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# Getting the Lead Out:

## Employment & Economic Impacts from Replacing America's Lead Pipes

PLUMBERS • UNION • PIPEFITTERS • SERVICE TECHS • STEAMFITTERS • SPRINKLERFITTERS

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# About This Report

This economic impact analysis was conducted by BW Research Partnership for E2 in partnership with the United Association of Union Plumbers and Pipefitters. It uses the Biden Administration's stated goal of 100 percent removal of lead service lines (LSLs) from America's drinking water systems, the Natural Resources Defense Council's (NRDC) national survey of LSLs, and the Environmental Protection Agency's (EPA) estimated LSL replacement costs.


Special thanks to NRDC and BW Research. For a description of the methodology used in this report, please refer to the explanation on page in Appendix A.


## About E2

E2 (Environmental Entrepreneurs) is a national, nonpartisan group of business leaders, investors, and professionals from every sector of the economy who advocate for smart policies that are good for the economy and good for the environment. E2 members have founded or funded more than 2,500 companies, created more than 600,000 jobs, and manage more than $100 billion in venture and private equity capital. For more information about E2's reports and research into clean energy jobs, see e2.org/reports.

## About UA

Founded in 1889, the United Association of Union Plumbers and Pipefitters (UA) proudly represents more than 359,000 highly skilled journeymen and apprentice plumbers, pipefitters, pipeliners, sprinkler fitters, welders, and HVACR service techs in the US and Canada. The UA is an affiliate of both the AFL-CIO and North America's Building Trades Unions (NABTU).

# Executive Summary

Lead service lines (LSLs) used to distribute water to communities across the United States are a huge environmental and health hazard.

Replacing this aging infrastructure will come with costs and challenges—but it also will create hundreds of thousands of jobs and inject billions of dollars into local economies across the country.

The Biden administration, citing an estimate that there are about 10 million lead service lines, plans to invest $45 billion into replacing America's lead service lines through the American Jobs Plan. This LSL Replacement Program is essential for combating dangerous lead contamination in our water systems and ensuring public health and safety. It will also generate substantial employment and job training opportunities in affected communities.

Importantly, this program will prioritize economically distressed areas where LSLs need to be replaced, but affected residents cannot afford the high cost of these repairs. The water utilities in many jurisdictions take the position that LSLs—which are water pipelines that connect large water mains in the street to homes and buildings—are the responsibility of the property owner. Many experts disagree that homeowners should be required to replace lead service lines that water utilities often required, installed, encouraged or explicitly approved. In order to avoid being bogged down in this dispute, it is critical to establish an effective, equitable and efficient LSL Replacement Program that ensures all LSLs are replaced, and prioritizes replacement for those who are disproportionately put at risk and often lack the resources to pay for these essential repairs.

We estimate that the $45 billion invested in this program will create and support 56,080 jobs annually for 10 years, or a total of 560,800 job-years. This annual estimate includes 26,900 direct jobs—construction workers, plumbers, pipefitters, heavy equipment operators—as a direct result of this activity. Another 13,600 jobs that last for 10 years are created throughout the value chain, and 13,800 jobs are created each year for 10 years as a result of workers spending their paycheck.

About 84 percent of all jobs created through this investment are in construction (52 percent), professional and business services (24 percent), and manufacturing industries (8 percent). Insofar as the bulk of these jobs involve high skill construction occupations, the jobs created will provide good wages and training opportunities for local residents and promote economic benefits to affected communities.

## By the Numbers

**560,800**
Total job-years*

**$104 billion**
Total economic activity generated**

**10 million**
Lead service lines that need to be replaced

*56,080 jobs annually over ten years

**Includes $38.3B in labor income; $11.7B in taxes and $53.9B in additional economic benefits

This investment into cleaning up our nation's water supply also would generate $38.3 billion in labor income, $11.7 billion in taxes, and $53.9 billion in additional value to the economy. That would represent a 120 percent return on investment.

In addition to the jobs created and value added to the economy from this activity, additional benefits like increased positive health outcomes would be generated. It has been estimated that an additional $22,000 of societal benefits are generated for every lead pipe replaced as a result of lower cardiovascular disease. Since in many areas lead service lines are more likely to exist in environmental justice communities, and since Black and Latino children have disproportionately high overall lead exposure, replacing these lead pipes will also greatly benefit low income and minority households.

The scope of this work is massive and reaches every state. The Natural Resources Defense Council (NRDC) estimates that between 9.7 million to more than 12 million lead service lines are distributing water throughout our nation.[1] About 700,000 or more of these service lines are found in Illinois, while Ohio, Michigan, New York, New Jersey Missouri and Wisconsin each contain more than 300,000 of the nation's lead service lines; the top ten states total about 4 million.

[1] Unless otherwise noted, all reported figures on the number of lead service line at the state and federal level are derived from the Natural Resources Defense Council's National Survey of Lead Service lines. July 2021. https://www.nrdc.org/lead-pipes-widespread-used-every-state

No state is free from lead contaminating its drinking water, and only seven states have less than 10,000 LSLs. In addition to the more than 6.2 million known LSLs estimated by NRDC, the seven states that have conducted detailed surveys, NRDC estimate that there are 3.5 million to 6.6 million service lines of unknown material that could be lead, bringing the total number of potential LSL replacements from 9.7 million to about 12.7 million.

The cost of replacing all lead service lines is dependent on many factors, the most impactful being the total number of LSLs needing to be replaced. According to the EPA, the cost of replacement can range from $1,200 to $12,300 per pipe, with an average cost of $4,700. Given this average cost estimate and the 9.7 million pipes, the total cost of replacement comes out to $45.7 billion. Of course, if there truly are 12 million lead service lines, the total costs would far exceed that number.

# Current Situation

## Lead Service Line System

A lead service line (LSL, also known as lead service pipe or a lead lateral) is a pipe made of lead which is used in potable water distribution to connect a water main to a user's premises. From the late 1800s and in some cities as late as the mid-1980s, it was common for lead to be used for service lines.[2] The installation of new LSLs was not prohibited until 1986.[3] There have been no federal mandates/requirements for the removal of most LSLs, so many are still in place. With the installation of LSLs starting so long ago, many LSLs have not been mapped and the exact location is often unknown to state and local municipalities.

According to state data compiled by the NRDC, there are as many as 6.2 million known LSLs that need to be replaced in the United States, and from 3.5 million to 6.6 million service lines that are of unknown material but are projected to be made of lead.[4] Table 4 in Appendix B: Lead Service Lines by State shows where LSLs are located based on NRDC's findings ranked by the state with the largest estimate.

Every state and the District of Columbia has at least 2,800 LSLs.[5] NRDC's data shows that Illinois has the largest estimate for LSLs at about 700,000 known, plus more than 782,000 service lines of unknown material that may be lead, for a staggering total that could reach well over 1 million. To put this in perspective, Ohio has the second largest number at 650,000 known LSLs. Fifteen states, or roughly 30 percent of the nation, have more than 100,000 known LSLs, while only 13 states have fewer than 20,000 known LSLs.

Wisconsin also has the largest concentration of known LSLs per 100,000 residents at 5,597 known LSLs (Table 5). Kansas follows at 5,548 known LSLs per 100,000 residents and Ohio with 5,509 known LSLs per 100,000 residents. It is significant to note that California, which has the largest population in the United States, has the smallest number of known LSLs per 100,000 residents at 164, though there are a potentially large number of unknown and partial LSLs in California and many other states with low current counts. As water utilities and states conduct more comprehensive surveys it is likely that additional full or partial lead service lines will be discovered, so these numbers will change as more data are collected.

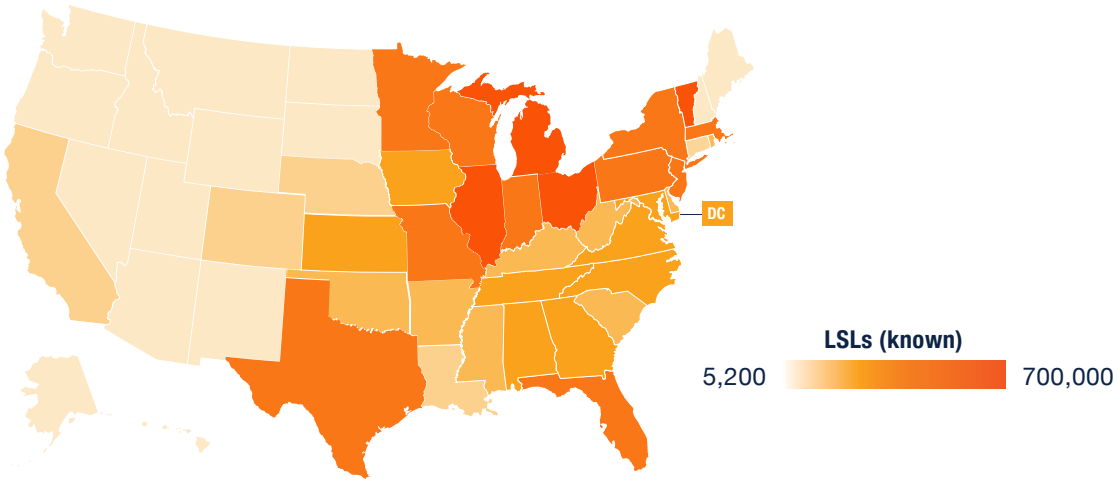
[2] How Can I Find Out If I Have a Lead Service Line? | NRDC

[3] Id.

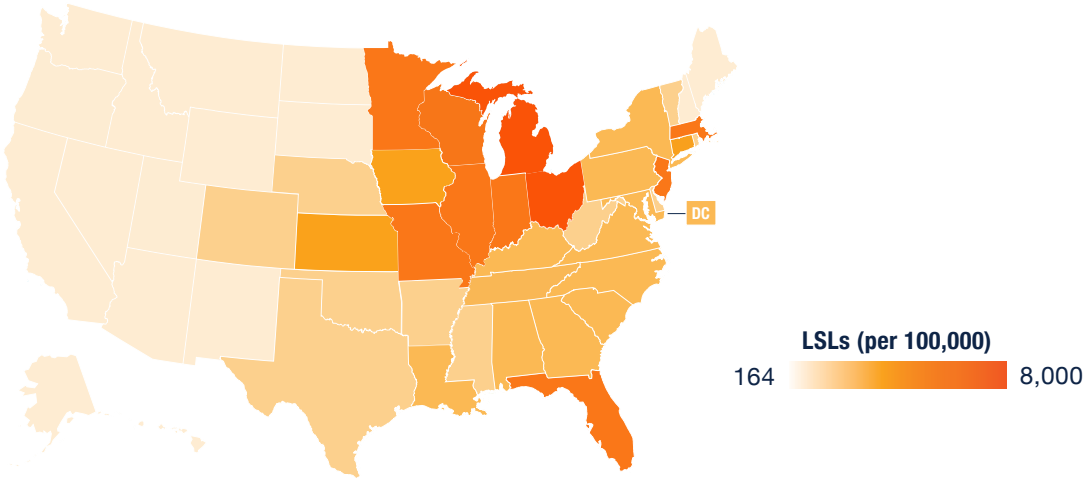
[4] Lead service line data by state provided by NRDC. These data are based on NRDC's survey of all 50 states and Washington D.C.; for states that reported they did not have data on lead service lines, NRDC used data from a published 2016 water industry survey. See Appendix B.

[5] Id.

## Figure 1. Heat Map of Total LSLs by State




## Figure 2. Heat Map of LSLs Per 100,000 Residents by State




Maryland, Nevada, and California are the states with the highest percentage of residents with LSLs who are served by larger systems, with at least 70 percent of their LSLs serving communities larger than 50,000. For LSLs serving communities between 10,000 and 50,000, Vermont's held the largest percentage at 96 percent. Maine, New Hampshire, and New Jersey follow in descending order with at least 90 percent of their LSLs serving communities between 10,000 to 50,000. For LSLs serving communities less than 10,000, Wyoming held the largest percentage at 86 percent. While Illinois has the most LSLs and the largest LSLs per capita, only eleven percent of its LSLs serve communities smaller than 10,000. (Table 10)

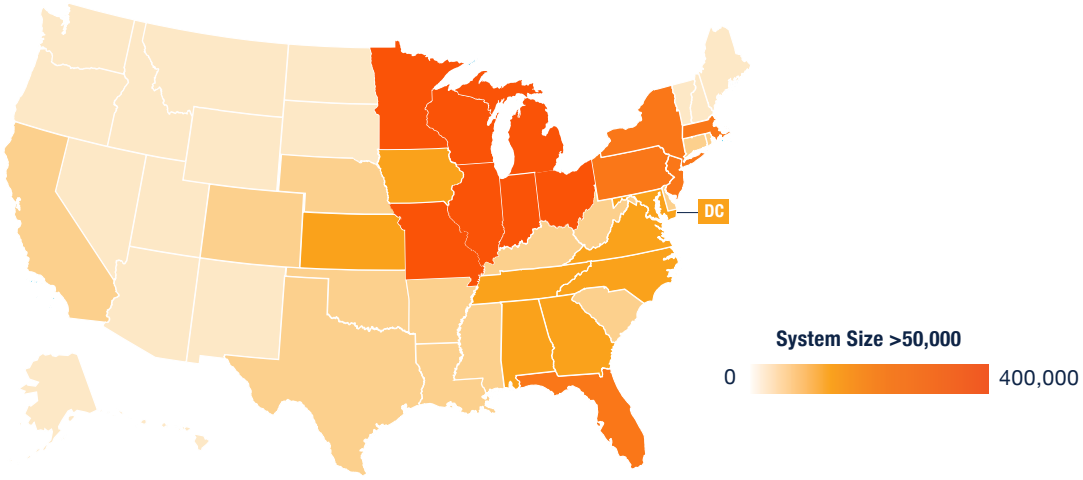
The Biden administration has announced plans to remove 100 percent of the lead service lines (LSL) in the nation's drinking water systems through the American Jobs Plan. To replace all LSLs, President Biden is calling on Congress to invest $45 billion in the Environmental Protection Agency's Drinking Water Revolving Fund and in Water Infrastructure Improvements for the Nation Act (WIIN) grants.[6] President Biden states that the investments in improving water infrastructure and replacing lead service lines will create good jobs, including union and prevailing wage jobs.[7]

Replacement costs vary as there is a lack of knowledge of exactly where every LSL is located.[8]

Some critiques have been raised that the $45 billion investment may not be large enough. The EPA has estimated an average cost of full LSL replacement of $4,700, ranging from $1,200 to $12,300 per line replaced.[9] Similarly, the American Water Works Association recently estimated that the average cost of planned full LSL replacement is about $5,200.[10] A 2019 Master's thesis by Shivani Gilhotra for Dalhousie University found a similar range in their review of LSL replacement funding, from $1,400 per pipe in Madison, WI to $10,000 per pipe in Pittsburgh, PA.[11]

Using the average cost from the EPA, and the known 6.2 million LSLs to be replaced from the NRDC, this would put the cost at $29B, well within the $45 billion investment.[12] Using the estimated 9.7 million LSLs, this would put the cost of LSL replacement at $45.7B, slightly greater than the $45 billion proposed by the American Jobs Plan. Discrepancies on average price for full replacement of LSLs and uncertainties about the precise number of LSLs pose an issue in quantifying the total national costs.

## Figure 3. Heat Map of LSLs Serving Populations Greater than 50,000




[6] FACT SHEET: The American Jobs Plan | The White House

[7] FACT SHEET: The American Jobs Plan | The White House

[8] Lead service line data by state provided by NRDC.

[9] https://www.epa.gov/sites/production/files/2019-10/documents/strategies_to_achieve_full_lead_service_line_replacement_10_09_19.pdf

[10] AWWA, Feb. 5, 2020, National Primary Drinking Water Regulations: Proposed Lead and Copper Rule Revisions, Docket No. EPA–HQ–OW-2017-0300, available online at https://www.awwa.org/Portals/0/AWWA/Government/020520AWWALCRRComments.pdf

[11] https://dalspace.library.dal.ca/bitstream/handle/10222/80163/Shivani-Gilhotra-MASc-CIVIL-December-2019.pdf?sequence=1&isAllowed=y

[12] NRDC also has noted that many of the more than 5 million service lines of unknown material also could be lead, so there could be substantially more LSLs and thus the cost of replacement would be higher.

The $45 billion investment into replacing all the nation's estimated lead service lines outlined in the American Jobs Plan are expected to result in about 268,600 direct, full-time job-years. In other words, this investment into America's clean water system would create nearly 26,900 jobs per year for 10 years. Additionally, this investment will create more than 156,100 job-years throughout the supply chain and about 136,100 induced job-years. This totals more than 560,800 job-years, or nearly 56,080 jobs each year that will last for 10 years. Other economic benefits resulting from this investment include $38.3 billion in total labor income and $53.9 billion in total value added, or a 120 percent return on investment.

These economic impacts are derived using IMPLAN, an input-output software. The $45 billion investment is split between two industry inputs, construction of non-residential structures and architecture, engineering, and related services. These are then further split by state using NRDC's provided data of LSLs by state. The model is then run at both the national and state level to determine outputs. For more information on methodology, please see Appendix A: Research Methodology.

Of the 268,600 direct job-years that are created as a result of the $45B invested into lead pipe replacement, 81 percent are in the construction of non-residential structures industry, while 19 percent are in architectural, engineering, and related services.[13] Of the 424,700 job-years that are created initially and throughout the supply chain, 52 percent are in construction, while 24 percent are in professional and business services and 8 percent are in manufacturing.

Every state will benefit from new jobs and investments created by the replacement of lead service lines. Ohio would see the most direct and indirect jobs created—about 4,700 jobs annually for 10 years—to replace its aging lead pipe service lines, while neighboring Midwest states such as Illinois (4,500 jobs), Michigan (3,200 jobs) and Wisconsin (2,300 jobs) also would see major increases in jobs related to the clean-up efforts.

Yet other states, including Texas, Missouri, New York, New Jersey and Massachusetts each would see thousands of jobs create to clean up lead service lines. For more state-specific details on these jobs, see Table 2 on page 6.

## Table 1. Total Summary Outputs of Lead Pipe Replacement Investment Under The American Jobs Plan

| | Employment | Labor Income | Value Added | | Taxes |
|---|---|---|---|---|---|
| **Direct** | 268,600 | $19.7 | $22.4 | Local | $1.7B |
| **Indirect** | 156,100 | $11.4 | $18.5 | State | $2.3B |
| **Induced** | 136,100 | $7.2 | $12.9 | Federal | $7.8B |
| **Total** | 560,800 | $38.3 | $53.9 | Total | $11.7B |

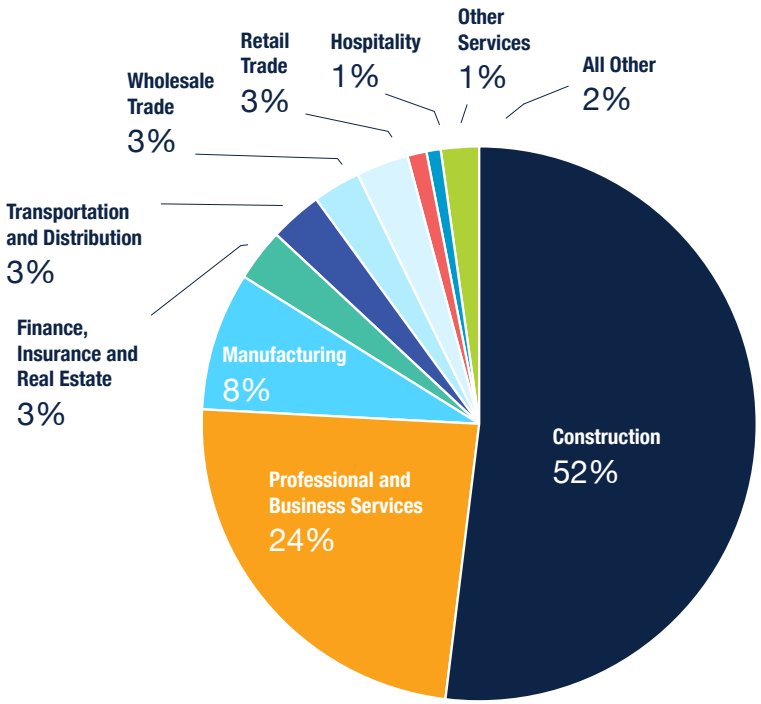
[13] IMPLAN includes "reservoirs, pump stations, and water pipeline construction" within this industry category. More information can be found in the IMPLAN Construction Industry Details file here: https://implanhelp.zendesk.com/hc/en-us/articles/360058813353-546-Industries-Conversions-Bridges-Construction-2019-Data

## Table 2. State Employment Impacts of Lead Pipe Replacement Investment Over 10 Years

| Job Impacts Annually over 10 Years | | | | | Total Job-Years | | | | |
|---|---|---|---|---|---|---|---|---|---|
| State | Direct | Indirect | Induced | Total | State | Direct | Indirect | Induced | Total |
| Alabama | 302 | 174 | 114 | 590 | Alabama | 3,019 | 1,741 | 1,136 | 5,896 |
| Alaska | 16 | 6 | 7 | 29 | Alaska | 160 | 64 | 66 | 289 |
| Arizona | 53 | 35 | 29 | 118 | Arizona | 534 | 353 | 290 | 1,177 |
| Arkansas | 202 | 114 | 66 | 383 | Arkansas | 2,021 | 1,145 | 662 | 3,828 |
| California | 255 | 158 | 137 | 550 | California | 2,553 | 1,577 | 1,372 | 5,501 |
| Colorado | 274 | 175 | 151 | 600 | Colorado | 2,743 | 1,751 | 1,505 | 5,999 |
| Connecticut | 180 | 85 | 79 | 344 | Connecticut | 1,803 | 848 | 793 | 3,444 |
| Delaware | 67 | 30 | 26 | 122 | Delaware | 665 | 301 | 258 | 1,225 |
| District of Columbia | 124 | 30 | 17 | 170 | District of Columbia | 1,235 | 297 | 166 | 1,698 |
| Florida | 912 | 671 | 496 | 2,079 | Florida | 9,121 | 6,712 | 4,961 | 20,793 |
| Georgia | 386 | 262 | 198 | 846 | Georgia | 3,858 | 2,621 | 1,982 | 8,461 |
| Hawaii | 11 | 5 | 5 | 21 | Hawaii | 110 | 50 | 51 | 211 |
| Idaho | 29 | 17 | 11 | 57 | Idaho | 295 | 165 | 111 | 571 |
| Illinois | 2,832 | 1,683 | 1,637 | 6,152 | Illinois | 28,316 | 16,829 | 16,372 | 61,516 |
| Indiana | 1,314 | 727 | 599 | 2,640 | Indiana | 13,144 | 7,268 | 5,986 | 26,398 |
| Iowa | 736 | 367 | 288 | 1,391 | Iowa | 7,357 | 3,672 | 2,879 | 13,908 |
| Kansas | 732 | 395 | 274 | 1,401 | Kansas | 7,323 | 3,946 | 2,743 | 14,012 |
| Kentucky | 248 | 135 | 97 | 479 | Kentucky | 2,479 | 1,345 | 968 | 4,792 |
| Louisiana | 259 | 147 | 115 | 521 | Louisiana | 2,595 | 1,468 | 1,148 | 5,211 |
| Maine | 76 | 44 | 35 | 155 | Maine | 762 | 437 | 354 | 1,553 |
| Maryland | 313 | 150 | 129 | 592 | Maryland | 3,131 | 1,503 | 1,285 | 5,919 |
| Massachusetts | 863 | 400 | 478 | 1,741 | Massachusetts | 8,626 | 4,000 | 4,780 | 17,406 |
| Michigan | 1,997 | 1,202 | 1,123 | 4,323 | Michigan | 19,974 | 12,022 | 11,232 | 43,228 |
| Minnesota | 1,100 | 664 | 665 | 2,430 | Minnesota | 11,005 | 6,640 | 6,651 | 24,296 |
| Mississippi | 150 | 81 | 45 | 277 | Mississippi | 1,502 | 810 | 454 | 2,766 |
| Missouri | 1,513 | 897 | 746 | 3,156 | Missouri | 15,130 | 8,969 | 7,458 | 31,557 |
| Montana | 49 | 28 | 20 | 97 | Montana | 485 | 278 | 204 | 967 |
| Nebraska | 486 | 270 | 192 | 948 | Nebraska | 4,861 | 2,699 | 1,918 | 9,477 |
| Nevada | 22 | 12 | 9 | 43 | Nevada | 222 | 120 | 88 | 430 |
| New Hampshire | 91 | 48 | 44 | 183 | New Hampshire | 910 | 482 | 437 | 1,829 |
| New Jersey | 1,385 | 754 | 687 | 2,827 | New Jersey | 13,854 | 7,545 | 6,869 | 28,268 |
| New Mexico | 123 | 55 | 42 | 220 | New Mexico | 1,225 | 550 | 421 | 2,196 |
| New York | 1,409 | 642 | 642 | 2,694 | New York | 14,094 | 6,416 | 6,425 | 26,935 |
| North Carolina | 383 | 250 | 171 | 804 | North Carolina | 3,829 | 2,503 | 1,708 | 8,041 |
| North Dakota | 35 | 15 | 14 | 63 | North Dakota | 347 | 150 | 137 | 635 |

| Job Impacts Annually over 10 Years | | | | | Total Job in Job-Years | | | | |
|---|---|---|---|---|---|---|---|---|---|
| State | Direct | Indirect | Induced | Total | State | Direct | Indirect | Induced | Total |
| Ohio | 2,901 | 1,837 | 1,629 | 6,367 | Ohio | 29,014 | 18,369 | 16,287 | 63,669 |
| Oklahoma | 236 | 139 | 90 | 465 | Oklahoma | 2,356 | 1,389 | 904 | 4,648 |
| Oregon | 60 | 37 | 31 | 128 | Oregon | 604 | 367 | 311 | 1,282 |
| Pennsylvania | 674 | 388 | 386 | 1,448 | Pennsylvania | 6,742 | 3,878 | 3,857 | 14,477 |
| Rhode Island | 88 | 44 | 38 | 169 | Rhode Island | 877 | 439 | 376 | 1,692 |
| South Carolina | 199 | 122 | 82 | 402 | South Carolina | 1,987 | 1,217 | 820 | 4,023 |
| South Dakota | 48 | 23 | 18 | 90 | South Dakota | 482 | 232 | 182 | 896 |
| Tennessee | 333 | 207 | 166 | 705 | Tennessee | 3,328 | 2,068 | 1,657 | 7,053 |
| Texas | 1,155 | 807 | 699 | 2,660 | Texas | 11,547 | 8,066 | 6,985 | 26,598 |
| Utah | 102 | 68 | 52 | 222 | Utah | 1,018 | 682 | 516 | 2,216 |
| Vermont | 38 | 19 | 15 | 72 | Vermont | 377 | 187 | 152 | 716 |
| Virginia | 420 | 226 | 172 | 818 | Virginia | 4,200 | 2,262 | 1,721 | 8,183 |
| Washington | 106 | 56 | 48 | 210 | Washington | 1,064 | 562 | 476 | 2,102 |
| West Virginia | 90 | 41 | 33 | 163 | West Virginia | 897 | 407 | 328 | 1,633 |
| Wisconsin | 1,455 | 861 | 763 | 3,079 | Wisconsin | 14,548 | 8,608 | 7,634 | 30,790 |
| Wyoming | 29 | 12 | 7 | 49 | Wyoming | 294 | 123 | 68 | 485 |
| Total US | 26,862 | 15,613 | 13,614 | 56,090 | Total US | 268,623 | 156,132 | 136,142 | 560,897 |

## Figure 4. Direct and Indirect Job Distribution by Industry[14]




[14] Information, Mining & Extraction, Agriculture & Forestry, Entertainment, Utilities, Education, and Healthcare are contained in the "All Other" category.

As mentioned in the previous section, the $45 billion investment in lead service line replacement will directly create jobs in the design, construction, and installation of these water pipelines.

The top water and sewer line and related structures construction and architectural, engineering, and related services occupations that will be created as a direct result of this investment are outlined in Table 2. The average annual wage for these occupations is $57,145, above the national average wage of $55,250.[15]

## Table 3. Top 15 Construction and Engineering Occupations and Wages

| Occupation | Average Annual Wages | Share of New Jobs |
|---|---|---|
| Construction Laborers | $42,500 | 19.9% |
| Operating Engineers and Other Construction Equipment Operators | $54,200 | 9.9% |
| First-Line Supervisors of Construction Trades and Extraction Workers | $68,100 | 7.4% |
| Pipelayers | $39,500 | 3.7% |
| Plumbers, Pipefitters and Steamfitters | $64,500 | 3.5% |
| Heavy and Tractor-Trailer Truck Drivers | $50,200 | 2.8% |
| Welders, Cutters, Solderers and Brazers | $55,700 | 2.7% |
| Construction Managers | $106,000 | 2.6% |
| Office Clerks, General | $42,000 | 2.5% |
| Civil Engineers | $95,200 | 2.5% |
| General and Operations Managers | $127,000 | 2.0% |
| Earth Drillers, Except Oil and Gas; and Explosives Workers, Ordnance Handling Experts, and Blasters | $43,800 | 1.8% |
| Carpenters | $50,000 | 1.7% |
| Secretaries and Administrative Assistants, Except Legal, Medical and Executive | $39,800 | 1.5% |
| Architects, Except Landscape and Naval | $89,500 | 1.3% |

[15] https://www.bls.gov/oes/current/000001.htm#17-0000

To protect the health and safety of communities affected by the LSL Replacement Program, this work must be done correctly. To this end, it is essential to use properly trained workers with the requisite skills on these projects. Accordingly, the grant programs and construction contracts used to implement this program should require contractors to certify that all workers employed for this work are graduates of bona fide apprenticeship training programs in trades needed for this work, e.g., plumbers, operating engineers. Contractual provisions for this work should also stipulate that all applicable state and local licensing or certification laws must be followed.

These requirements are vital. If any aspect of this work is flawed, it would obviously defeat the purpose of the program. For example, if defective construction procedures should permit new water lines to become tainted by any types of contaminants, residents would be exposed to unsafe water. Likewise, if the pipes are improperly installed and leak, residents would bear the cost of excessive future water bills.

Requiring contractors to certify they participate in bona fide apprenticeship programs will also yield substantial socio-economic benefits. Such programs can be defined simply as those that are registered with the U.S. Department of Labor and have graduated apprentices for at least (3) three years. This requirement will benefit local communities in several ways. For example, bona fide apprenticeship programs are virtually always locally based and, therefore, promote meaningful employment and training opportunities for residents of affected communities. Consequently, such requirements not only ensure that workers are qualified to perform the work, they also create employment and training opportunities for local residents.

Further, connecting the LSL Replacement Program to bona fide local apprenticeship programs is important because the construction industry is currently facing a major, industry-wide skill shortage, which means contractors and apprenticeship programs have a growing need to recruit new workers and trainees into the construction industry. This means the LSL Replacement Program can be a win-win proposition for local workers, the construction industry and the federal/state and/or local government stakeholders in the process.

Assuming that these LSL replacement projects will be funded through the Safe Drinking Water Act, as the Biden American Jobs Plan calls for, they will be subject to federal fair wage laws and will likely be heavily unionized.[16] Unionization brings better wages and benefits and increased worker protections to the workforce. The occupations in high demand for this work also have high unionization rates (Table 6). Two-thirds of these occupations have double-digit union membership rates, while the average private sector unionization rate is only 6.3 percent.[17] Investing in this work will bring good high-wage union jobs to communities that need them, though work must be done to ensure that more women and people of color have access to the opportunities. As noted, the LSL Replacement Program could be highly effective in bringing good jobs to economically disadvantaged areas. Moreover, requiring the use of bona fide apprenticeship programs will not only help accomplish this key goal, it can also create unprecedented opportunities for women and minorities wishing to gain employment and training opportunities in the construction industry. There are several compelling points that support this fact. First, numerous research reports further show that bona fide apprenticeship programs, especially those affiliated with the building and construction trade unions far outperform other apprenticeship programs in terms of both recruiting and graduating women and minority workers.

Second, many bona fide apprenticeship programs have developed various types of pre-apprenticeship or apprenticeship-readiness programs throughout the country, which are highly effective in expanding outreach and recruitment efforts to minorities and women. Much of this success lies in efforts by such programs to assist young and unemployed/underemployed workers gain necessary remedial education and basic life skills that facilitate placement from the pre-apprenticeship program directly into the most successful bona fide apprenticeship programs. These points were recently underscored in a report from the Brookings Institute, which found that:

An efficient reskilling architecture featuring pre-apprenticeship and community-based programs would allow education and training providers to focus on skills differentials and address only the incremental skills that workers will need, enabling more rapid and cost-effective scaling of high-quality training that leads to employment.

While scores of pre-apprenticeship programs have been developed in recent years, one of the most successful is the Apprenticeship Readiness Collective ("ARC") created by the New York City Building and Construction Trades Council to expand diversity in the construction market. This initiative brings together four major pre-apprenticeship/apprenticeship-readiness programs from across the city under a single new umbrella alliance. To date, ARC has produced excellent results: 76 percent of individuals placed by ARC into the NYC building trades apprenticeship programs are city residents; 73 percent are minorities; and 35 percent are women. These efforts have effectively changed the face of apprenticeship participation and the face of the city's construction workforce. The latter point was documented by a 2017 study by the Economic Policy Institute, which showed that "[m]inorities held 55.1 percent of the construction occupation jobs in the union construction" in NYC. Expanded efforts with these types of strategies could greatly benefit the LRL Program and local residents of affected communities.

[16] See for example Safe Drinking Water Act section 1450(e), 42 USC section 300j-9(e).

[17] Unionstats.com. Barry T. Hirsch and David A. Macpherson, private sector union membership rate, 2020

The benefits of lead service line replacement stretch beyond the direct economic impacts. Lead in water has been linked to numerous negative health impacts that disproportionately effect children, including behavioral and learning difficulties, lower IQ, hyperactivity, slowed growth, hearing problems, and anemia. In pregnant women, presence of the metal in water is correlated with reduced fetal growth and premature births. Adults exposed to lead report cardiovascular effects like high blood pressure and hypertension in addition to decreased kidney function and reproductive problems.[17] While previous sections highlight how the American workforce benefits from the abundance of jobs created as a direct result of infrastructure activities, the positive public health outcomes of such widespread replacement of toxic plumbing are projected to generate additional economic growth.

The Environmental Defense Fund (using EPA data) estimates, using data collected by EPA contractors and published health studies, that the full replacement of LSLs would yield 'societal benefits of more than $205 billion, or about $22,000 per LSL removed.' This projection is based on reducing the incidence of cardiovascular diseases which lead exposure is linked to over a thirty five-year period.[18] It does not include the benefits to children's brain development. The state of Minnesota found that the benefits to the public and economy of replacing its LSLs are from 10 to 18 times greater than the cost of replacements. This analysis focused on correlations between IQ and earning gains with IQ being a measure of developmental health and wellbeing.[19]

Research suggesting projections and economic advantages to healthy communities are not new. In 1987 the EPA conducted a cost-benefit analysis of the impacts of reducing the amount of lead permitted in drinking water by sixty percent found that benefits outweighed costs at a four to one ratio. Such benefits included avoided medical expenses and increased lifetime earnings.[20]

Higher property values are an additional potential economic benefit of LSL replacement. A study based in Pittsburgh found that the LSLs reduce sales values of homes by five percent. LSL replacement, therefore, may increase home worth and translate to household wealth.[21]

Replacing lead service lines also generates equity benefits due to the disproportionate presence of LSLs in many low income and minority communities. Majority Black and Latinx neighborhoods in Illinois, for instance, are twice as likely to have LSLs as their white counterparts.[22] The impact of replacing LSLs could not only effect historically disinvested communities' generational health and income but could also raise the value of their homes and therefore their wealth. However, with all occasions of increasing housing values, gentrification of historic communities of color is possible.

# Conclusion

Replacing lead service lines will not only provide America with clean water but will also support hundreds of thousands of jobs. While cost estimates of total replacement of known LSLs can vary, the $45 billion investment outlined by the American Jobs Plan just about covers the necessary costs of replacing 9.7 million LSLs using average costs from EPA and academic estimates. This investment will create good jobs, and with proper policy provisions the country can ensure these jobs are spread equitably. Along with the economic benefits from additional social benefits are generated by this investment, including vast health benefits and more equitable outcomes for minority communities.

[17] https://www.epa.gov/ground-water-and-drinking-water/basic-information-about-lead-drinking-water

[18] http://blogs.edf.org/health/2020/02/20/lslr-reduced-cardiovascular-disease-deaths/

[19] https://www.health.state.mn.us/communities/environment/water/docs/leadreport.pdf

[20] https://www.epa.gov/environmental-economics/reducing-lead-drinking-water-benefit-analysis-1987

[21] https://www.ucsur.pitt.edu/files/center/Lead_and_Property_Sales_2018-04.pdf

[22] https://www.metroplanning.org/news/9960/Data-Points-the-environmental-injustice-of-lead-lines-in-Illinois

# Appendix A

## Research Methodology

BW Research used IMPLAN to conduct the economic impact analysis, resulting in the jobs, value added, labor income, and taxes data. IMPLAN is an input-output modeling software that tracks spending patterns through the economy and their resulting impacts on economic indicators. The cumulative effects of the initial investment are quantified, and the results are categorized into direct, indirect, and induced effects. To capture interstate flows, direct and indirect impacts are results of national level multipliers, distributed across states using state level modeling. Induced impacts are the results of state level multipliers, so as not to overestimate the impacts of household spending.

Workforce data such as occupational demographics and wages are derived from JobsEQ by Chmura. JobsEQ is a workforce data software that derives data from Bureau of Labor Statistics and Census Bureau data, among other sources. Unionization rates are derived from unionstats.com.

**Direct Impacts** show the initial change in the economy associated with the investment. For example, pipefitters installing new service pipes or engineers planning the replacement.

**Indirect Impacts** include the supply chain responses as a result of the initial investment (i.e., water pipe manufacturers).

**Induced Impacts** refer to household spending and are the result of workers who are responsible for the direct and indirect effects spending their wages (i.e., direct and indirect workers spend income on clothes, food, healthcare, etc.).

**Labor Income** includes all forms of employment income, such as employee compensation (wages and benefits) and proprietor income (i.e. payments received by self-employed individuals and unincorporated business owners). Labor income is a component of value added.

**Value Added** is defined as the total value of production after netting out intermediate goods. This is another term for GDP.

# Appendix B

## Lead Service Lines by State

### Table 4. Number of known LSLs by State

| State | LSLs (known) | State | LSLs (known) |
|---|---|---|---|
| Alabama | 63,000 | Montana | 10,000 |
| Alaska | 3,800 | Nebraska | 97,000 |
| Arizona | 12,000 | Nevada | 5,200 |
| Arkansas | 40,000 | New Hampshire | 20,000 |
| California | 65,000 | New Jersey | 350,000 |
| Colorado | 64,650 | New Mexico | 26,000 |
| Connecticut | 43,000 | New York | 360,000 |
| Delaware | 16,000 | North Carolina | 82,000 |
| District of Columbia | 31,974 | North Dakota | 8,200 |
| Florida | 200,000 | Ohio | 650,000 |
| Georgia | 86,000 | Oklahoma | 48,000 |

| State | LSLs (known) | State | LSLs (known) |
|---|---|---|---|
| Hawaii | 2,800 | Oregon | 14,000 |
| Idaho | 6,200 | Pennsylvania | 160,000 |
| Illinois | 679,292 | Rhode Island | 20,000 |
| Indiana | 290,000 | South Carolina | 44,000 |
| Iowa | 160,000 | South Dakota | 10,000 |
| Kansas | 160,000 | Tennessee | 74,000 |
| Kentucky | 53,000 | Texas | 270,000 |
| Louisiana | 56,000 | Utah | 23,000 |
| Maine | 15,000 | Vermont | 7,400 |
| Maryland | 74,000 | Virginia | 97,000 |
| Massachusetts | 220,000 | Washington | 27,000 |
| Michigan | 460,000 | West Virginia | 20,000 |
| Minnesota | 260,000 | Wisconsin | 329,866 |
| Mississippi | 29,000 | Wyoming | 6,300 |
| Missouri | 330,000 | Total | 6,182,682 |

## Table 5. Number of Additional Estimated LSL Per State

| State | Estimated Additional LSLs (low-end) | Estimated Additional LSLs (high-end) | State | Estimated Additional LSLs (low-end) | Estimated Additional LSLs (high-end) |
|---|---|---|---|---|---|
| Alabama | 36,059 | 85,139 | Montana | 5,724 | 13,514 |
| Alaska | 2,175 | 5,135 | Nebraska | 55,519 | 131,086 |
| Arizona | 6,868 | 16,217 | Nevada | 2,976 | 7,027 |
| Arkansas | 22,894 | 54,056 | New Hampshire | 11,447 | 27,028 |
| California | 27,364 | 27,364 | New Jersey | 472,993 | 472,993 |
| Colorado | 37,003 | 87,368 | New Mexico | 14,881 | 35,137 |
| Connecticut | 24,612 | 58,111 | New York | 206,050 | 486,507 |
| Delaware | 9,158 | 21,623 | North Carolina | 46,934 | 110,815 |
| District of Columbia | 15,435 | 15,435 | North Dakota | 4,693 | 11,082 |
| Florida | 114,472 | 270,281 | Ohio | 372,035 | 878,415 |
| Georgia | 49,223 | 116,221 | Oklahoma | 27,473 | 64,868 |
| Hawaii | 1,603 | 3,784 | Oregon | 8,013 | 18,920 |
| Idaho | 3,549 | 8,379 | Pennsylvania | 91,578 | 216,225 |
| Illinois | 391,123 | 391,123 | Rhode Island | 11,447 | 27,028 |
| Indiana | 135,593 | 135,593 | South Carolina | 25,184 | 59,462 |

| State | Estimated Additional LSLs (low-end) | Estimated Additional LSLs (high-end) | State | Estimated Additional LSLs (low-end) | Estimated Additional LSLs (high-end) |
|---|---|---|---|---|---|
| Iowa | 91,578 | 216,225 | South Dakota | 5,724 | 13,514 |
| Kansas | 91,578 | 216,225 | Tennessee | 42,355 | 100,004 |
| Kentucky | 30,335 | 71,625 | Texas | 154,538 | 364,880 |
| Louisiana | 32,052 | 75,679 | Utah | 13,164 | 31,082 |
| Maine | 8,585 | 20,271 | Vermont | 4,235 | 10,000 |
| Maryland | 42,355 | 100,004 | Virginia | 55,519 | 131,086 |
| Massachusetts | 125,920 | 297,310 | Washington | 15,454 | 36,488 |
| Michigan | 157,060 | 157,060 | West Virginia | 11,447 | 27,028 |
| Minnesota | 148,814 | 351,366 | Wisconsin | 63,140 | 63,140 |
| Mississippi | 16,598 | 39,191 | Wyoming | 3,606 | 8,514 |
| Missouri | 188,879 | 445,964 | Total | 3,537,015 | 6,632,590 |

## Table 6. Per Capita LSLs by State (Per 100,000 People)*

| State | LSLs per 100,000 | State | LSLs per 100,000 |
|---|---|---|---|
| Alabama | 1,254 | Montana | 922 |
| Alaska | 518 | Nebraska | 4,945 |
| Arizona | 168 | Nevada | 167 |
| Arkansas | 1,328 | New Hampshire | 1,452 |
| California | 164 | New Jersey | 3,768 |
| Colorado | 1,120 | New Mexico | 1,228 |
| Connecticut | 1,192 | New York | 1,782 |
| Delaware | 1,616 | North Carolina | 785 |
| District of Columbia | 4,637 | North Dakota | 1,053 |
| Florida | 929 | Ohio | 5,509 |
| Georgia | 803 | Oklahoma | 1,212 |
| Hawaii | 192 | Oregon | 330 |
| Idaho | 337 | Pennsylvania | 1,231 |
| Illinois | 5,302 | Rhode Island | 1,823 |
| Indiana | 4,274 | South Carolina | 860 |
| Iowa | 5,015 | South Dakota | 1,128 |
| Kansas | 5,446 | Tennessee | 1,071 |
| Kentucky | 1,176 | Texas | 926 |
| Louisiana | 1,202 | Utah | 703 |

* Does not include projected Number of LSLs Based on Service Lines Currently of Unknown Material

| State | LSLs per 100,000 | State | LSLs per 100,000 |
|---|---|---|---|
| Maine | 1,101 | Vermont | 1,151 |
| Maryland | 1,198 | Virginia | 1,124 |
| Massachusetts | 3,129 | Washington | 350 |
| Michigan | 4,565 | West Virginia | 1,115 |
| Minnesota | 4,556 | Wisconsin | 5,597 |
| Mississippi | 979 | Wyoming | 1,092 |
| Missouri | 5,362 | | |

## Table 7. LSL Per State by Community Size

| State | <10,000 | 10,000-50,000 | >50,000 |
|---|---|---|---|
| Alabama | 5,400 | 38,000 | 19,000 |
| Alaska | 2,900 | 96 | 840 |
| Arizona | 4,600 | 830 | 7,000 |
| Arkansas | 8,100 | 31,000 | 1,000 |
| California | 15,000 | 4,700 | 46,000 |
| Colorado | 22,000 | 1,000 | 35,000 |
| Connecticut | 270 | 32,000 | 11,000 |
| District of Columbia | 21 | 790 | 8,100 |
| Delaware | 970 | 8,500 | 6,000 |
| Florida | 6,000 | 64,000 | 130,000 |
| Georgia | 5,200 | 29,000 | 52,000 |
| Hawaii | 1,000 | 240 | 1,500 |
| Idaho | 4,500 | 270 | 1,400 |
| Illinois | 76,000 | 240,000 | 410,000 |
| Indiana | 40,000 | 75,000 | 180,000 |
| Iowa | 46,000 | 48,000 | 66,000 |
| Kansas | 37,000 | 37,000 | 89,000 |
| Kentucky | 3,900 | 35,000 | 15,000 |
| Louisiana | 12,000 | 42,000 | 2,600 |
| Maine | 250 | 14,000 | 820 |
| Maryland | 2,000 | 15,000 | 57,000 |
| Massachusetts | 650 | 180,000 | 32,000 |
| Michigan | 52,000 | 140,000 | 270,000 |
| Minnesota | 32,000 | 83,000 | 140,000 |
| Mississippi | 7,000 | 20,000 | 2,200 |

| State | <10,000 | 10,000-50,000 | >50,000 |
|---|---|---|---|
| Missouri | 68,000 | 65,000 | 200,000 |
| Montana | 8,800 | 95 | 1,600 |
| Nebraska | 20,000 | 17,000 | 60,000 |
| Nevada | 1,400 | 110 | 3,600 |
| New Hampshire | 290 | 18,000 | 1,300 |
| New Jersey | 1,100 | 320,000 | 31,000 |
| New Mexico | 3,300 | 22,000 | 1,000 |
| New York | 2,900 | 280,000 | 84,000 |
| North Carolina | 6,000 | 35,000 | 40,000 |
| North Dakota | 6,600 | 110 | 1,600 |
| Ohio | 52,000 | 170,000 | 430,000 |
| Oklahoma | 8,600 | 38,000 | 1,800 |
| Oregon | 8,200 | 660 | 5,000 |
| Pennsylvania | 10,000 | 72,000 | 79,000 |
| Rhode Island | 110 | 16,000 | 3,700 |
| South Carolina | 2,900 | 23,000 | 18,000 |
| South Dakota | 8,400 | 130 | 1,600 |
| Tennessee | 4,200 | 39,000 | 30,000 |
| Texas | 46,000 | 210,000 | 17,000 |
| Utah | 13,000 | 760 | 8,900 |
| Vermont | 290 | 7,100 | - |
| Virginia | 4,800 | 33,000 | 59,000 |
| Washington | 16,000 | 1,500 | 10,000 |
| West Virginia | 3,700 | 12,000 | 4,700 |
| Wisconsin | 36,000 | 70,000 | 130,000 |
| Wyoming | 5,400 | 93 | 800 |

## Table 8. LSL Percentage Per State by Community Size

| State | % <10,000 | % 10,000-50,000 | % >50,000 |
|---|---|---|---|
| Alabama | 8.7% | 60.9% | 30.4% |
| Alaska | 75.6% | 2.5% | 21.9% |
| Arizona | 37.0% | 6.7% | 56.3% |
| Arkansas | 20.2% | 77.3% | 2.5% |
| California | 22.8% | 7.2% | 70.0% |
| Colorado | 37.9% | 1.7% | 60.3% |
| Connecticut | 0.6% | 74.0% | 25.4% |
| District of Columbia | 0.2% | 8.9% | 90.9% |
| Delaware | 6.3% | 54.9% | 38.8% |
| Florida | 3.0% | 32.0% | 65.0% |
| Georgia | 6.0% | 33.6% | 60.3% |
| Hawaii | 36.5% | 8.8% | 54.7% |
| Idaho | 72.9% | 4.4% | 22.7% |
| Illinois | 10.5% | 33.1% | 56.5% |
| Indiana | 13.6% | 25.4% | 61.0% |
| Iowa | 28.8% | 30.0% | 41.3% |
| Kansas | 22.7% | 22.7% | 54.6% |
| Kentucky | 7.2% | 64.9% | 27.8% |
| Louisiana | 21.2% | 74.2% | 4.6% |
| Maine | 1.7% | 92.9% | 5.4% |
| Maryland | 2.7% | 20.3% | 77.0% |
| Massachusetts | 0.3% | 84.6% | 15.0% |
| Michigan | 11.3% | 30.3% | 58.4% |
| Minnesota | 12.5% | 32.5% | 54.9% |
| Mississippi | 24.0% | 68.5% | 7.5% |
| Missouri | 20.4% | 19.5% | 60.1% |
| Montana | 83.8% | 0.9% | 15.2% |
| Nebraska | 20.6% | 17.5% | 61.9% |
| Nevada | 27.4% | 2.2% | 70.5% |
| New Hampshire | 1.5% | 91.9% | 6.6% |
| New Jersey | 0.3% | 90.9% | 8.8% |
| New Mexico | 12.5% | 83.7% | 3.8% |
| New York | 0.8% | 76.3% | 22.9% |
| North Carolina | 7.4% | 43.2% | 49.4% |
| North Dakota | 79.4% | 1.3% | 19.3% |

| State | % <10,000 | % 10,000-50,000 | % >50,000 |
|---|---|---|---|
| Ohio | 8.0% | 26.1% | 66.0% |
| Oklahoma | 17.8% | 78.5% | 3.7% |
| Oregon | 59.2% | 4.8% | 36.1% |
| Pennsylvania | 6.2% | 44.7% | 49.1% |
| Rhode Island | 0.6% | 80.8% | 18.7% |
| South Carolina | 6.6% | 52.4% | 41.0% |
| South Dakota | 82.9% | 1.3% | 15.8% |
| Tennessee | 5.7% | 53.3% | 41.0% |
| Texas | 16.8% | 76.9% | 6.2% |
| Utah | 57.4% | 3.4% | 39.3% |
| Vermont | 3.9% | 96.1% | - |
| Virginia | 5.0% | 34.1% | 61.0% |
| Washington | 58.2% | 5.5% | 36.4% |
| West Virginia | 18.1% | 58.8% | 23.0% |
| Wisconsin | 15.3% | 29.7% | 55.1% |
| Wyoming | 85.8% | 1.5% | 12.7% |