Community Water Fluoridation: A Position Paper Prepared by the Office of Oral Health and the Science Advisory Committee

Arkansas Department of Health

- **187,000 Arkansans Over Age 40 Have No Teeth**

- **Fluoridation Of All Community Water Systems In Arkansas Would Reduce This Number By 65,450**

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EXECUTIVE SUMMARY

Dental caries, or tooth decay, is an infectious, communicable, but largely preventable, bacterial disease striking without regard to age, income, race, or ethnicity. Often presenting as small, repairable holes in teeth, untreated caries (i.e., cavities) can cause severe pain, bacterial infections leading to the death of the nerves and blood vessels in the tooth, tooth loss, inability to chew effectively or speak clearly and on rare occasions an infection that can spread throughout the body causing great harm. [1]

In the United States tooth decay is experienced by more than 66% of children and adolescents by age 19, and by 91% of adults, including 93% aged 60 or older.[2] Many American adults suffer untreated dental caries; 27% aged 20 to 39 years, 21% aged 40 to 59 years and 19% aged 60 years and older. [3]

While dental caries may affect anyone, all members of a community are benefited by community water fluoridation.[4] Fluoride, a natural element found in rocks, soil and both fresh and ocean waters, exists in some public water systems naturally at levels ranging from 0.1 to more than 12 mg/l.[5] Fluoridation of community water systems is a public-health measure targeted at community water systems with fluoride levels below the optimal level.[6] "Community water fluoridation" means using fluoride additives to achieve an optimal concentration of fluoride in public water systems. Optimally fluoridated water, whether controlled or occurring naturally, maximizes caries-prevention by providing both systemic and topical protection to teeth. After more than 60 years of usage and scientific study in the United States and around the world, community water fluoridation remains the safest, and most equitable and effective method for caries prevention.[7] [8] Worldwide, water fluoridation benefits over 405 million people in approximately 60 countries,[9] including more than 67% or 170 million of the United States population served by public water systems.[10] It decreases tooth decay by 29% to 51% in children and adolescents (ages 4 through 17),[11] and by 20%-40% in adults. [12]

Fluoridation of drinking water is cited by the Centers for Disease Control and Prevention (CDC) as one of the greatest public health achievements of the 20th Century,[13] and is described in *Oral Health in America: A Report of the Surgeon General* as "the cornerstone of caries prevention" for the past 50 years.[14] **The U.S. Public Health Service (US-PHS) includes fluoridated drinking-water as one of the nation's Healthy People objectives for Year-2010: namely, to increase to 75% the U.S. population served by optimally fluoridated community water systems.**[15] Well respected professional, health-provider, and non-governmental organizations endorse community fluoridated water, including the American Dental Association (ADA),[16] the American Medical Association,[17] and the World Health Organization.[18]

Over the past several decades community water fluoridation has contributed to the reduced prevalence and severity of dental caries in the United States.[19] However, about one million Arkansans receiving public water supplies do not benefit from the protection of such a public health program. This report reviews the science that supports water fluoridation, sets out the history of fluoridation in the U.S. and describes the current status of fluoridation in Arkansas, including the health consequences for Arkansans who do not drink optimally fluoridated water.

The Arkansas Department of Health advocates expanding the benefits of fluoridated drinking water to those Arkansans whose community water systems do not currently contain optimal levels of fluoride.

INTRODUCTION

This report provides an overview of community water fluoridation, including a review of the science that provides the rationale for its use together with a review of its cost effectiveness and use in other states. **The Department of Health advocates expanding the benefits of fluoridated drinking-water to the state's one million citizens whose community water systems do not contain the optimal amount of fluoride**.

I. COMMUNITY WATER FLUORIDATION.

A. Definitions

Fluoride, a natural element found in rocks, soil and both fresh and ocean waters, exists in all public water systems [a]naturally at levels having variable beneficial health effects: e.g., little or no caries-prevention effect (fluoride concentrations under 0.7 milligrams (mg)/liter); maximum caries-prevention benefit (fluoride concentrations from 0.7 mg/l to 1.2 mg/l.)[b] In public water systems having little or inadequate levels of naturally occurring fluoride, many systems provide for the controlled addition of fluoride to the water supply to achieve an optimal fluoride concentration to prevent dental caries. Unless otherwise indicated in this report, "fluoridation" means a fluoride concentration in the drinking water adjusted to an optimal level (0.7 mg/l –1.2 mg/l).

B. Brief History and Recommended Daily Intake of Fluoride

The benefits of fluoride for teeth were initially studied in the 1930s when it was noted that children living in communities using drinking water with a higher concentration of naturally-occurring fluoride had lower rates of dental caries. Public drinking water fluoridation was first used in Grand Rapids, Michigan in 1945.[20] In 1962, based on studies of the relationship of water consumption and dental caries conducted across different climates and geographic regions of the United States, the U.S. Public Health Service (US-PHS) recommended the optimum range of fluoride concentration in drinking water to prevent caries without having adverse health effects: namely, 0.7 mg/l for warmer climates where water consumption is higher and 1.2 mg/l for colder climates where water consumption is lower.[21] The US-PHS standard is endorsed by the American Water Works Association, the National Sanitation Foundation International and the American National Standards Institute.[22] Foods and beverages commonly consumed by Americans contain natural fluoride. Fluoride contained in tooth paste, mouth rinses and soft drinks is not sufficient to meet the needed fluoride on a regular basis.[23] Most bottled water does not contain fluoride in the proper concentration, while fluoride added to public drinking water is present in the correct concentration and closely regulated by the Environmental Protection Agency (EPA).[24]. Adding fluoride to community drinking water provides the extra fluoride needed to meet the recommended daily intake. To prevent dental caries, dental fluorosis and skeletal fluorosis, the Institute of Medicine has

[a] A "community water system" is a public water system regularly serving at least 25 residents throughout the year or serving at least 15 service connections used by year-round residents. A "public water system" is a piped public system (including community water systems) having at least 15 service connections or regularly serving an average of at least 25 individuals 60 or more days per year.[a a]

[b] 1 mg/l = 1 part per million (ppm]

determined the recommended intake of fluoride per day for infants, children and adults.[25] For infants up to six months of age the fluoride needed is about 0.01 mg/day, for infants and children over six months of age the fluoride needed is based on the weight of the child and should be about 0.05 mg/kg/day. For adult females the recommended intake is 3 mg/day and for adult males 4mg/day is advised.

The amount of fluoride contained in many foods and beverages has been measured and reported by the Nutrient Data Laboratory of the Agricultural Research Service, U.S. Department of Agriculture [26] Fluoride is found in soil and it follows that it would be found in plants and animals. Among the foods and beverages tested by the U.S.D.A. laboratory, brewed teas were found to contain the highest concentration of fluoride. Thus, if an adult female were to consume four 8 ounce glasses of brewed tea daily year round, the daily recommended intake of fluoride would be met. Many other foods and beverages contain fluoride but in much lower concentrations than does brewed tea. However, some foods and beverages contain approximately a tenth of the fluoride found in tea; some examples of these are fried shrimp, canned crab meant, white grape juice, white wine, raisins and corn chowder.

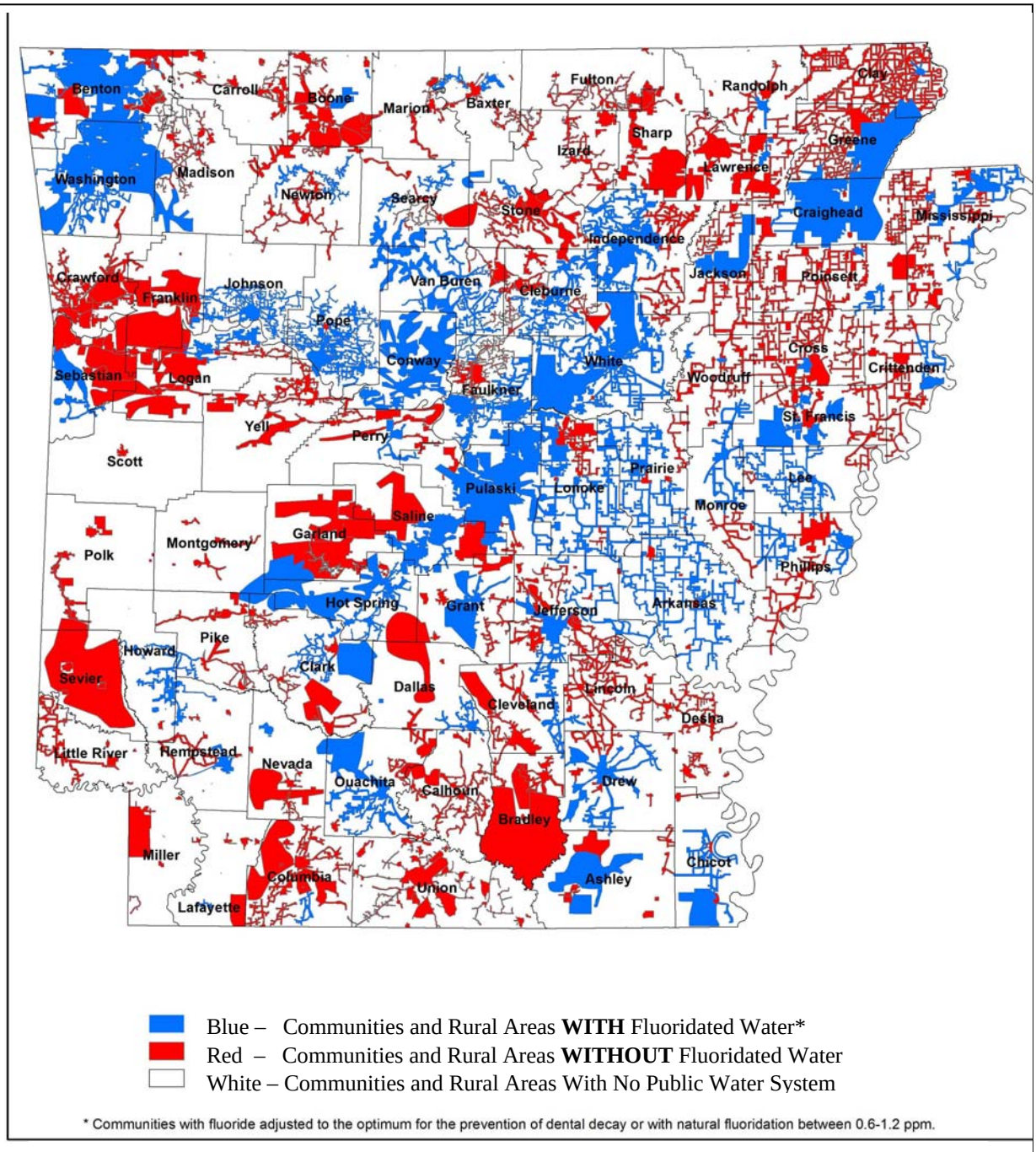
C. Current Status: National and Arkansas.

In 2002, optimally fluoridated drinking-water reached more than 170 million people living in the U.S. or about 67.3%, of the population, an increase from 144 million [27] people in 1992. Among the states, the percent of the population having fluoridated water varies from two percent to 100% of the state population.[28] In 2002, 75% or more of the residents in 26 States and the District of Columbia were supplied with properly fluoridated water.[29] As of May 2005, 44 of the 50 largest U.S. cities had fluoridated water.[30] Between 2000 and 2005, 125 communities, ranging from a few thousand to more than one million, initiated community water fluoridation.[31] In Arkansas in 2006, 64.5% of the population had community water fluoridation and an additional nine communities had public water systems that are naturally fluoridated at optimal levels. Currently, about one million Arkansans do not have community water fluoridation.

Figure 1 sets out a geographic depiction of the community water system locations in Arkansas that do and do not provide optimally fluoridated water.

Table 2 provides a list of all community water systems in Arkansas by county with the approximate number of persons served by each system together with the fluoridation status of each system.

Figure 1: Community Water Systems in Arkansas With and Without Fluoridation



*Communities with fluoride adjusted to the optimum for the prevention of dental decay or with natural fluoridation between 0.7 mg/l – 1.2 mg/l

II. DENTAL CARIES: NATIONAL AND ARKANSAS STATUS

Populations at increased risk for dental caries that frequently progress to loss of teeth often are persons with low income who do not benefit from dental care on a regular basis or persons who lack dental insurance or access to dental services.[32] Untreated dental caries is more prevalent among lower-income, ethnic-minority children and adults.[33] By protecting all members of the community, fluoridation of drinking water helps to reduce these disparities.[34] Fluoridation is a particularly important strategy to prevent oral diseases and improve overall general health in communities where it is difficult to reach individuals through other public health programs.

A. Infants

When infants and children are exposed to fluoride as the teeth are forming a small minority develop changes on the outer surfaces of the tooth called enamel fluorosis. Currently, about one third of all U.S. children aged 12-15 years have mild or very mild enamel fluorosis. These cosmetic changes are not noticeable by a non professional and require the skill of a dental professional to detect.

For many years manufacturers of infant formula have produced a product that contains low amounts of fluoride. When this formula is in the form of a powder or liquid concentrate it must be reconstituted with water. If fluoridated tap water is used for this purpose it may increase the fluoride to levels above the amount recommended to minimize the risk for minimal fluorosis. Formula that is ready to feed and does not require reconstitution has low fluoride levels and does not contribute to enamel fluorosis[35] [36]. For decades parents have been mixing infant formula with optimally fluoridated tap water and no association has been observed between infant formula use and risk for moderate or severe forms of fluorosis.

B. Children

Dental caries is the most common chronic childhood disease,[37] disproportionately afflicting low-income ethnic-minority children, the very same children who have the least access to dental care and the highest disease levels. [38] By age 5, 60% of all children have had tooth decay, and more than 80% of 18-year-olds have experienced decay. Among children ages 6-8 years, the prevalence of untreated caries is 43% in Hispanics, 36% in blacks and 26% in whites.[39] **An estimated 51 million school hours per year are lost due to dental-related childhood illness**. Children who live below the poverty line suffer twice as many dental caries as those whose family income is above the poverty line.[40] Poor children experience nearly 12 times more restricted-activity days due to dental-related illness than their higher-income counterparts. Problems with eating, speech, and "attentive learning" result from the pain of untreated caries. Poor children also have difficulty accessing dental-care through Medicaid because of dentists' low participation rates. Nationally, fewer than one in five Medicaid-eligible children received at least one preventive dental service in a recent year.[41] As of December 2006, only 393 among almost 1,100 Arkansas dentists participated in the Medicaid program.

C. Adults

The topical effect of community fluoridated water benefits not only children but also adults, for whom caries has been reduced by 20%-40% by fluoridation.[42] Retention of most or all teeth during their senior years is expected for the "baby boomer" generation, in contrast to those in earlier generations for whom significant to complete loss of teeth was commonly experienced: e.g., among 45-54 year-olds nationally, all permanent teeth were lost by 20% of the population in 1960-1962; but by only 9% of this age group in 1988-1994.[43] In Arkansas, tooth loss remains a significant tragic consequence of untreated dental caries. **Surveys done in 2002 and 2004 of 8,000 randomly selected Arkansans revealed that 15% over age 40 have lost all their teeth.** [44] [45] **A second survey, using slightly different methodology and focusing on oral health alone in 2002, showed that 23% of Arkansans over 40 have no teeth.** [46]

Medicare does not cover any dental procedures and Medicaid programs are inadequate to address the dental needs of low-income adults. In Arkansas, adults are not covered for dental treatment under the Medicaid system. Nationally, 45% of the population has no public or private dental insurance. Loss of all permanent teeth, having numerous missing permanent teeth, having numerous untreated caries in teeth is a burden that falls inordinately on the poor.

III. FREE DENTAL CLINIC

The impact upon the poor and uninsured was demonstrated dramatically on May 18 and 19, 2007 at the Robinson Auditorium in Little Rock when the Arkansas "Mission of Mercy" event provided dental care to 1,542 Arkansans, extracting 2,774 teeth and providing 886 fillings in two days. People seeking dental treatment began to arrive the day before and many spent the night in line sleeping on the ground outside in the cold. By 5:00 am the next day the line wrapped around the Double Tree Hotel next door and down Markham Street to the Old State House Museum. When the doors opened at 7:00 am there were more people in line than could be treated in one day.

The photographs shown in figures 2, 3 and 4 document the large unmet need for dental care among Arkansans, particularly for the poor. Fluoridation of all community water systems in Arkansas would, over time, reduce this health burden by approximately 35%.

Figure 2: Arkansans Seeking Free Dental Care Wait in Line the Night of May 17 Sleeping and Standing Out in the Cold

Figure 3: By 5 AM The Waiting Line Extended To The Old State House Museum

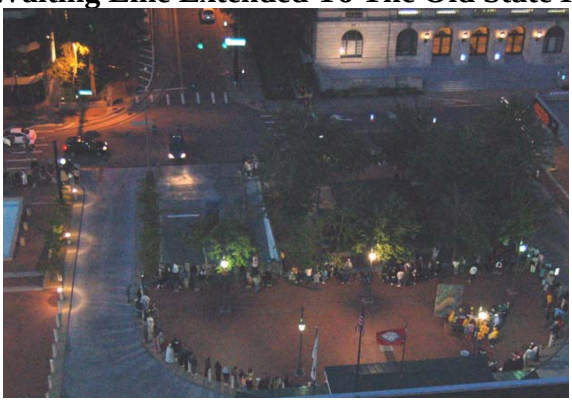


Figure 4: Thousands of Arkansans Wait to Be Treated Inside Robinson Auditorium

IV. HOW FLUORIDE PREVENTS TOOTH DECAY

A. Tooth Decay Process

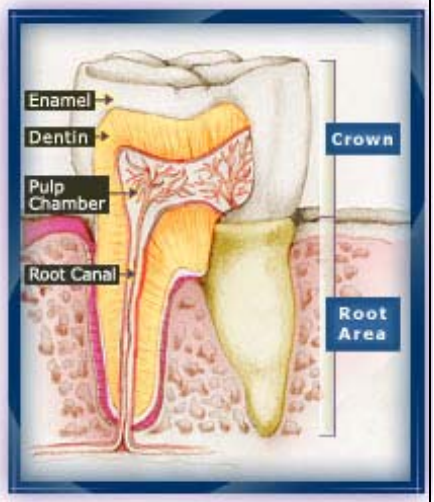
A tooth is a specialized tissue whose outer covering, enamel, makes it harder than bone.

- A major portion of enamel is hydroxyapatite, a crystalline formation composed of the minerals calcium and phosphorous.
- Fluoride is another mineral that, when present in the body fluids, is incorporated into the enamel's crystalline structure where it has a markedly favorable effect: it makes the enamel resistant to acid erosion.

Teeth undergo a constant cycle of demineralization and remineralization with caries-prevention dependent on effective remineralization. Every normal mouth contains bacteria that feed on the sugars and starches that remain in the mouth and on teeth after eating. As the bacteria grow on teeth surfaces, acid is produced that dissolves the mineral on the tooth surface, thus creating a small hole or cavity that will continue to grow unless remineralization occurs. Teeth undergo a constant cycle of demineralization and remineralization with caries-prevention dependent on effective remineralization. When fluoride is present in the tooth crystalline structure, the tooth becomes more resistant to acid erosion. The process of how acid erosion produces a cavity is set out in Figure 5.

Figure 5: How a Tooth Decays

1. Healthy Tooth

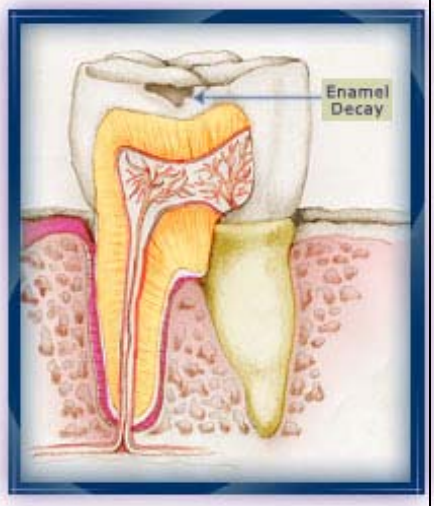


Enamel is the hard outer crystal-like layer. Dentin is the softer layer beneath the enamel. The pulp chamber contains nerves and blood vessels and is considered the living part of the tooth.

2. White Spots

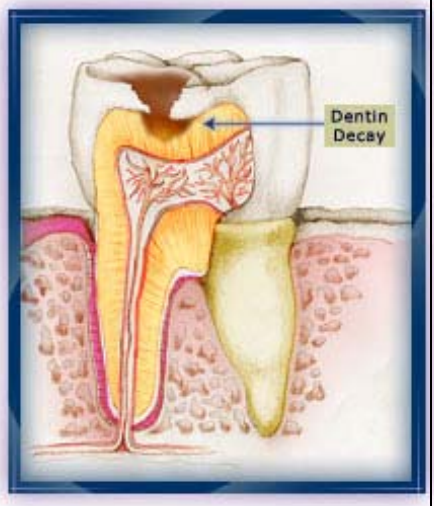
Bacteria that are exposed to sugars or carbohydrates can make acid, which attacks the crystal-like substance in the tooth's outer surface. This process is known as demineralization. The first sign of this is a chalky white spot. At this stage, the decay process can be reversed. Fluoride's topical effect can help the tooth repair itself.

3. Enamel Decay



Demineralization continues. Enamel starts to break down. Once the enamel surface is broken, the tooth can no longer repair itself. The cavity has to be cleaned and restored by a dentist.

4. Dentin Decay



The decay reaches into the dentin where it can spread and undermine the enamel.

5. Pulp Involvement

If decay is left untreated, it will reach the tooth's pulp, which contains nerves and blood vessels. The pulp becomes infected. An abscess (swelling) or a fistula (opening to the surface of the gum) can form in the soft tissues. Acute systemic infection may result.

Illustrations created by Simple Steps designer Lynda Buchhalter. Text revised. Original reviewed by the Faculty of Columbia University College of Dental Medicine and available at http://www.simplestepsdental.com/SS/ihtSS/r.WSIHW000/st.31843/t.31886/pr.3.html

B. Systemic and Topical Effects of Fluoride.

Fluoride acts in two ways to prevent dental caries. One, during tooth formation, ingested fluoride contained in drinking water is absorbed in the gastrointestinal tract and carried by the bloodstream to the developing tooth beneath the gum.[47] This ensures that fluoride is present throughout the tooth crystalline structure providing protection from acid erosion.[48] After the tooth erupts ingested fluoride incorporated into saliva flows over the tooth providing a topical, decay-resistant effect that strengthens and protects the surface of the permanent tooth.[49] Two, fluoride also becomes incorporated into dental plaque, the thin film of bacteria and carbohydrates on the tooth surface that leads to tooth decay. Its presence in plaque facilitates remineralization by inhibiting the acid erosion [50] [51] [52] [53] [54] Maximum reduction in caries is achieved when fluoride is available via the blood supply for incorporation during tooth formation below the gum line and after the tooth erupts topically at the tooth surface over the lifetime of the individual.

V. COMMUNITY WATER FLUORIDATION

A. Effective Tooth–Decay Prevention

Studies comparing communities with and without proper water fluoridation have consistently shown lower rates of caries/cavities in communities with fluoridated water.[55] The CDC estimates fluoridation reduces tooth decay among children by 18 to 40 percent.[56] A study comparing Medicaid-eligible children in Louisiana communities with and without water fluoridation found that those without fluoridated water were three times more likely to receive dental treatment in a hospital operating room, resulting in cost of dental treatment per eligible child approximately twice as high as for those who had fluoridated drinking water.[57]

In Arkansas, dental surveys show that tooth decay is a major problem. In 2006, 57% of third-grade children had a cavity, 27% attend school with untreated caries, and 10% of children had emergency dental needs.[58]

In 2002, studies were done in Morrilton, Arkansas and in the Perry County, Arkansas schools. The public water is fluoridated in Morrilton, but was not in Perry County. The kindergarten students in Perryville, Casa and Ann Watson elementary schools, all in Perry County, received dental screenings, as did all kindergarten students in Morrilton. The Perry County children were found to have twice the number of cavities as did the Morrilton children. As is shown in Table 1, the Morrilton kindergarten had, on average, 1.7 decayed teeth per child and the Perry County kindergarten had 3.4 per child.[59] See **Table 1**.

Table 1: Kindergarten Tooth-Decay Rates in Morrilton, AR Compared to Perry County, AR

STUDY SITE	NO. OF KINDERGARTEN STUDENTS SCREENED	PUBLIC WATER SYSTEM	AVERAGE NUMBER OF DECAYED TEETH
Perry County, AR	99	Not Fluoridated	3.4 teeth per child
Morrilton, AR	156	Fluoridated	1.7 teeth per child

B. Costs and Cost-Savings.

The cost of fluoridation varies according to the size of the community, with an average cost per person of 72 cents per person per year.[60] The cost for communities with more than 20,000 residents is about 50 cents per person per year. For communities of 10,000-20,000 residents, the cost is about $1 per person per year, and for communities of fewer than 5,000 residents the cost is about $3 per person per year.[61] Compared to the costs of dental treatment, community water fluoridation is much cheaper. For every one dollar invested in optimally-fluoridated water in communities with more than 20,000 residents yields $38 in savings from fewer cavities treated. For some children the treatment cost for severe cases of dental caries can be several thousand dollars per child. The per capita cost of water fluoridation over a person's lifetime can be less than the cost of one dental filling.[62] Depending on who seeks treatment for dental caries, the economic cost of inadequately fluoridated public drinking-water may be borne by the public via services provided by health departments, community health clinics, health and dental insurance premiums and publicly supported medical and dental programs.[63] Finally, caries-prevention brings valuable indirect benefits that are difficult to measure in dollars such as unbiased job hiring and advancement, freedom from dental pain, a more positive self-image, fewer missing teeth, fewer cases of malocclusion aggravated by tooth loss, fewer teeth requiring root-canal treatment, reduced need for dentures, bridges, and implants, and less school or work-time lost due to pain or visits to the dentist.[64]

C. Implementation of Public Water Fluoridation

Community water fluoridation is a state or local decision. Federal law does not regulate the addition of fluoride for the purpose of preventing tooth decay. However, federal law does provide for enforceable means of protecting and informing consumers about fluoridated public drinking-water. First, the Federal Safe Drinking Water Act requires that all community water systems issue to their customers an annual water quality report, or "Consumer Confidence Report", notifying them of detectable amounts of any of about 90 listed substances – including fluoride – whether present naturally or by chemical additive. Second, the EPA sets a maximum concentration level of fluoride at 4 mg/l.[65] No community water system may contain fluoride concentrations – whether due to natural sources or additives – exceeding the 4 mg/l maximum standard.[66] Public water systems exceeding 4.0 mg/l are required to provide a special notice to their customers on a quarterly basis.[67] Third, the EPA has established a guideline that fluoride not exceed 2.0 mg/l that states may, and Arkansas does, enforce. This guideline is meant to assist States in managing their public water systems to avoid the potential cosmetic effect that fluoride levels

above 2.0 mg/l may have on developing teeth: namely, moderate to severe enamel fluorosis (tooth discoloration).

When excessive fluoride is ingested before the tooth erupts above the gum line, occurring from infancy to about age eight, it may affect the enamel surface of the tooth causing enamel fluorosis. The extent of fluorosis can range from mild discoloration, discernable only by a professional, to moderate or severe changes producing a brown stain and/or pitting of the enamel. For teeth already existing in the mouth – e.g., for adults – ingesting fluoride poses no risk of enamel fluorosis. The EPA regards enamel fluorosis as having a cosmetic effect on teeth, i.e., tooth structure and tooth function are unaffected. The EPA's suggested maximum of 2 mg/l recognizes that moderate to severe fluorosis does not occur at the levels of 0.7mg/l to 1.2 mg/l, the range the US-PHS recommends for optimal fluoridation. In all States the public water systems whose fluoride levels exceed 2.0 mg/l, but are less than 4.0 mg/l, are required to provide customers either a special notice on an annual basis or include a notice as part of its Consumer Confidence Report.

Once community water fluoridation is approved by the state or local government, the only requirement for the implementation of fluoridation is the presence of a treatable centralized water supply.[68] Automatic monitoring equipment is available to facilitate maintenance and control of the optimal fluoride level for the site.[69] There is no Federal funding provided specifically to support fluoridation, however, the CDC,[70] the American Dental Association,[71] and the American Water Works Association [72] offer engineering advice as well as safety and legal training to assist communities in achieving and maintaining optimally-fluoridated community water systems.

D. Science and Law

Opponents of fluoridation have challenged its safety and effectiveness, but these claims are not scientifically valid. Notably, many organizations dedicated to fighting diseases that fluoridation opponents claim are caused by fluoridation are indeed, advocates of fluoridation.[73] [74] These include the American Cancer Society, the March of Dimes Birth Defects Foundation, the Alzheimer's Association, the National Downs Syndrome Congress, the National Down Syndrome Society, and the National Eating Disorders Association.[75] [76] [77] Fluoridation's safety has been recognized by many scientific and public health organizations, including the American Association for the Advancement of Science, the American Public Health Association, the Association of American Medical Colleges, the Institute of Medicine, America's Health Insurance Plans, the World Health Organization and the U.S. PHS.[78]

Fluoridation has been viewed by the courts as a proper means of furthering public health and welfare.[79] No court of last resort has ever determined fluoridation to be unlawful. The highest courts of more than a dozen states have confirmed the constitutionality of fluoridation.[80] In 1984, the Illinois Supreme Court upheld the constitutionality of the state's mandatory fluoridation law.[81] The U.S. Supreme Court has denied review of fluoridation cases thirteen times, citing that no substantial federal or constitutional questions are involved. Rejecting the contention that fluoridation ordinances are a deprivation of religious or individual

freedoms guaranteed under the Constitution, [82] courts have ruled that: (1) fluoride is a nutrient, not a medication, and is present naturally in the environment (2) no one is forced to drink fluoridated water as alternative sources are available; and (3) in cases where a person believes that fluoridation interferes with religious beliefs, there is a difference between the freedom to believe, which is absolute, and the freedom to practice beliefs, which may be restricted in the public's interest.[83] [84]

E. Examples of Other State Programs

Eleven states as well as Puerto Rico and the District of Columbia have statutory fluoridation requirements. States have used a number of strategies to implement community water fluoridation programs: legislation, administrative regulation, and state or local public referenda. State laws also address fluoridation costs in different ways. Some states have used funds from the Federal Maternal and Child Health Block Grant or the Preventive Health Services Block Grant to support fluoridation programs. A few states have funding for fluoridation that permit state funds to be used for a community's purchase of fluoridation equipment, or outside funds to be used for operational costs of a community's fluoridation system. Other state laws set lower limits on the population-size of communities that must comply with mandated fluoridation. Described below are two States' successful fluoridation programs.

(1) Illinois

Illinois has a long legislative history of promoting fluoridation. In 1951, the Illinois Department of Public Health adopted a policy supporting water fluoridation and launched an aggressive program to promote it, culminating, in 1967, with the Illinois Fluoridation Statute, that requires all community water systems with ten or more properties or lots to adjust their fluoride to optimal levels. By 1973, nine million people in Illinois were drinking fluoridated water.[85] Currently 99.1% of Illinois residents are protected by fluoridated water.[86]

(2) Kentucky

A major focus of the Kentucky Department of Public Health's Office on Oral Health is fluoridation, a program dating to 1951, when Kentucky began water fluoridation in two communities. In the 1960s, the Kentucky Legislature required the State's Board of Health to promulgate regulations mandating fluoridation of public water systems. Although this law was challenged in court, the court of appeals upheld the state legislature. Today, over 96% of Kentucky's population on public water systems receives fluoridated water.[87] Kentucky's regulation mandating water fluoridation imposes different requirements according to the population-size of the community. For instance, community water systems serving a population of 3,000 or more must adjust fluoride-deficient

waters to the optimal level, but community water systems serving a population between 1,500 and 3,000 must adjust fluoride to optimal levels only if the Kentucky Department of Health provides adequate fluoride-feed equipment.

CONCLUSION

Great progress has been made in reducing dental caries over the past thirty years through a variety of preventive-health measures. As demonstrated throughout this report, public drinking-water fluoridation is cost-effective, equitable, and safe. Fluoridation is a major public health program and is the least expensive and most effective health and wellness promotion step Arkansas can take in this decade. It is especially needed for low income populations where dental care is frequently not available or affordable.

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Table 2: Water Systems in Arkansas (September 1, 2008)

COUNTY	Fluoridated Water	Estimated Population Served	Non-Fluoridated Water	Estimated Population Served
Arkansas	Dewitt	5,530		
	Grand Prairie Regional Water	10,400		
	North Lague Water Assn	312		
	NE Dewitt Water Assn	578		
	Stuttgart	11,000		
Ashley	Boydell (natural)	156	North Crossett	3,167
	Crossett	7,693		
	Fountain Hill (natural)	1,247		
	Hamburg	4,929		
	West Ashley County	650		
Baxter	Lakeview-Midway Water Assn.	3,668	Gassville	1,238
	Mountain Home	15,458		
	North East Water Assn.	3,540		
Benton	Beaver Lake District		Gateway Rural Water	1,664
	Bella Vista	24,482		
	Benton Water Co.	4,420		
	Benton Co. Water Authority 1	1,520		
	Benton/Washington Co. Water			
	Bentonville	28,050		
	Cave Springs	790		
	Centerton	3,149		
	Decatur	1,589		
	Gentry	3,715		
	Gravette	2,428		
	Leisure Hills (naturally fluoridated)	96		
	Oakhill Suburban Improvement	107		
	Old Bella Vista	120		
	Pea Ridge	4,509		
	Rogers	54,458		
	Siloam Springs	13,468		
	Springdale	45,798		
Boone			Bergman	1,651
			Diamond	1,390
			Harrison	15,820
			Krooked Kreek	1,562
			Omaha	1,300
			SW Boone Water Assn	2,775
			Valley Springs	2,830

Table 2 (continued)

COUNTY	Fluoridated Water	Estimated Population Served	Non-Fluoridated Water	Estimated Population Served
Bradley			Bradley Water Co.	1,036
			SE Bradley Water	2,009
			Warren	6,904
Calhoun			Hampton	1,776
Carroll			Berryville	5,152
			Eureka Springs	2,500
			Green Forest	4,727
			Holiday Island	3,453
Chicot	Airport Road Water Assn.	619	Dermott	3,455
	Chicot Junction Water Assn.	802		
	Eudora	3,096		
	Indian Switch Rural Water	722		
	Lake Chicot Water Assn.	1,687		
	Lake Village	2,870		
	Readland-Grandlake Water Assn.	258		
Clark	Arkadelphia	11,540	Gurdon	3,403
	Caddo Waterworks	648		
	Clark County Water	2,150		
	Sum Springs Water Assn.	995		
Clay	Piggot	4,975	Clay Co Regional Water Distrib.	4,460
	Rector	2,194	Corning	3,679
	St Francis River Regional Water	2,766		
Cleburne	Heber Springs	11,818	Community Water Assn.	15,529
	Mountain Top Water Assn.	6,145	Quitman	1,335
	Tumbling Shoals	5,020		
Cleveland			Cleveland Co Water Assn.	1,746
			Hwy 15 Water Assn.	7,303
			Rison	1,365
			West Saline Water Assn.	1,822
Columbia			Dorcheat	2,183
			Emerson	1,205
			Lakeside Water Assn.	1,615
			Magnolia	10,866
			Waldo	1,988
			Walker Water Assn.	1,140

Table 2 (continued)

COUNTY	Fluoridated Water	Estimated Population Served	Non-Fluoridated Water	Estimated Population Served
Conway	Conway Co Regional Water	19,685		
	Menifee Water Department	600		
	Oppelo Water Department	1,245		
	Plumberville Waterworks	1,095		
Craighead	Bono Waterworks	1,847	Bay Waterworks	1,737
	Cash Waterworks	375	Brookland Waterworks	1,845
	Jonesboro Water System	67,995	Buffalo Island Reg Water Dist	2,775
	Lake City Waterworks	2,050	Caraway Waterworks	1,350
			Cross County Rural Water Sys	1,500
			Monette Waterworks	1,427
Crawford			Alma Waterworks	4,738
			Cedarville Waterworks	6,958
			Concord Water User Assn.	2,815
			Hwy 71 Water Association	5,460
			Kibler Water System	1,650
			Mulberry Waterworks	2,998
			Oak Grove Water Association	2,815
			Van Buren Waterworks	17,813
Crittenden	Clarksdale-Jericho Water Assn.	927	Crawfordsville Waterworks	2,608
	Hwy 64 Water Association	231	Earle Waterworks	3,000
	Lakeshore Estates Water Assn	1,200	Midway Water Association	2,600
	Marion Waterworks	10,600		
	Sunset Water Association	880		
	West Memphis Waterworks	32,150		
Cross	Wynne Waterworks	8,837	Cross County Rural Water Sys	6,968
			Parkin Waterworks	1,602
			Vanndale-Birdeye Water Assn.	2,479
Dallas	Fordyce Rural Water Assn.	1,410		
	Fordyce Water Co	4,726		
	River Valley Water Assn	421		
	Sparkman Waterworks (natural)	716		
Desha			Dumas Waterworks	5,777
			Kelso-Rohwer Water Association	1,125
			Mc Gehee Waterworks	5,114
			Pendleton-Pea Ridge Water Assn	1,010

Table 2 (continued)

COUNTY	Fluoridated Water	Estimated Population Served	Non-Fluoridated Water	Estimated Population Served
Drew	Barkada Water Association	380		
	Enon Water Association	450		
	Green Hill-Brooks Chapel Water	706		
	Lacey-Ladelle Water Association	1,353		
	Monticello Water Department	10,138		
	Mt. Zion Water Association	185		
	Selma Water Association	986		
Faulkner	Conway Water System	48,727	Beaverfork Volunteer FD WSD	2,200
	Vilonia Waterworks	16,191	Greenbrier Waterworks	6,940
			Guy Waterworks	1,490
			Mayflower Waterworks	6,440
			Wooster Waterworks	3,000
Franklin			Altus Waterworks	1,793
			Charleston Waterworks	3,412
			Ozark Waterworks	3,550
			Pleasant View Water FAC Board	1,580
			Riversouth Rural Water Dist	3,728
			Watalula Water Association	1,783
Fulton			Fulton county Water Assn.	1,500
			Mammoth Spring Waterworks	1,448
			Salem Waterworks	1,850
Garland			Hot Springs Village Waterworks	16,952
			Hot Springs Waterworks	68,780
			N Garland Co reg water Dist	5,235
Grant	Little Creek Water Association	2,338	Center Grove Water Association	4,050
	Sheridan Waterworks	4,022	Prattsville Waterworks	1,282
	South Sheridan Water Assn.	3,231		
Greene	Paragould City Light Water	22,744	Lafe Rural Water Association	2,470
			Western Greene County R W D	5,012
Hempstead	Bois D'Arc Water System (natural)	128		
	Hope Water Light Comm	11,405		
	Saratoga School (natural)	249		
	Spring Hill Schools	524		
Hot Springs	Hot Springs Co Water Assn..	3,225	Magnet-Butterfield Water Assn.	1,513
	Hwy 9 Water Association	1,065		
	Kimzery Regional Water District	9,023		
	Malvern Waterworks	9,026		
	Northern Malvern Water Assn	1,118		
	Perla Water Association	1,830		

Table 2 (continued)

COUNTY	Fluoridated Water	Estimated Population Served	Non-Fluoridated Water	Estimated Population Served
Howard	Cottonshed Waterworks (natural)	79		
	Dierks Waterworks	1,695		
	Mineral Springs Waterworks	1,265		
	Nashville Rural Water	6,000		
	Nashville Waterworks	4,878		
Independence	Batesville Water Utilities	10,752	Dota Water Association	2,371
	Bethesda Water Association	1,215	Independence Jackson Regional	2,012
	Cushman Water System	1,262	Newark Waterworks	1,512
	Pfeifer Water Association	3,191	Rock Moore Water Association	3,759
	Southside Water Association	8,000		
Izard			Calico Rock Waterworks	1,675
			Horseshoe Bend Waterworks	2,278
			Melbourne Waterworks	3,878
			Mt. Pleasant Waterworks	1,127
			Oxford Waterworks	1,062
Jackson	Campbell Station Waterworks	250	Breckenridge Union Water Assn.	1,601
	Diaz Waterworks	1,228	Cross County Rural Water Sys	1,450
	Grubbs Waterworks	955	Tuckerman Waterworks	1,944
	Jacksonport Waterworks	286		
	Newport Waterworks	7,811		
Jefferson	Hardin Water Association	4,924	ADC Tucker Unit Maint	1,600
	United Water Arkansas	57,140	Altheimer Waterworks	1,142
			Arsenal Water System	2,577
			Jefferson-Sample-Dexter Water	2,543
			Ladd Water Association	2,800
			Redfield Waterworks	2,507
			Watson Chapel Water Assn.	5,912
			White Hall Waterworks	4,323
			Wright-Pastoria Water Assn.	1,425
Johnson	Clarksville Waterworks	9,073		
	Coal Hill Waterworks	1,440		
	East Johnson Co Water Assn	3,100		
	Hartman Waterworks	975		
	Horsehead Water Association	3,950		
	Knoxville Waterworks	1,670		
	Lamar Waterworks	1,575		
	Ludwig Water Association	1,205		
Lafayette	Bradley Waterworks (natural)	482	Lewisville Waterworks	1,850
	Walnut Hill Waterworks	265	Stamps	2,900
			Walker Creek Stateline RWA	1,188

Table 2 (continued)

COUNTY	Fluoridated Water	Estimated Population Served	Non-Fluoridated Water	Estimated Population Served
Lawrence	Hoxie Water Department	2,817	Lawrence Co Reg Water Dist	5,458
	Walnut Ridge Waterworks	5,929		
Lee	Lee County Water Association	5,020	ADC East Arkansas Regional	1,624
	Marianna Waterworks	4,388		
	Moro Waterworks	391		
Lincoln			ADC Cummins Unit Maint	3,800
			Gould Municipal Watersewer	1,290
			Star City Water company	2,760
			Yorktown Water Association	7,956
Little River			Ashdown Waterworks	4,235
			Foreman Waterworks	1,383
Logan	Carbon City Water	153	Boonville Waterworks	4,823
	Central Logan County PWFB	1,050	East Logan Co Rural Water	1,700
	Gray Rock Water Association	650	Magazine Waterworks	1,076
	Greasy Valley Water Assn.	280	Ratcliff Waterworks	1,293
	Morrison Bluff Water System	288	South Logan County Water	1,103
	North Carbon City Water Assn.	155		
	Paris Waterworks	4,710		
	Scaranto Waterworks	1,095		
Lonoke	Bayou Two Public Facilities BD	3,385	Grand Prairie Water Users	3,548
	Cabot Waterworks	16,000	Ward Waterworks	7,340
	Carlisle Waterworks	2,304		
	Coy Waterworks	350		
	England	3,170		
	Furlow Water Association	2,800		
	Grand Prairie Regional Water	800		
	Humnoke Waterworks	281		
	Hwy 319 Water Users	1,100		
	Keo Water Works	423		
	Lonoke Waterworks	4,200		
Madison	St. Paul Waterworks (natural)	178	Huntsville Waterworks	2,676
			Madison Co Water Association	5,260
Marion			Bull Shoals Water System	2,362
			Flippin Waterworks	3,325
			Yellville Waterwoks	2,329
Miller			Dogwood Water Association	1,513
			Gosnell Water Association	3,878
			Joiner Waterworks	1,109
			Leachville Waterworks	2,431
			Luxora Waterworks	1,317

Table 2 (continued)

COUNTY	Fluoridated Water	Estimated Population Served	Non-Fluoridated Water	Estimated Population Served
Mississippi	Blytheville Water Systems 2	450	Dogwood Water Association	1,513
	Blytheville Waterworks	18,272	Gosnell Water Association	3,878
	Dell Waterworks	1,344	Joiner Waterworks	1,109
	Driver Grider Water Assn.	264	Leachville Waterworks	2,431
	Manila Waterworks	3,281	Luxora Waterworks	1,317
	Marie Water System	130		
	NE Mississippi Co Water Assn.	1,056		
	Osceola Waterworks	8,875		
	Wilson Water System	1,059		
	Yarbro Waterworks	356		
Monroe	Brinkley Waterworks	4,485	Holly Grove Waterworks	2,072
	Clarendon Waterworks	2,070		
	E. Monroe County Water Users	966		
	United Water Assn.	568		
Montgomery			Mount Ida Waterworks	2,458
			Norman Waterworks	1,170
Nevada	Prescott Waterworks	4,000		
Newton	East Newton County Water (nat)	1,512		
	Mt Sherman Water Assn. (nat)	671		
Ouachita	Buena Vista-Ogeman Water As	537	Bearden Waterworks	2,247
	Camden Waterworks	13,450	Harmony Grove Water Assn.	2,160
	Frenchport Water Association	1,860	Stephens Waterworks	1,426
	HWY 4 24 Water Association	2,175		
	Wire Road Water System	765		
Perry	Cherry Hill Public Facility BD	726	Casa Water Dept	1,220
	Houston Waterworks	611		
	Perry Water System	658		
	Perryville Waterworks	2,122		
	Thornburg Water Assn.	673		
	Toad Suck Public Facility BD	1,086		
	Wyee Mountain Water Assn.	1,250		
	Bigelow	544		
Phillips	Helena Water Sewer	6,200	Barton Lexa Water Association	4,080
	Long Lake Water Assn.	500	Elaine Waterworks	1,963
	Marvell Rural Water Assn.	2,500		
	Marvell Waterworks	1,374		
	West Helena Waterworks	8,442		

Table 2 (continued)

COUNTY	Fluoridated Water	Estimated Population Served	Non-Fluoridated Water	Estimated Population Served
Pike			Delight Waterworks	1,375
			Glenwood Water Department	2,107
			Murfreesboro Waterworks	
Poinsett	Heartland Spring Water Co	30	Crowley's Ridge Water Assn.	3,868
	Marked Tree Waterworks	2,800	Lepanto Waterworks	2,288
	Northern Ohio Water Assoc	748	Trumann Rural Water Assn.	2,348
	Trumann Waterworks	6,889		
	Harrisburg Waterworks	2,192		
Polk			Acorn Rural Water Assn	1,105
			Freedom Water Association	1,523
			Mena Water Dept	5,109
			Wickes Waterworks	1,035
Pope	Atkinson Water System	2,930	Dover Waterworks	1,746
	City Corporation	28, 973		
	Hector Waterworks	1,250		
	London Waterworks	1,250		
	Pottsville Water Association	3,460		
	Russellville Wid 2	145		
	Southwest Atkins Water Users	1,120		
	Tri-County Water Distbr Dist	16,500		
	W. Crow Mountain Water Assn	3,445		
Prairie	Des Arc Waterworks	3,882	Hazen Waterworks	1,687
	Grand Prairie Regional Water	800		
	ULM Waterworks	206		
Pulaski	Brookwood Mobile Home Village	212	Maumelle Water Corporation	2,201
	Brushy Island Water Assn.	789	Woodson-Hensley Water Co.	1,164
	Camp Robinson	1,000		
	Carrington Park	493		
	Central Arkansas Water	311,778		
	Jacksonville Waterworks	16,878		
	Maumelle Water Management	14,000		
	North Pulaski Waterworks Assn	6,537		
	US Air Force Base Little Rock	6,000		
Randolph	Pocahontas Waterworks	6,798		

Table 2 (continued)

COUNTY	Fluoridated Water	Estimated Population Served	Non-Fluoridated Water	Estimated Population Served
Saline	Arkansas Health Center	1,600	Paron Water	1,675
	Arkansas Labeling (natural)	32	Saline Co WW SS PFB	1,395
	Benton Waterworks	18,100	Sardis Water Association	12,061
	Branch Hollow MHP	175		
	Bryant Waterworks	14,000		
	East End Water IMP Dist 1	5,027		
	Haskell Water System	2,645		
	Hurricane Lake MHP	285		
	Oak Forest Mobile Home Park	147		
	Salem Water Users	8,224		
	Shannon Hills Water Dept	2,489		
	Southwest Water Association	5,780		
	Tull Water Association	1,507		
	West Bauxite Water Association	439		
Searcy	Morning Star Water Assn. (nat.)	1,224	Marshall Waterworks	2,822
	SDM Water Association (natural)	358	S P G Water Association	1,277
Sebastian	Hackett Waterworks	838	Barling Waterworks	3,950
	Hartford Waterworks	768	Central Water Association	1,228
	Hunting Waterworks	738	Fort Smith Waterworks	73,184
	James Fork Regional Water Dist.	10,322	Greenwood Waterworks	7,070
	Mansfield Waterworks	2,358	Lavaca Waterworks	2,958
	Sebastian Lake Utility Co	225	Milltown-Washburn Water Users	2,605
Sevier			DeQueen Water Work	5,723
			Horatio Waterworks	1,135
			Sevier CO Water Association	1,000
Sharp			Cave City Waterworks	2,172
			Cherokee Village Water Assn.	6,692
			Garrett Bridge Water Association	1,826
			Grange-Calamine Water Assn.	1,640
St. Francis	Caldwell Water	1,288	Colt Water Association	1,158
	Forrest City Waterworks	15,592	Hughes Community Water Assn.	2,483
	Palestine Water Association	2,088	Hughes Waterworks	1,867
	St Francis Rural Water Assn.	1,212		
	Wheatley Waterworks	840		
	Widener Waterworks	795		
Stone			Mountain View Waterworks	5,864
			Pleasant Grove	2,047
			Richwood Water Association	1,317
			West Stone County Water Assn	3,023

Table 2 (continued)

COUNTY	Fluoridated Water	Estimated Population Served	Non-Fluoridated Water	Estimated Population Served
Union			El Dorado Waterworks	13,784
			Lawson-Urbana Water Assn.	1,140
			New Hope Water Association	1,161
			Norphlet Waterworks	1,084
			Old Union Water Association	1,175
			Parkers Chapel Water Assn.	2,362
			Smackover Waterworks	2,609
			Strong Waterworks	1,000
			Wildwood Water Association	1,282
Van Buren	Bee Branch Water	2,750		
	Clinton Waterworks	7,057		
	Damascus Water Association	1,300		
	Dennard Water Association	600		
	Van Buren County W U A	3,008		
Washington	Elkins Waterworks	2,054	Winslow Waterworks	1,368
	Fayetteville Waterworks	80,640		
	Lincoln Waterworks	4,284		
	Mount Olive Water Association	4,123		
	Northern Hills MH Community	458		
	Oak Glen Mobile Home Comm	219		
	Prairie Grove Waterworks	4,490		
	Springdale Water Utilities	46,101		
	Tonitown Waterworks	1,967		
	Washington Water Authority	10,692		
	West Fork Waterworks	2,470		
White	Bald Knob North Water Assn.	1,979	Bradford Waterworks	1,049
	Bald Knob Waterworks	3,972	Pangburn Waterworks	2,315
	Beebe Waterworks	4,930		
	Four Mile Hill Water Assn.	4,030		
	Judsonia Waterworks	3,042		
	Kensett Waterworks	1,667		
	North White CO Water Assn.	4,330		
	Russell Waterworks	275		
	SE White County Water Assn.	4,500		
	Searcy Waterworks	22,304		
	SW White County Water Assn	3,521		
Woodruff	Augusta Waterworks	2,665		
	Mc Crory Waterworks	1,850		

Table 2 (continued)

COUNTY	Fluoridated Water	Estimated Population Served	Non-Fluoridated Water	Estimated Population Served
Yell	Dardanelle Waterworks	3,648	Danville Waterworks	2,693
			Havana Waterworks	1,143
			N. Yell County Water Assn.	5,350
			Ola Waterworks	1,204
			Plainview Water-Department	1,312
			Tri County RWDD-Mores Chapel	1,008

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