



Watershed Management: From Concept to Implementation, a Drinking Water Utility Perspective

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10 Health Advances That Changed the World

Clean Water and Improved Sanitation

Put them beside surgical advances and other cutting-edge technologies, and public health measures don't look so sexy. But the fact is that **clean water and sanitation** have likely saved millions of lives. They were widely implemented in the

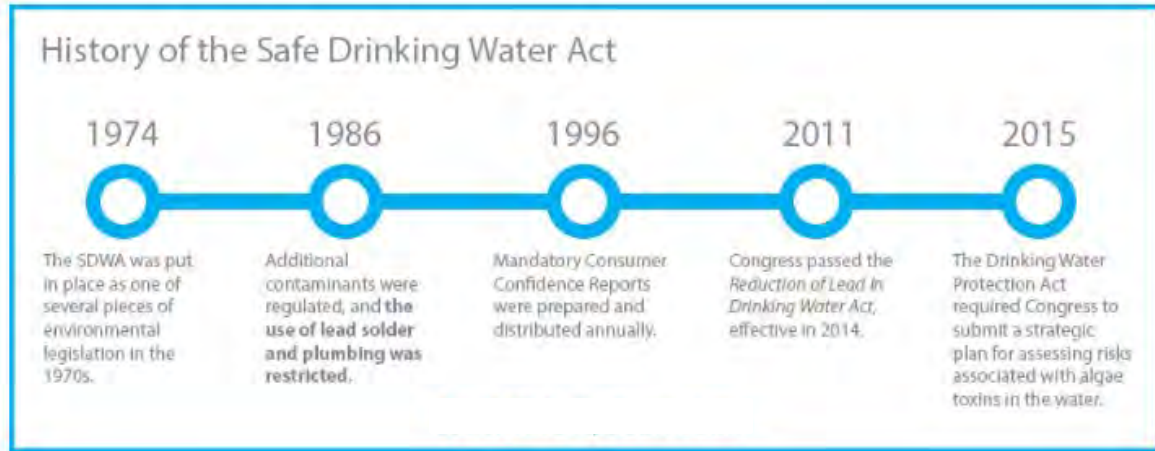
Public Health

Clean water and improved sanitation measures dramatically reduced the incidence of **deadly water-borne diseases such as cholera & typhoid** and improved sanitation, drastically lowering the health impacts of parasitic infections and other health conditions related to the environment.



Standards and Regulations

In the US, public drinking water is governed by the laws and regulations enacted by the state and federal governments. The most notable regulation is the **Safe Drinking Water Act (SDWA)** of 1974. This is the principal federal law that applies to every public water system in the United States. Enforced by the **Environmental Protection Agency (EPA)**, it is intended to ensure safe drinking water for public consumption.

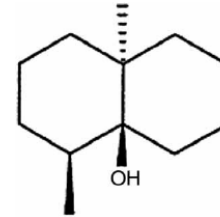
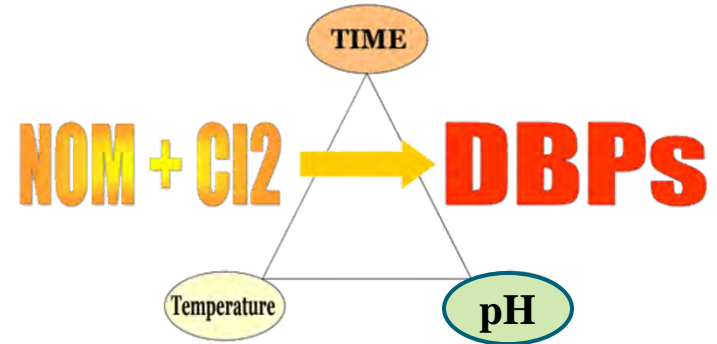


SDWA regulates 6 Types of Contaminants

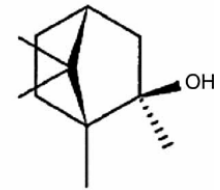
1. Microorganisms
2. Disinfectants
3. Disinfection Byproducts
4. Inorganic Chemicals
5. Organic Chemicals
6. Radionuclides



DBP Formation



Geosmin



2-Methylisoborneol



National Primary Drinking Water Regulations

Contaminant	MCL or TT (mg/L)	Potential health effects from long-term exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)
OC Acrylamide	0.1	Nervous system or blood problems; increased risk of cancer	Added to water during sewage treatment process	zero
OC Atrazine	0.05	Phys. dev., kidney or spleen problems; asthma; increased risk of cancer	Runoff from herbicide used on row crops	zero
R Asphyxiants (nitrite)	Asphyxiants (mg/L) Nitrite: 0.1	Increased risk of cancer	Breakdown of natural deposits of nitrate; nitrate can be reduced and may need a trace of nitrite to become a higher oxidation	zero
OC Asbestos	0.05	Increased blood cholesterol; decrease in blood sugar	Discharge from petroleum refineries, fire refineries, cement, electronics, and other	0.05
OC Arsenic	0.05	Skin damage or problems with circulatory system, and may have increased risk of getting cancer	Breakdown of natural deposits; runoff from pesticides; runoff from glass and electronics production waste	0
OC Barbiturates (others >10 subcategory)	7 mg/L (others >10 subcategory)	Increased risk of developing benign (noncancerous) polyps	Dump of adverse content in water; waste; residue of natural deposits	7 MFL
OC Bifenox	0.05	Cardiovascular system or reproductive problems	Runoff from herbicide used on row crops	0.05
OC Bifenox	0.1	Increased blood pressure	Discharge from drilling water; discharge from metal refineries; residue of natural deposits	0
OC Bifenox	0.05	Asbestos; decrease in blood clotting; increased risk of cancer	Discharge from factories; leaching from gas storage tanks and landfills	zero
OC Bifenox/Asbestos (BFA)	0.05	Reproductive difficulties; increased risk of cancer	Leaching from tanks of water storage; waste and distribution lines	zero
OC Bifenox	0.05	Industrial lesions	Discharge from metal refineries and coal-burning facilities; discharge from metal refineries, waste, and other industrial	0.05
R Bifenox (nitrite)	0.05 (nitrite)	Increased risk of cancer	Dump of natural and man-made deposits of certain minerals that are radioactive and may emit forms of radiation known as radon and radon progeny	zero
OC Bifenox	0.05	Increased risk of cancer	Byproduct of drinking water disinfection	zero
OC Bifenox	0.05	Corrosion of gastrointestinal tract; residue of natural deposits; discharge from metal refineries; runoff from waste facilities and ponds	Residue of natural deposits; residue of natural deposits; discharge from metal refineries; runoff from waste facilities and ponds	0.05
OC Bifenox	0.05	Problems with blood, nervous system, or reproductive system	Leaching of soil leached used on rice and other	0.05
OC Bifenox (nitrite)	0.05	Liver problems; increased risk of cancer	Discharge from chemical plants and other industrial activities	0.05
D Chloramine (as Cl ₂)	MCLG=0.7	Respiratory irritation; stomach discomfort; asthma	Water additive used to control bacteria	MCLG=0.7
OC Chloramine	0.05	Liver or spleen system problems; increased risk of cancer	Residue of insecticide	zero
D Chloramine (as Cl ₂)	MCLG=0.7	Respiratory irritation; stomach discomfort; asthma	Water additive used to control bacteria	MCLG=0.7
D Chloramine (as Cl ₂)	MCLG=0.7	Asbestos; asthma; young children, and fetuses of pregnant women; nervous system effects	Water additive used to control bacteria	MCLG=0.7
OC Chloramine	0.05	Asbestos; asthma; young children, and fetuses of pregnant women; nervous system effects	Byproduct of drinking water disinfection	0.05
OC Chloramine	0.05	Liver or kidney problems	Discharge from chemical and agricultural chemical factories	0.05
OC Chloramine (total)	0.1	Allergic dermatitis	Discharge from steel and pulp mills; residue of natural deposits	0.1
OC Copper	1.3	Short-term exposure: Gastrointestinal distress; long-term exposure: Liver or kidney damage; People with Wilson's Disease should consult their personal doctor if the amount of copper in their water exceeds the action level	Corrosion of household plumbing systems; residue of natural deposits	1.3
R Cryptosporidium	TT	Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	zero

Legend

D Disinfectant **OC** Inorganic Chemical **OC** Organic Chemical
OC Disinfection Byproduct **R** Microorganism **R** Radionuclides

Contaminant	MCL or TT (mg/L)	Potential health effects from long-term exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)
OC Dieldrin	0.05	Nerve damage or thyroid problems	Discharge from metal refineries; discharge from plastic and fertilizer factories	0.1
OC Dieldrin	0.05	Kidney, liver, or adrenal gland problems	Runoff from herbicide used on row crops	0.05
OC Dieldrin	0.1	Mixed kidney changes	Runoff from herbicide used on right of way	0.1
OC 1,2-Dibromo-3-chloropropane (DBCP)	0.005	Reproductive difficulties; increased risk of cancer	Runoff from herbicide used on crops; plastic, paint, and other	zero
OC 1,2-Dichlorobenzene	0.6	Liver, kidney, or circulatory system problems	Discharge from industrial chemical factories	0.6
OC 1,2-Dichlorobenzene	0.05	Asbestos; liver, kidney or spleen damage; changes in blood	Discharge from industrial chemical factories	0.05
OC 1,2-Dichlorobenzene	0.05	Increased risk of cancer	Discharge from industrial chemical factories	zero
OC 1,1-Dichlorobenzene	0.05	Liver problems	Discharge from industrial chemical factories	0.05
OC 1,1,2-Dichlorobenzene	0.05	Liver problems	Discharge from industrial chemical factories	0.05
OC 1,1,2-Dichlorobenzene	0.1	Liver problems	Discharge from industrial chemical factories	0.1
OC Dichlorobenzene	0.05	Liver problems; increased risk of cancer	Discharge from drug and chemical factories	zero
OC 1,2-Dichloropropane	0.05	Increased risk of cancer	Discharge from industrial chemical factories	zero
OC Dieldrin	0.05	Weight loss, liver problems, or possible reproductive difficulties	Discharge from chemical factories	0.05
OC Dieldrin	0.05	Reproductive difficulties; liver problems; increased risk of cancer	Discharge from rubber and chemical factories	zero
OC Dieldrin	0.05	Reproductive difficulties	Runoff from herbicide used on soybeans and vegetables	0.05
OC Dieldrin (2,3,7,8-TCDD)	0.00005	Reproductive difficulties; increased risk of cancer	Discharge from waste incineration and other combustion; discharge from chemical factories	zero
OC Dieldrin	0.05	Cataracts	Runoff from herbicide use	0.05
OC Endosulfan	0.1	Stomach and intestinal problems	Runoff from herbicide use	0.1
OC Endosulfan	0.05	Liver problems	Residue of insecticide	0.05
OC Epichlorohydrin	0.1	Increased cancer risk; stomach problems	Discharge from industrial chemical factories; an impurity of some water treatment chemicals	zero
OC Epichlorohydrin	0.1	Liver or kidney problems	Discharge from petroleum refineries	0.1
OC Epichlorohydrin	0.0005	Problems with liver, stomach, reproductive system, or kidneys; increased risk of cancer	Discharge from petroleum refineries	0.0005
M Fecal coliforms and E. coli	MCL	Fecal coliforms and E. coli are bacteria whose presence indicates that the water may be contaminated with human or animal waste. Microbes in these waste may cause short-term effects, such as diarrhea, cramps, nausea, headache, or other symptoms. They may pose a special health risk for infants, young children, and people with severely compromised immune systems.	Human and animal fecal waste	zero
OC Fluoride	4.0	From disease (pain and tenderness of the bones; children may get skeletal teeth)	Water additive which granulates during bottling; residue of natural deposits; discharge from fertilizer and chemical factories	4.0
M Giardia lamblia	TT	Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	zero
OC Glyphosate	0.7	Kidney problems; reproductive difficulties	Runoff from herbicide use	0.7
OC Halomethane acids (HMAA)	0.05	Increased risk of cancer	Byproduct of drinking water disinfection	0.05
OC Heptachlor	0.004	Liver damage; increased risk of cancer	Residue of insecticide	zero
OC Heptachlor epoxide	0.005	Liver damage; increased risk of cancer	Residue of insecticide	0.005
M Heterotrophic plate count (HPC)	TT	HPC has no health effects; it is an indicator used only to measure the variety of bacteria that are common in water. The lower the concentration of bacteria in drinking water, the better maintained the water system is.	HPC measures a range of bacteria that are naturally present in the environment	n/a

Legend

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Contaminant	MCL or TT* (mg/L)	Potential health effects from long-term exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)
OC Hexachlorobenzene	0.06	Liver or kidney problems; reproductive difficulties; increased risk of cancer	Discharge from metal refineries and agricultural chemical factories	zero
OC Hexachlorocyclopentadiene	0.05	Kidney or stomach problems	Discharge from chemical factories	0.05
IOC Lead	TTA: Action Level=0.015	Infants and children: Delays in physical or mental development; children could show slight delays in attention span and learning abilities; Adults: Kidney problems; High blood pressure	Corrosion of household plumbing systems; erosion of natural deposits	zero
M Legionella	TTT	Legionnaires' Disease, a type of pneumonia	Found naturally in water; multiply in cooling systems	zero
OC Lindane	0.0002	Liver or kidney problems	Runoff/leaching from insecticides used on crops, lawns, gardens	0.0002
IOC Mercury (inorganic)	0.002	Kidney damage	Breakdown of natural deposits; discharge from refineries and factories; runoff from landfills and coalfields	0.002
OC Methylenechloride	0.04	Reproductive difficulties	Runoff/leaching from insecticides used on crops, lawns, gardens	0.04
IOC Nitrate (measured as nitrogen)	10	Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits	10
IOC Nitrite (measured as nitrogen)	1	Infants below the age of six months who drink water containing nitrite in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits	1
OC Oxydemeton (Dithion)	0.2	Slight nervous system effects	Runoff/leaching from insecticides used on apples, peaches, and berries	0.2
OC Para-chlorophenol	0.06	Liver or kidney problems; increased cancer risk	Discharge from wood-preserving factories	zero
OC Picloram	0.5	Liver problems	Herbicide runoff	0.5
OC Polychlorinated biphenyls (PCBs)	0.0005	Skin changes; thyroid gland problems; immune deficiencies; reproductive or nervous system difficulties; increased risk of cancer	Runoff from landfills; discharge of waste chemicals	zero
R Radon-226 and Radon-228 (combined)	5 pCi/L	Increased risk of cancer	Breakdown of natural deposits	zero
IOC Selenium	0.05	Hair or finger nail loss; rashes on fingers or toes; circulatory problems	Discharge from petroleum and metal refineries; erosion of natural deposits; discharge from mines	0.05
OC Simazine	0.06	Problems with blood	Herbicide runoff	0.06
OC Styrene	0.1	Liver, kidney, or circulatory system problems	Discharge from rubber and plastic factories; leaching from landfills	0.1
OC Tetrachloroethylene	0.005	Liver problems; increased risk of cancer	Discharge from factories and dry cleaners	zero
IOC Thallium	0.002	Hair loss; changes in blood; kidney, intestine, or liver problems	Leaching from ore-processing sites; discharge from electronics, glass, and drug factories	0.0005
OC Toluene	1	Nervous system, kidney, or liver problems	Discharge from petroleum factories	1
M Total Coliforms	5.0 per 100 mL	Coliforms are bacteria that indicate that other, potentially harmful bacteria may be present. See fecal coliforms and E. coli.	Naturally present in the environment	zero
DBP Total Trihalomethanes (THMs)	0.08	Liver, kidney or central nervous system problems; increased risk of cancer	Byproduct of drinking water disinfection	not
OC Triphenylamine	0.005	Kidney, liver, or thyroid problems; increased risk of cancer	Runoff/leaching from insecticides used on crops and lawns	zero
OC 2,4,5-TP (dibrom)	0.05	Liver problems	Residue of banned herbicide	0.05
OC 1,2,4-Trichlorobenzene	0.07	Changes in adrenal glands	Discharge from textile finishing factories	0.07
OC 1,1,1-Trichloroethane	0.5	Liver, nervous system, or circulatory problems	Discharge from metal degreasing sites and other factories	0.5
OC 1,1,2-Trichloroethane	0.005	Liver, kidney, or immune system problems	Discharge from industrial chemical factories	0.005
OC Trichloroethylene	0.005	Liver problems; increased risk of cancer	Discharge from metal degreasing sites and other factories	zero

Legend

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DBP Disinfection Byproduct	M Microorganism	R Radionuclides

Contaminant	MCL or TT* (mg/L)	Potential health effects from long-term exposure above the MCL	Common sources of contaminant in drinking water	Public Health Goal (mg/L)
M Turbidity	TT*	Turbidity is a measure of the cloudiness of water. It is used to indicate water quality and filtration effectiveness (e.g., whether disease-causing organisms are present). Higher turbidity levels are often associated with higher levels of disease-causing microorganisms such as viruses, parasites and water bacteria. These organisms can cause short-term symptoms such as nausea, cramps, diarrhea, and irritated throats.	Soil runoff	n/a
R Uranium	30 µg/L	Increased risk of cancer; kidney toxicity	Breakdown of natural deposits	zero
OC Vinyl chloride	0.002	Increased risk of cancer	Leaching from PVC pipes; discharge from plastic factories	zero
M Vireon (viral)	TT*	Short-term exposure: Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste	zero
OC Xylene (total)	10	Nervous system damage	Discharge from petroleum factories; discharge from chemical factories	10

Legend

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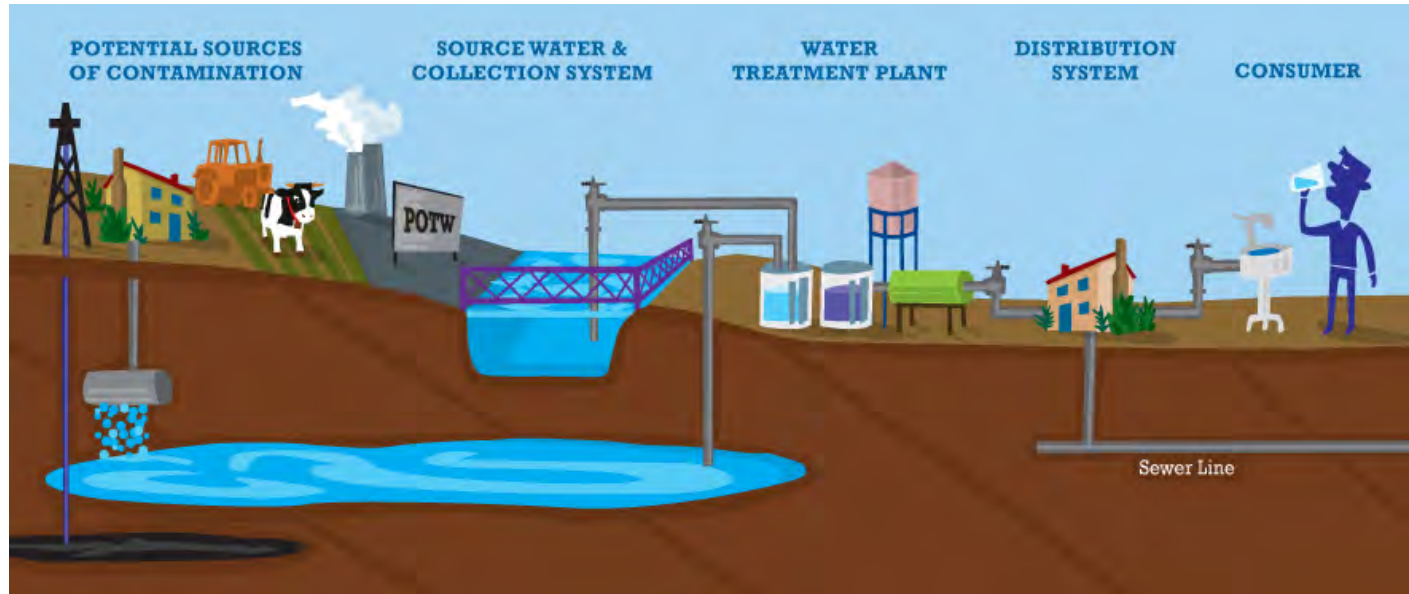
Source Water Protection

Source Water Protection programs are programs with the specific goal of protecting drinking water supplies.

It is more widely recognized that source water protection is a critical first step in the **Multiple-barrier Approach** to providing safe drinking water advocated by the Environmental Protection Agency (EPA) and the American Water Works Association (AWWA, 1997; EPA, 1997a).

Multi-Barrier Approach to Source Water Protection

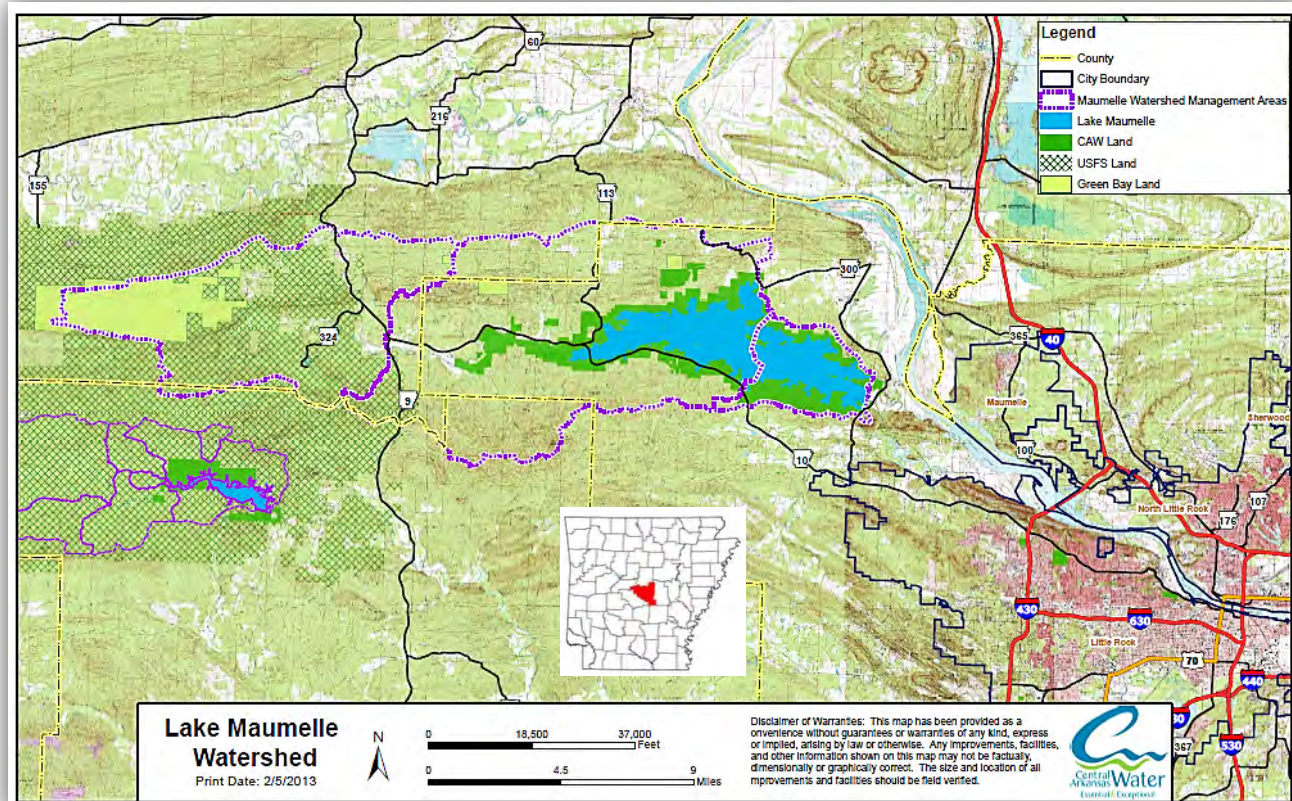
The Multi-Barrier Approach is: “An integrated system of procedures, processes and tools that collectively prevent or reduce the contamination of drinking water from source to tap in order to **reduce risks to public health**.”



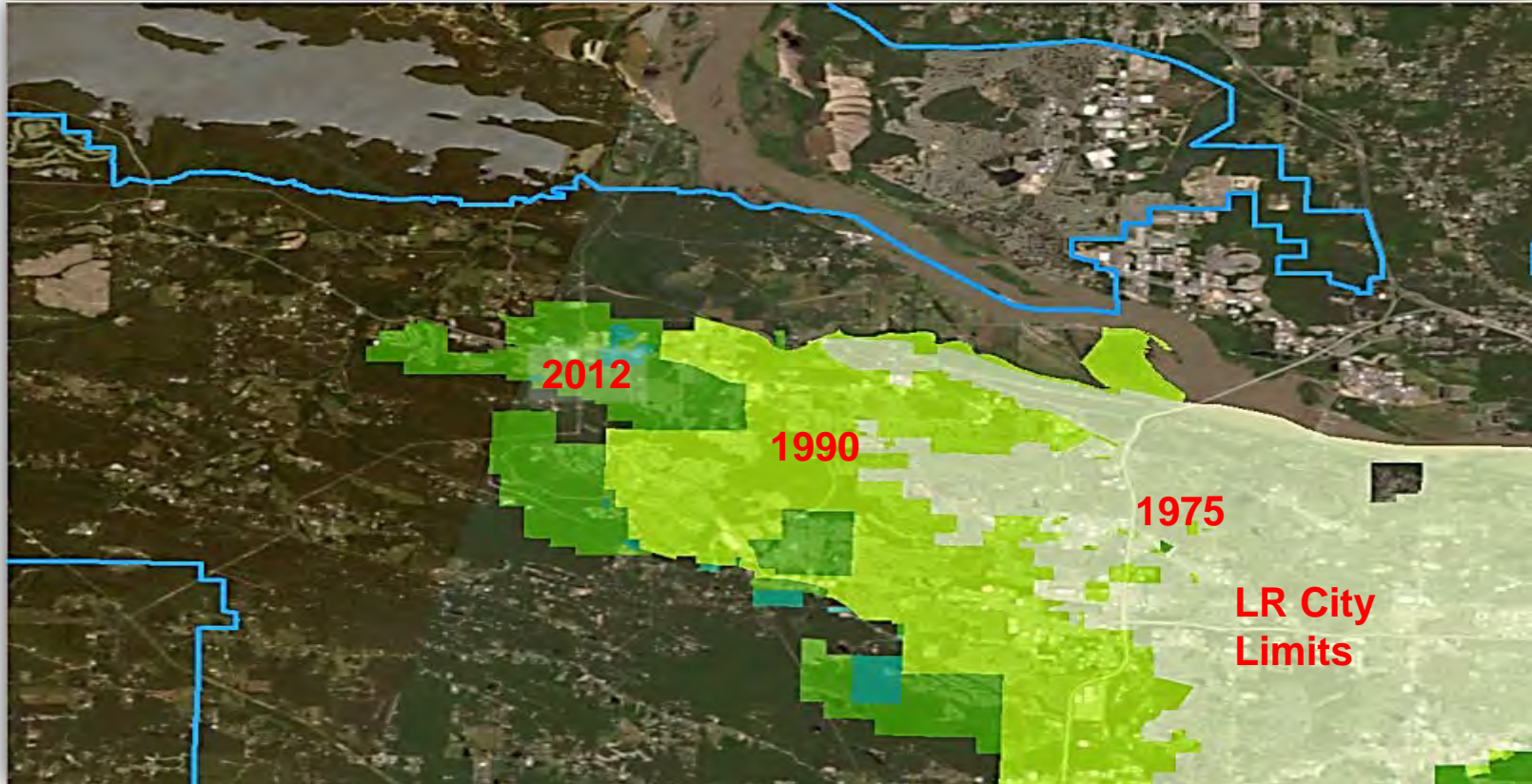
CAW Reservoirs and Watersheds

Winona – Built in 1936 for drinking water supply;
1,240 acre reservoir;
27,500 acre watershed;
0.60 persons/square mile;
93.6% forested

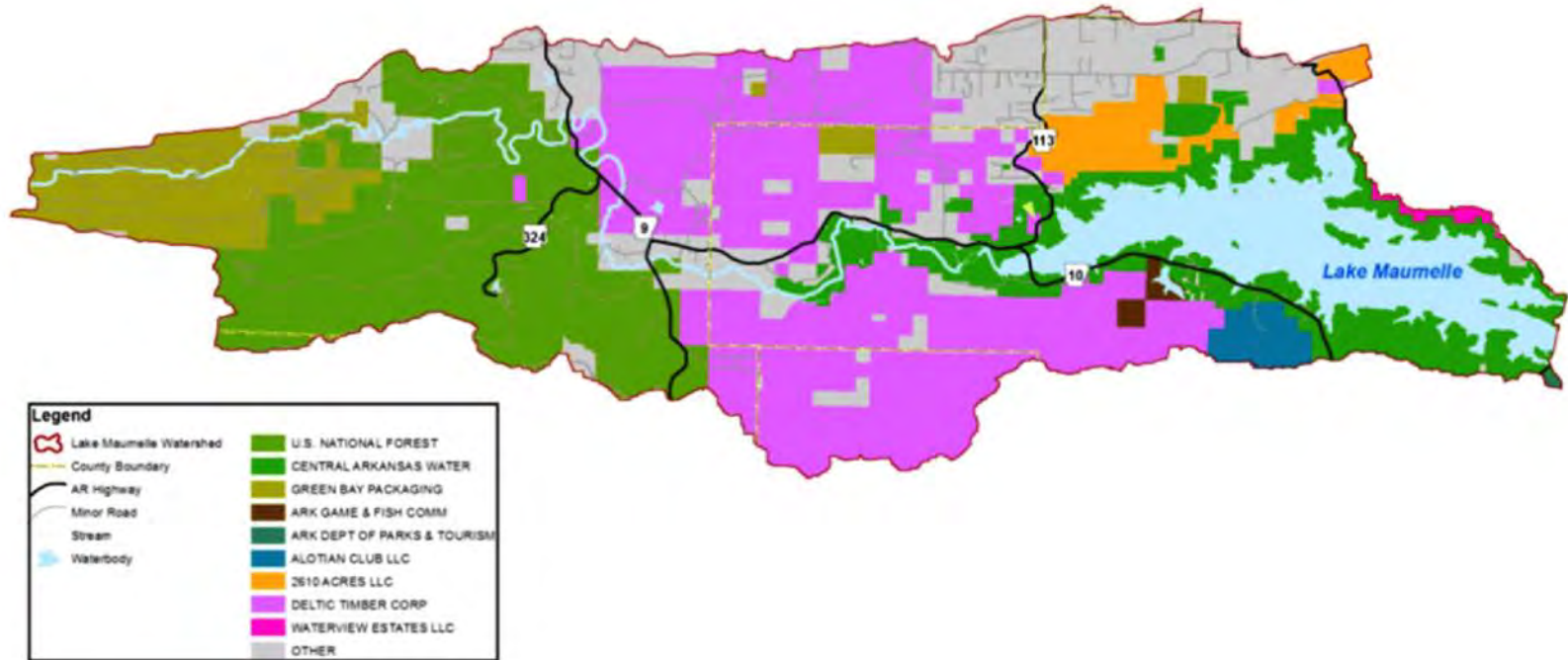
Maumelle – Built in 1956 for drinking water supply;
8,900 acre reservoir;
88,000 acre watershed;
14.1 persons/square mile;
81.9% forested



Westward Expansion of City Limits



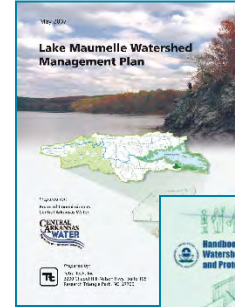
Westward Expansion of City Limits



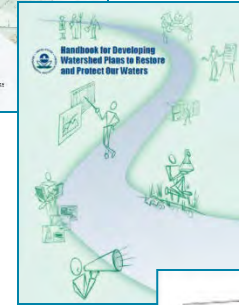
Guiding Documents

2007 Watershed Management Plan (3 year process)

- Technical Advisory Group
- Policy Advisory Group



Handbook for Developing Watershed Plans to Restore and protect our Waters (EPA 2008)



AWWA G300-14 Source Water Protection (2007, 2014)

Operational Guide to AWWA Standard G300, Source Water Protection (2010, 2016)



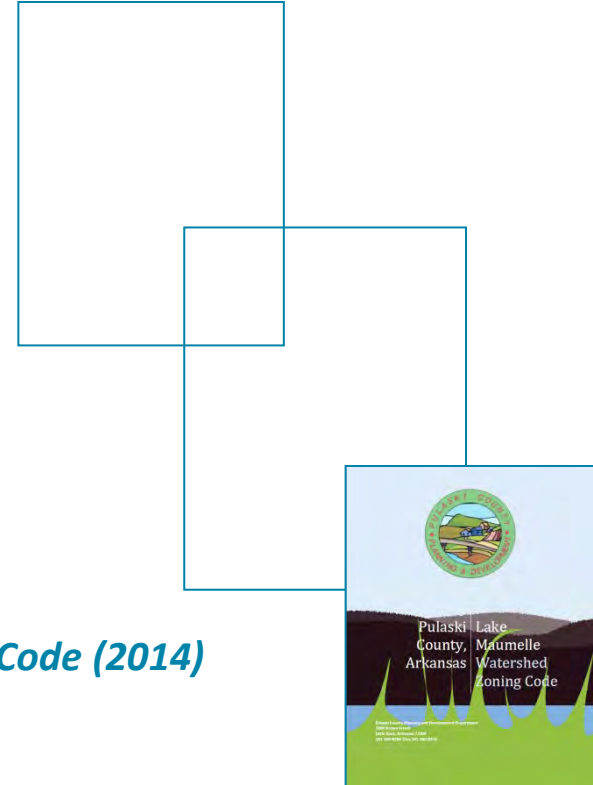
Watershed Regulation

Pulaski County Subdivision and Development Code (2009, 2010, 2016)

*Regulation No. 6 Regulations For State Administration Of
The National Pollutant Discharge Elimination System
(NPDES) (2013)*

*CHAPTER SIX: Watershed Specific Regulations
Reg.6.601 Lake Maumelle Basin*

Pulaski County, Arkansas Lake Maumelle Watershed Zoning Code (2014)



How do We Protect our Resource?.....

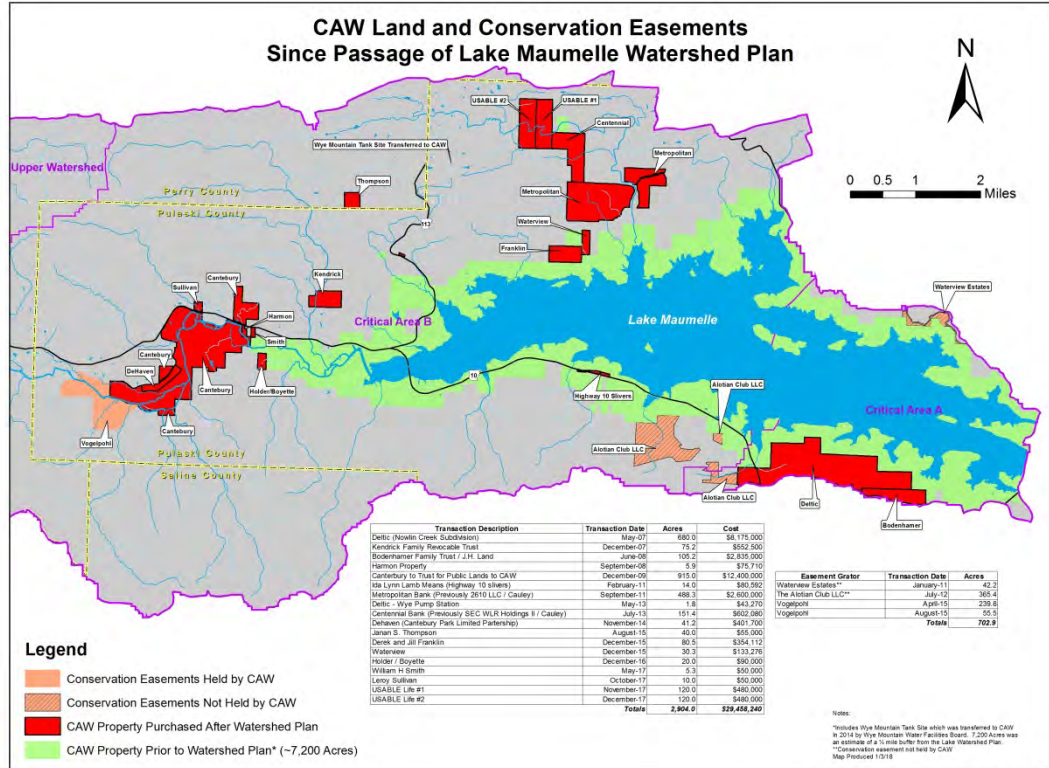


Managing the Land & Setting the Standard

- 1) Land Acquisitions and Conservation
- 2) Forest Management: Fire, Thinning, Roads
- 3) Restoration & Reforestation
- 4) Monitoring
- 5) Wildlife and Recreation
- 6) Education and Outreach
- 7) Risk Mitigation and Emergency Response

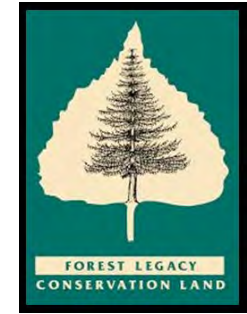
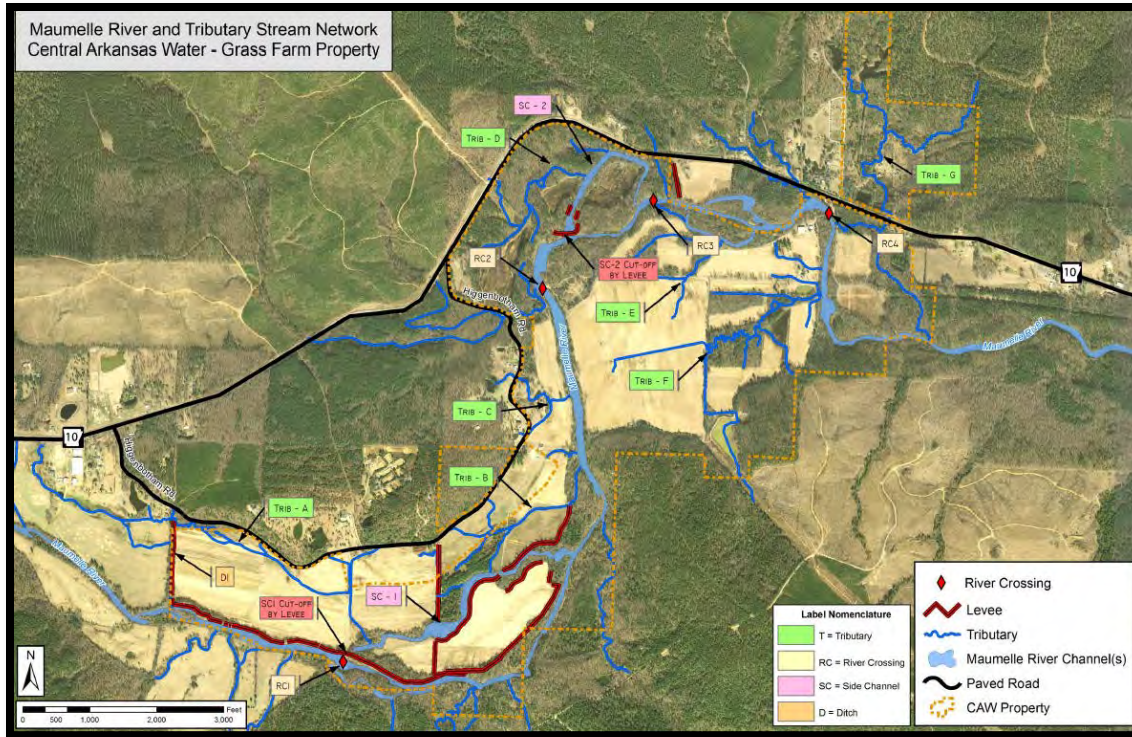
Land Acquisitions and Conservation

- Purchased 2,904 acres of property since plan adoption
- Placed 295 acres under Conservation Easement since plan adoption



Highlight: Purchase of the WGF

2010 CAW purchased the 915ac Winrock Grass Farm (WGF)



Forest Management: Rx Fire & Ecological Thinning

Primary Goals:

- Reduce TOC (DBP)
- Provide Water Quality Filtration

Secondary Goals:

- Produce Healthier & More Resilient Forests
- Reduces the Risk of Wildfire
- Improve Wildlife Habitat, Plant and Animal Diversity, and Recreational Opportunities



The Nature Conservancy
Protecting nature. Preserving life.

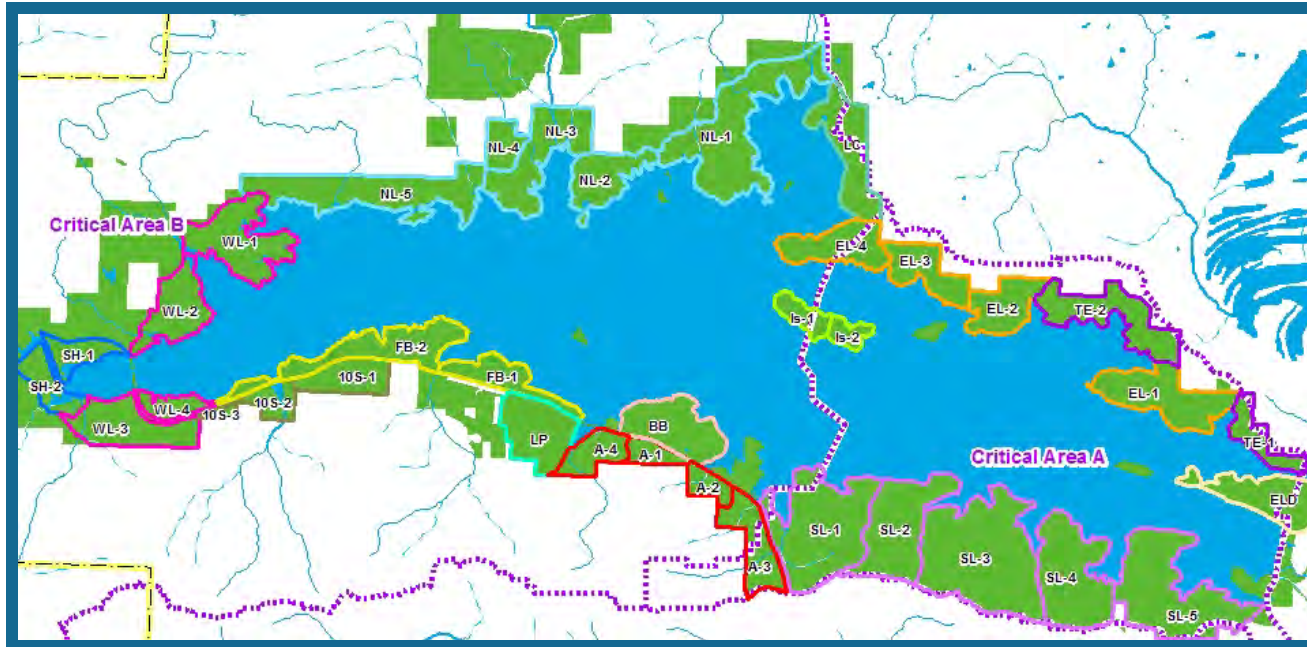


Forest Management: Rx Fire & Ecological Thinning

Burned: ~2,100 acres– 9 units; 10 burns (annual goal 800 – 1,600)

Thinned: 748 acres- 4 units

2018: ~ 500 acres



Rotating
Rx burns
&
ecological
thinning
on existing
CAW
properties

Forest Management: Unpaved Roads

Primary Goals:

- Reduce Sediment
- Stabilize Access for Management

Pilot project with Arkansas Forestry Commission on CAW forest roads to demonstrate road BMPs to forest owners.



Before



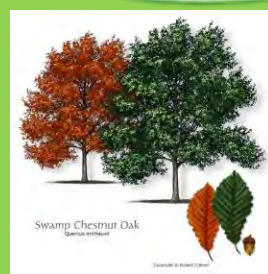
After

Restoration & Reforestation

Trees planted in 2016

140 acres 44,000+ Trees

PLANT
SOMETHING.



Restoration: Low-water Crossing Removal

Primary Goals:

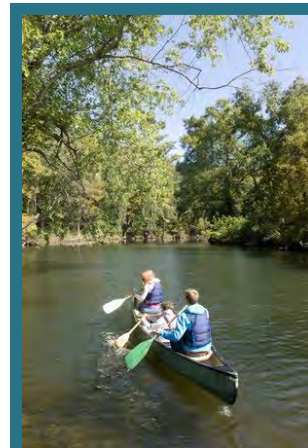
- Reduce sediment
- Reduce nutrients
- Attenuate flood waters

Secondary Goals:

- Improve fish passage
- Restore hydrological and ecological connectivity
- Increase habitat complexity
- Reestablish recreational connectivity
- Improve fisheries



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Restoration: Streambank Stabilization



Before



After-2013



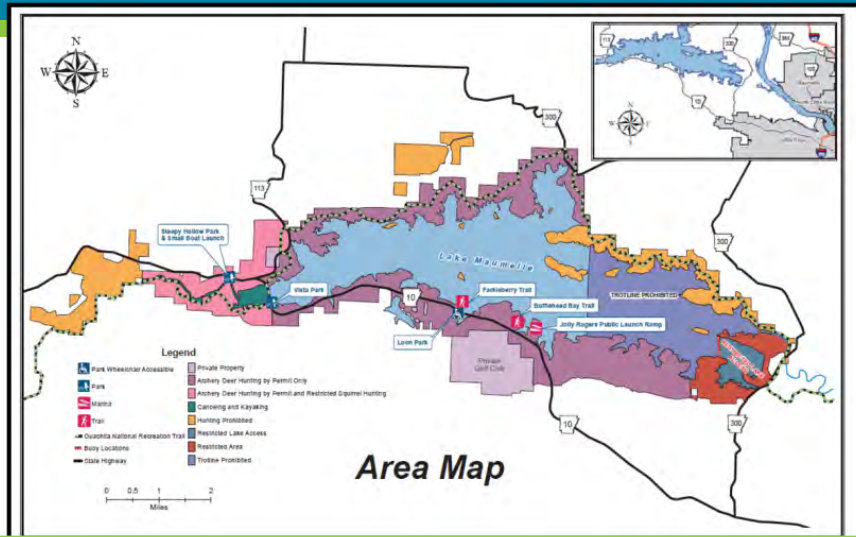
Restoration is estimated to keep: 123,333 lbs of Sediment & 123 lbs of Phosphorus per year out of Lake Maumelle, an expected reduction of 95%.

Monitoring

- Water Quality
- Watershed Health
- Forest Health
- Aquatic Life
- Terrestrial Animals
- Pipeline



#5 Wildlife & Recreation

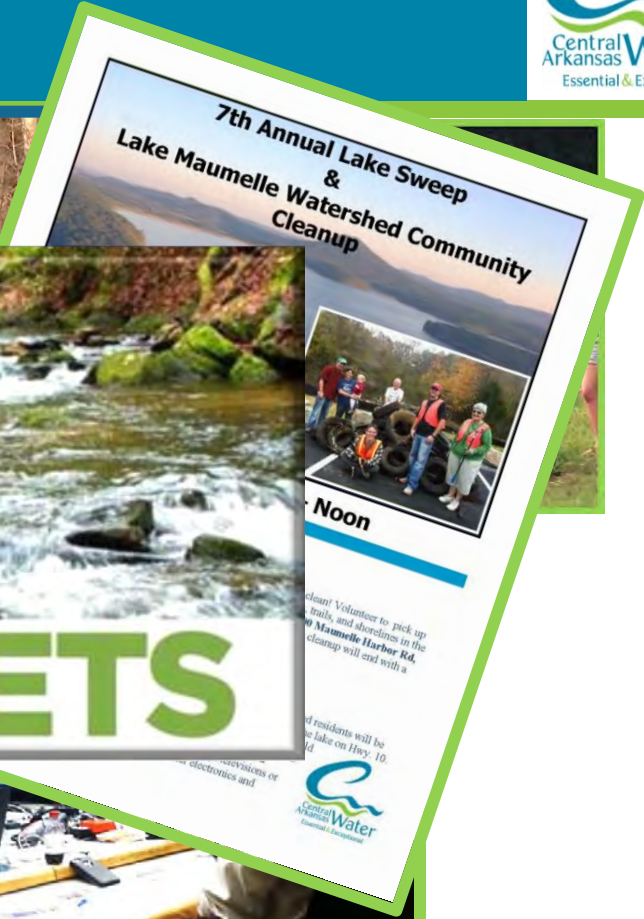


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#6

Education & Outreach



Risk Mitigation & Emergency Response

Hazardous Spill Mitigation

- Emergency Response Plans & Drills
- Installation of North Shore “boom box”
- Emergency spill response trailer
- Vulnerability Assessment



New in 2017

Increased Data Transparency

- Micro website including GUI data interface
- Additional Laboratory Certification
- Annual Report

Science Planning – USGS, WQ Monitoring, Distribution WQ management (water age, monitoring, system)



Landowner Education & Programs

- Improve access to user incentives
- Provide landowner resource education

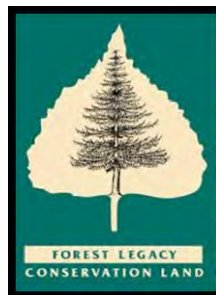


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We can't do it alone:



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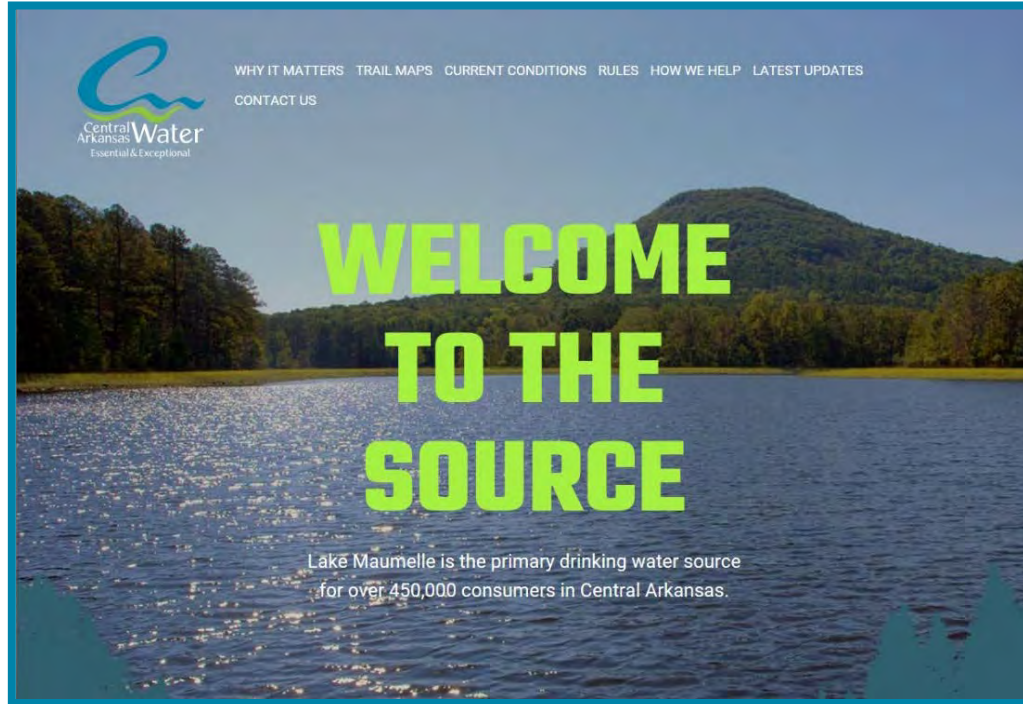
WATERSHED CONSERVATION
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Questions?



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