

Grade of "Full" Operator	Required Years of Experience	Experience must be at a level of responsibility comparable to a:	Education may be substituted for up to __ years of Experience
Grade 1	1	Class I plant or higher	0.5
Grade 2	3	Class I plant or higher	2
Grade 3	5	Class 2 plant or higher	3
Grade 4	6	Class 3 plant or higher	4
Grade 5	6	Class 4 plant or higher	4
Grade 6	7	Class 5 plant or higher	5
Grade 7	8	Class 6 plant or higher	5

Acceptable Education	Experience Equivalent
Master's Degree (in one of the fields below)	5
Bachelor's Degree (Engineering: Chemical, Civil, Electrical, Environmental, Mechanical, or Sanitary; Environmental Science; Biology; Chemistry; Bacteriology; or Public Health)	4
Associate's Degree in the above or Wastewater Treatment Technology	3
Bachelor's Degree in other fields	3
Graduation from High School or its equivalent	2

Short courses in wastewater treatment and related technical fields may qualify applicants for additional experience equivalents ranging from 3–18 months as determined by the Board.

## Appendix E: Interview Questions

### Survey Tool

#### Career Pathways in Drinking and Wastewater Sectors: Initial Labor Market Scan

Intro: We've been contracted to do a labor market analysis on entry level water treatment jobs. We know that a large number of operators in public drinking water and wastewater utilities will be retiring in the next 5-10 years and that many of those retiring began in entry level positions and worked themselves up the licensing ladder. Generally we are interested in the types of jobs and careers coming available, how/if they are changing, and the best ways for folks to get ready for them.

Name of Water/Wastewater Utility:

MGD: \_\_\_\_

Person being interviewed:

Title:

Date:

Interviewed by:

### Questions

How did you get into the water/wastewater field?

#### Current and Future Structure of the Water Workforce

1. What are the existing job classifications in your utility?
  - a. What levels of operator titles are there in your utility?
    - i. What education/certification do they have?
  - b. What other job titles do you currently have in your utility?
    - i. What education/certification do they have?
  - c. What do you consider to be an entry-level job at your utility now?
    - i. Are there entry level jobs at your utility? (Are there related jobs in the field where people have been exposed to the work of operators and have pursued certification? E.g. laborers)
    - ii. What education/certification is needed for these jobs?
  - d. What other opportunities exist at your utility over the next 5 years?
    - i. What education/certification is needed for these jobs?

2. How are these jobs changing? What does that mean for education and certification? (With technology? With energy efficiency measures? With clean technology? In relations to storm surges?)
3. How do you see the workforce changing over the next 5-10 years?

Job Classification	Now			Future		
	Position Titles	Education Required	Certifications Required	Position Titles	Education Required	Certifications Required
Entry Level-Laborers						
Other						
Certified Operators						
Directors/Managers						
Other:						
Other:						

4. Are you currently seeing the number of retirements that you thought you would 5 years ago?
5. Do you have information on who is retiring in the next 5-10 years?
  - a. Do you have information on the number and types of jobs that will be opening up to lower-skilled workers?
6. How would you suggest we estimate the actual numbers and type of operator and other jobs in water/wastewater utilities coming available in the next 5-10 years?

**Current and Future Job Classifications with Educational and Certification Requirements**

Current# of Employees	Estimate of % who will retire within:		Will they be replaced?	Will they be replaced with same positions?
	5 years	10 Years		
Entry Level-Laborers				
Other				
Certified Operators				
Directors/Managers				

## Career Pathways

7. What are the ways people currently enter the pipeline for operator jobs?
  - a. Has this changed in the past 5-10 years?
8. With new technology and equipment playing an increasing role in the water and wastewater sector, will entry level positions still be available as they have been in the past?
  - a. What would it take for lower-skilled workers to compete for them?
  - b. What initial and continuing training and education will be required to support them in entering this sector and moving along a career pathway?
9. What are potential career pathways within the drinking water and wastewater industries? How do people commonly move along the trajectory. How did you?

## Training and Education

10. What would it take for lower-skilled, low-income people to enter the “pipeline” of operators-in-training?
  - a. What are the changes in 2012 that will require some “pre-training” before taking the test for certification as an operator?
11. What initial and continuing training and education do you think will be required and/or necessary?
12. What training programs for these positions and continuing ed are you aware of?
13. If you felt your employees needed more training, how would they get it?
14. How do think educational institutions could promote awareness of and interest in this sector?
15. How will educational institutions and/or training providers meet the need for “pre-training” for people interested in taking the test to become certified as operators?
16. How can current internship and mentorship opportunities (e.g., DEP’s *Green Jobs Placement Partnership*) be improved?

### **Challenges and Obstacles**

17. What are the challenges and obstacles in (a) entering into this sector and (b) moving along a certification career pathway?
18. What are potential ways to remove obstacles to these career pathways and encourage entry by lower-skilled workers?

### **Conclusion**

19. Do you see any themes emerging in the evolution of water treatment jobs?
20. If you had it to do all over again, what's the skill or knowledge that you wish you had more of?
21. For your employees?
22. What else should we have asked? What did you expect me to ask that I didn't?

## Appendix F: Electronic Survey

### Electronic Survey: Career Pathways in Drinking and Wastewater

1. What region does your facility serve?

<input type="radio"/> Southeastern MA <input type="radio"/> Northeastern MA <input type="radio"/> Central MA/Northern Tier <input type="radio"/> Western MA
--

2. Does your facility process:

<input type="radio"/> Drinking Water <input type="radio"/> Waste Water <input type="radio"/> Both
---

3. What is the MGD size of your facility or population served?

4. What number of shifts do you have per 24 hour day?

5. We know that a large number of operators in public drinking water and wastewater utilities will be retiring in the next 5-10 years and that many of those retiring began in entry level positions and worked themselves up the licensing ladder. Generally we are interested in the types of jobs and careers coming available, how/if they are changing, and the best ways for folks to get ready for them.

How many of the following positions do you have in your facility?

Total employees	
Chief Operator(s)	
Other Grade Operators	
Operators in Training	
Laboratory	
Instrumentation	
Distribution/Collection	
Laborers	
Maintenance	
Senior Manager/Director	

6. Of your current workforce, approximately how many do you anticipate *retiring or leaving* in the next 5-10 years?

Total employees	
Chief Operator(s)	
Other Grade Operators	
Operators in Training	
Laboratory	
Instrumentation	
Distribution/Collection	
Laborers	
Maintenance	
Senior Manager/Director	

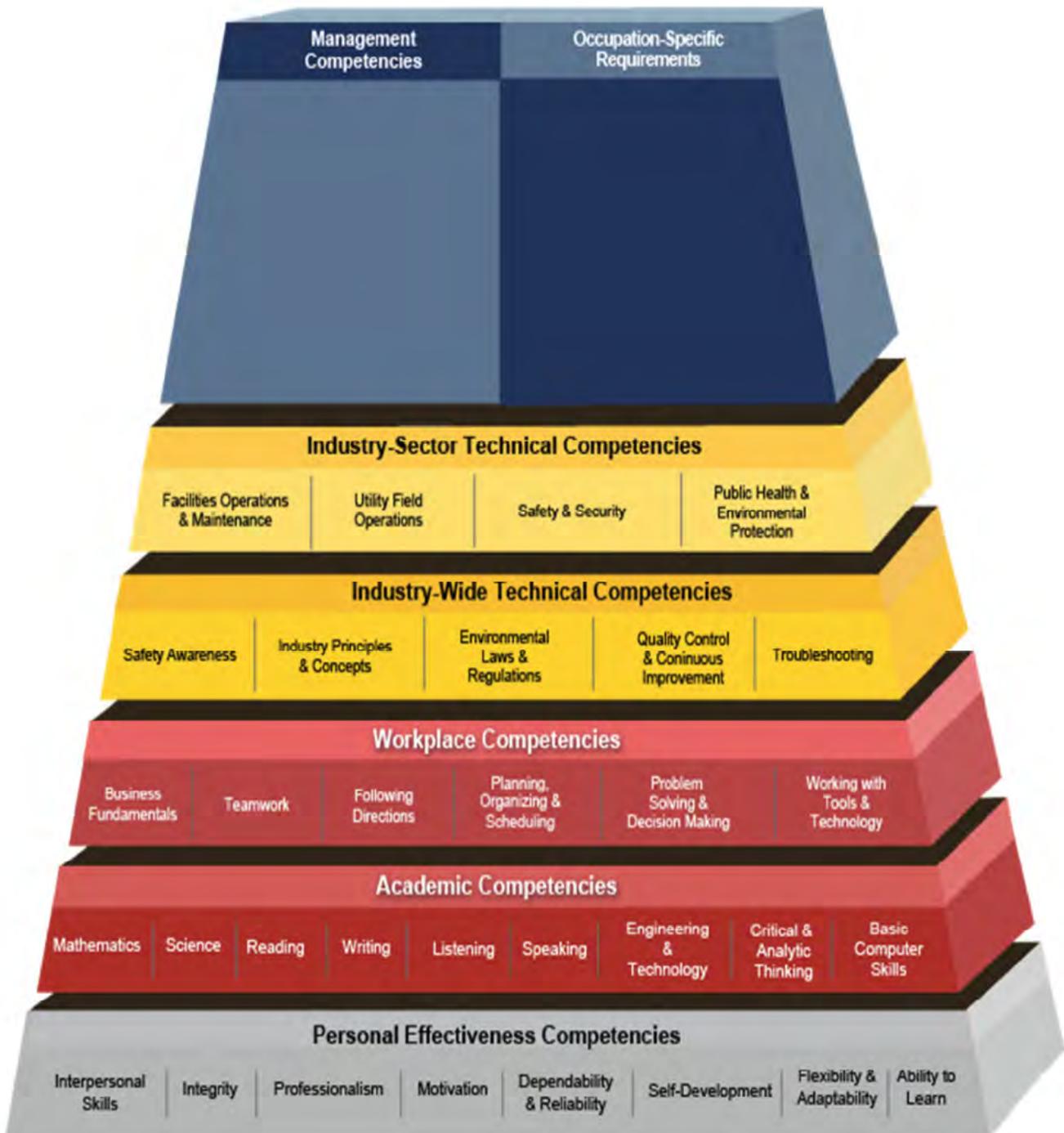
7. What *percentage* of your *current* positions do you consider *entry level*?

Total employees	
Other Grade Operators	
Operators in Training	
Laboratory	
Instrumentation	
Distribution/Collection	
Laborers	
Maintenance	

8. Are there new types of positions or additional responsibilities in current positions that you will need to add in the next 5-10 years? If so, what might those be?

9. What are the three most common ways that people enter the workforce at your facility?

## Appendix G: Water Sector Competency Model



## Appendix H

### The Drinking Water Workforce Crisis on the Horizon: What Can be Done to Recruit and Develop Future Operators and Who Can Do It?



#### Introduction

We all recognize the threat the impending shortage of qualified drinking water operators poses to our profession and society at large. If we do not act, the projected 50 percent loss of our current national workforce in the next 8 years could have dire consequences. Our ability to maintain and operate our public drinking water systems could be compromised, endangering public health, public safety, and the environment. This workforce issue has three separate but interrelated components:

- Who will take the place of our retiring operators?
- How can we best train and qualify operators?
- How can we preserve and pass along needed institutional knowledge?

This document addresses only the first question. It focuses on identifying the next generation of drinking water professionals and the methods and means of attracting them to our profession. The inability to successfully address this first question leaves the remaining two questions moot.

Many of us have participated in workshops and discussions on this issue. Numerous studies have been conducted to better define the scope and scale of this problem. Yet, a key consensus derived from these efforts points to the fact there is no "magic" bullet, but rather a broad-based, stakeholder approach will best work towards meeting and resolving this challenge. In short, the workforce crisis can only be addressed if each of us "does our part."

The New England Water Works Association Operator Certification Committee has developed this list of key stakeholders and a series of concrete actions each can take. Everyone's time and resources are limited, but if each of us "does our part" in our professional spheres of influence, we can recruit, develop, and retain a competent, motivated, professional workforce to insure a bright future for the drinking water profession.

#### Stakeholder Groups and What Each Can Do to Meet the Drinking Water Workforce Crisis

Utilities ♦ States ♦ Associations  
Public Officials and Community Water System Owners ♦ U.S. EPA



## “Encourage recruitment and development of future operators to ensure succession”

### What Can Utilities Do as Stakeholders?

Review job descriptions to include more definition; make job descriptions more representative of professional status. Include such key items as:

- certification/educational requirements
- job title/level (inclusive/complete)
- job functions
- identify and define decision-making responsibilities

Conduct an organizational analysis to promote a high level of professionalism:

- create an internal career ladder
- create an internal professional development program
- consider developing internship programs for professional succession
- consider the following, as public perception is based on appearances:
  - ◊ establishing a dress code/uniforms for utility personnel
  - ◊ establishing a code of conduct for utility personnel
  - ◊ maintaining the appearance of personnel and facilities

Promote organization-wide professional development/training:

- identify training needs in your organization for operations, management, and administrative staff
- identify resources to meet training needs
- evaluate the benefits of cross training within your organization
- consider individual professional development plans for all employees

Develop a public relations program which targets the utility's role in public health and safety and economic development. Target audiences should include:

- rate payers
- public officials
- the media
- youth
- other key stakeholders



### What Can States Do as Stakeholders?

Develop a straightforward document/checklist on how to become an operator:

- post “How to Become an Operator” information on state certification Web sites
- distribute “How to Become an Operator” information to community colleges
- keep ABC Web site information up to date, clear, and concise
- develop and maintain demographic statistics which target operator employment opportunities

Partner with organizations dealing with workforce issues to provide drinking water career path information:

- partner with EPA to utilize funding for paid internships
- partner with educational organizations/associations to offer and promote operator training opportunities
- partner with state programs offering displaced worker retraining
- partner with organizations to offer career fairs to promote the drinking water profession
- promote/encourage operator internships, co-ops, placements, and work studies
- promote succession planning (e.g. during sanitary surveys)



### What Can Associations Do as Stakeholders?

Advocate the importance of drinking water in public health, public safety, economic development, and quality of life:

- develop/place news releases
- write op-ed responses
- serve as an “expert” contact for information on drinking water

Educate key groups on the importance of drinking water and the role of the professional operator in providing a safe and adequate supply:

- address current drinking water issues as they develop
- identify key public outreach grounds
- provide outreach information and strategies

Provide tools to assist utilities in recruiting, developing, and retaining professional operators:

- identify, develop, and provide training to keep pace with technology and regulations
- provide “advance” regulatory information
- provide guidance/best practice information, including:
  - ◊ Operator Certification Committee best practice documents
  - ◊ position description templates
  - ◊ publications
  - ◊ public outreach tools

Collaborate with state, regulatory, and national agencies to raise the drinking water profession's visibility.

**I want to be here for you.**

If only one water infrastructure crew could call to us. The corner hydrant might remind us that only tap water provides us against the threat of fire, and that the pipes below our streets need constant attention to keep life-saving water flowing at the right pressure, 24/7, without fail.

We are all strands of the water infrastructure operators before handed down to us, and our water bills keep that stream strong and reliable. For more information about what your tap water delivers, visit [www.aawwa.org](http://www.aawwa.org).

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### What Can Public Officials and Community Water System Owners Do as Stakeholders?

Identify and understand the requirements to operate a public water system.

Work with water supply professionals in the development of an asset management plan.

Adopt a rate structure that adequately funds:

- personnel
- operation and maintenance, security, and emergency response
- capital improvement—short and long term
- potential growth

Promote professional development/training and succession planning.

Educate the public about the importance of the public water system in providing:

- public health
- public safety
- economic development
- quality of life
- conservation and resource protection



### What Can the U.S. EPA Do as a Stakeholder?

Advocate the importance of drinking water in public health, public safety, economic development, and quality of life:

- raise public awareness

Promote recognition of the importance of certified operators as professionals in the protection of public health:

- continue to mark the path forward to enter the profession
- identify new sectors for recruitment

Promote effective utility management:

- encourage adoption of best management practices
- encourage coordination across programs
- promote sustainability

Funding:

- develop grant funding which supports workforce succession
- identify and coordinate other sources of funding



## **SkillWorks**

[www.skill-works.org](http://www.skill-works.org)

*SkillWorks*, a public-private partnership, is addressing the needs of employers for more skilled workers and of workers for more and better access to jobs that pay a family-supporting wage.

### **SkillWorks Phase II Funders**

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