Overview of EPA's Arsenic Treatment Research Program

Briefing for the Local Government Advisory Committee
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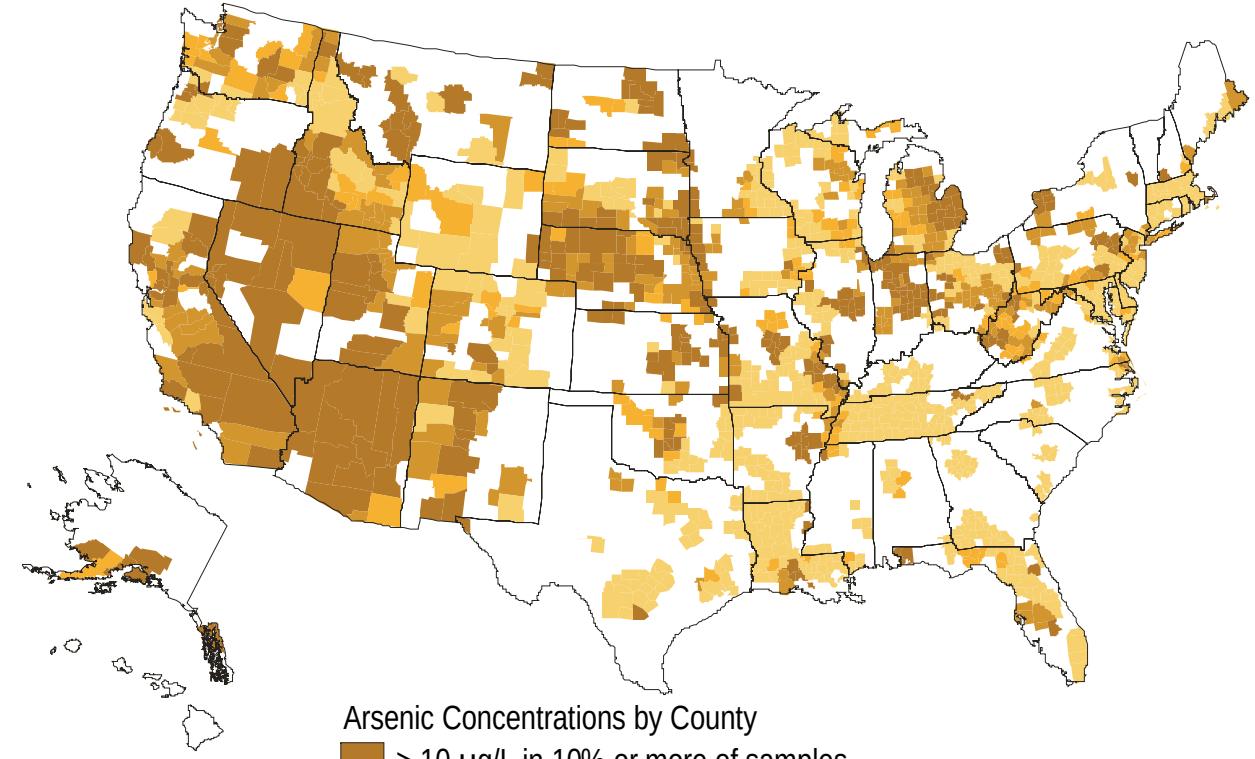
Presentation

- Background arsenic in drinking water
- Arsenic chemistry
- Contaminant Management Framework
- Arsenic Rule Implementation Research Program
- Detail demonstration component

Arsenic Occurrence



Source: Welch, A.H., et al.,
U.S. Geological Survey, 2000

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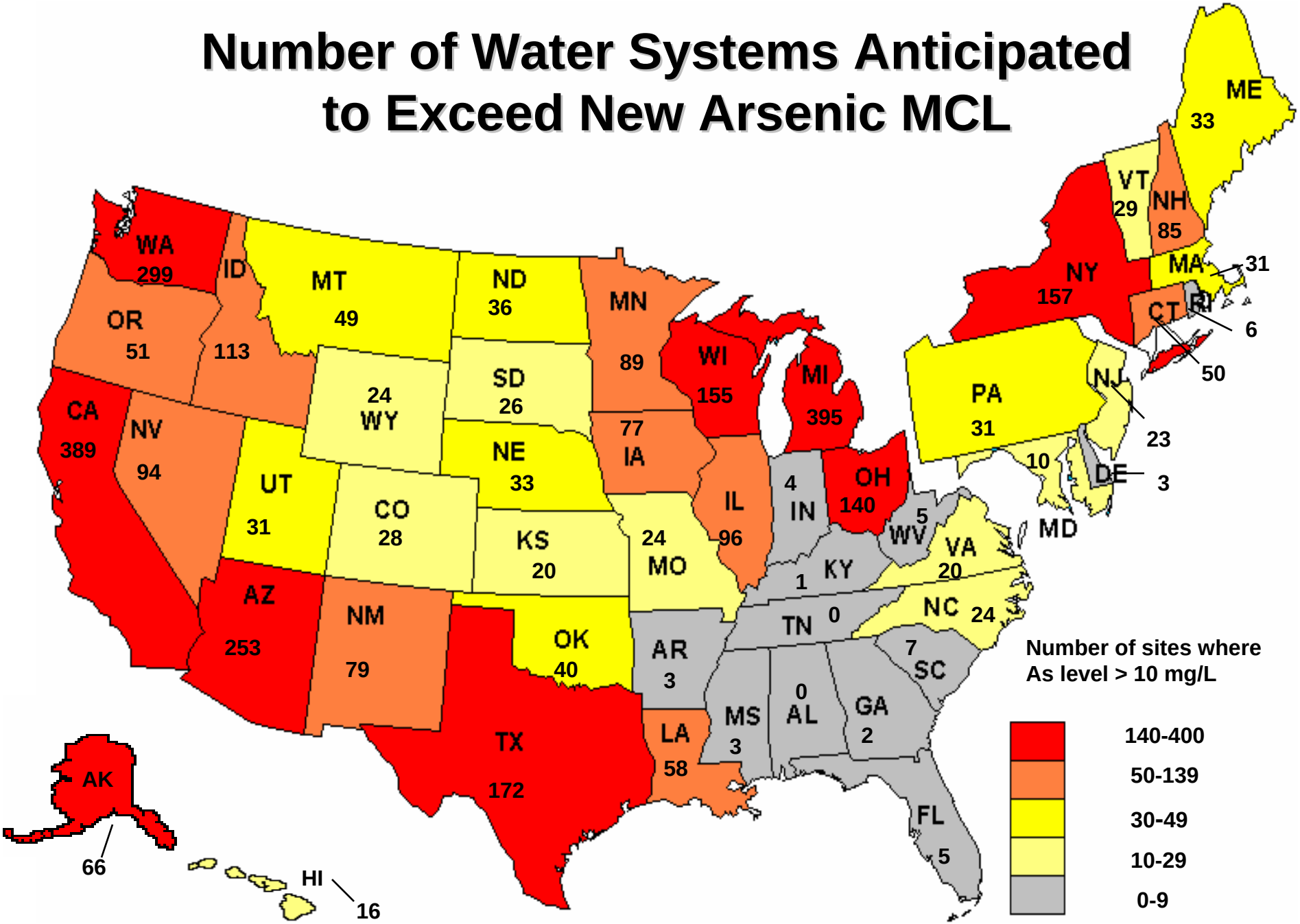
Arsenic Regulatory History

- October 31, 2001, Administrator announced lowering of arsenic drinking water standard to 10 ppb.

- Also announced that “EPA plans to provide $20 million over next two years for research and development of more cost-effective technologies, training and technical assistance.”

Number of Water Systems Anticipated to Exceed New Arsenic MCL



Source: USEPA (2000a), (2000b)

ARSENIC CHEMISTRY

Arsenic Chemistry

Two primary valence states

As (III), As +3, arsenite

*As (V), As +5, arsenate

Effect of Arsenic Species on Removal Efficiency

Treatment Process	Percent Removal	
	As III	As V
Lime soft. (pH 10)	18	55
Lime soft. (pH 11.5)	78	98
Reverse Osmosis	60	98
Anion Exchange	0	99

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Arsenic Treatment Technologies

Precipitative Processes

Process	BAT	Small System
Lime Softening	**+**	**-**
Coagulation/Filtration	**+**	**-**
Coagulation/MicroFil	**-**	**+**
Coagulation/DirFil	**+**	**+**
Oxidation/Filtration	**+**	**+**

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Arsenic Treatment Technologies

***Sorption* Processes**

Process	BAT	Small System
Ion Exchange	**+**	**+**
Activated Alumina	**+**	**+**
Iron Based Sorbents	**Research Needed**	

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Arsenic Treatment Technologies

***Membrane* Processes**

Process	BAT	Small System
Reverse Osmosis	**+**	**+**

Best Available Technology (BAT)

Technology	Maximum Percent Removal (As V)
Ion Exchange	95
Activated Alumina	90
Reverse Osmosis	>95
Modified Coag/Filtration	95
Modified Lime Softening	80
ElectrodialysisReversal	85
Oxidation/Filtration (20:1 Fe/As)	80

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WATER QUALITY ANALYSIS

Prior to determining management approach:

- Conduct comprehensive study of water chemistry
- Field speciation of arsenic is recommended
- Phosphate, silica, pH, sulfate, iron are essential measurements

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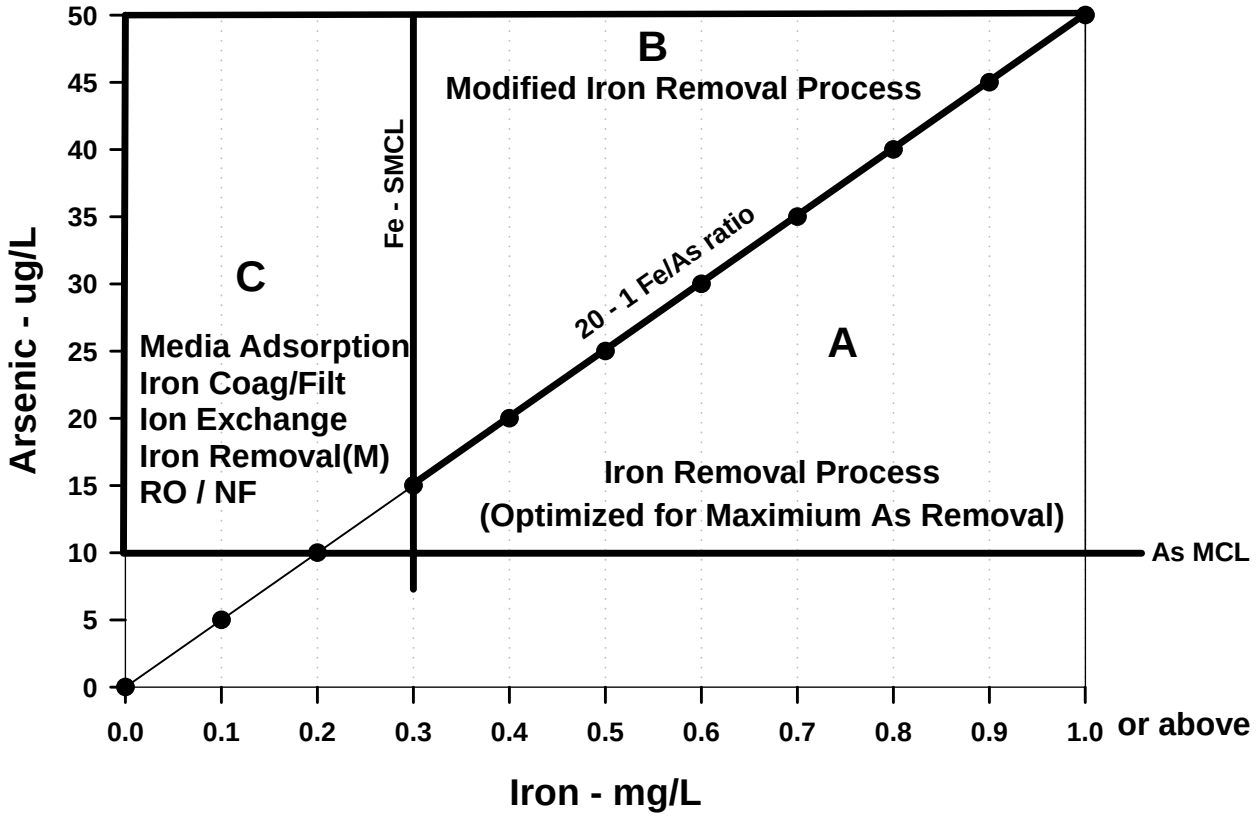
Arsenic Treatment - Process Selection Guide



IRON REMOVAL = ARSENIC REMOVAL

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CASE STUDY

Iron Removal Processes

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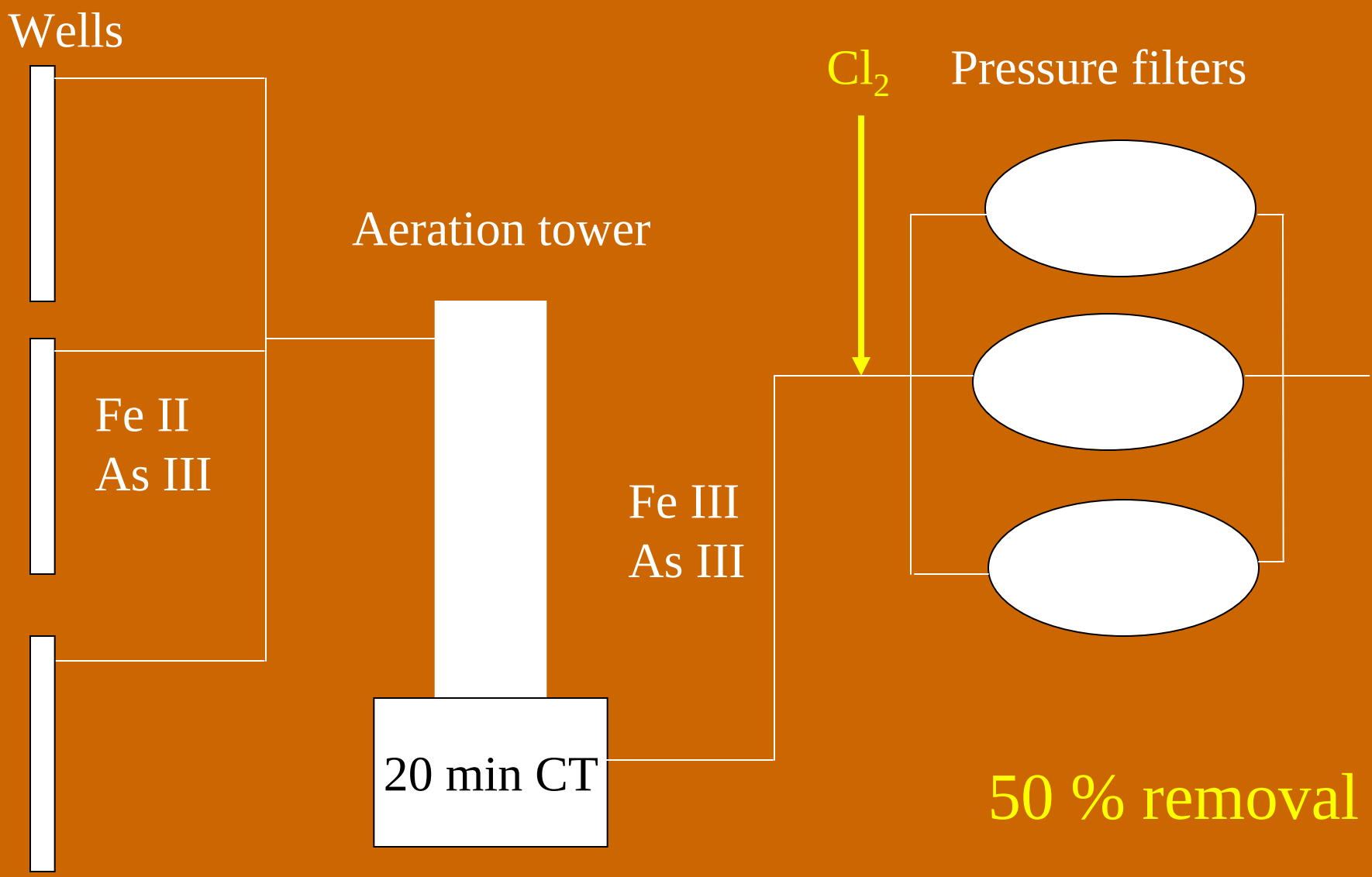
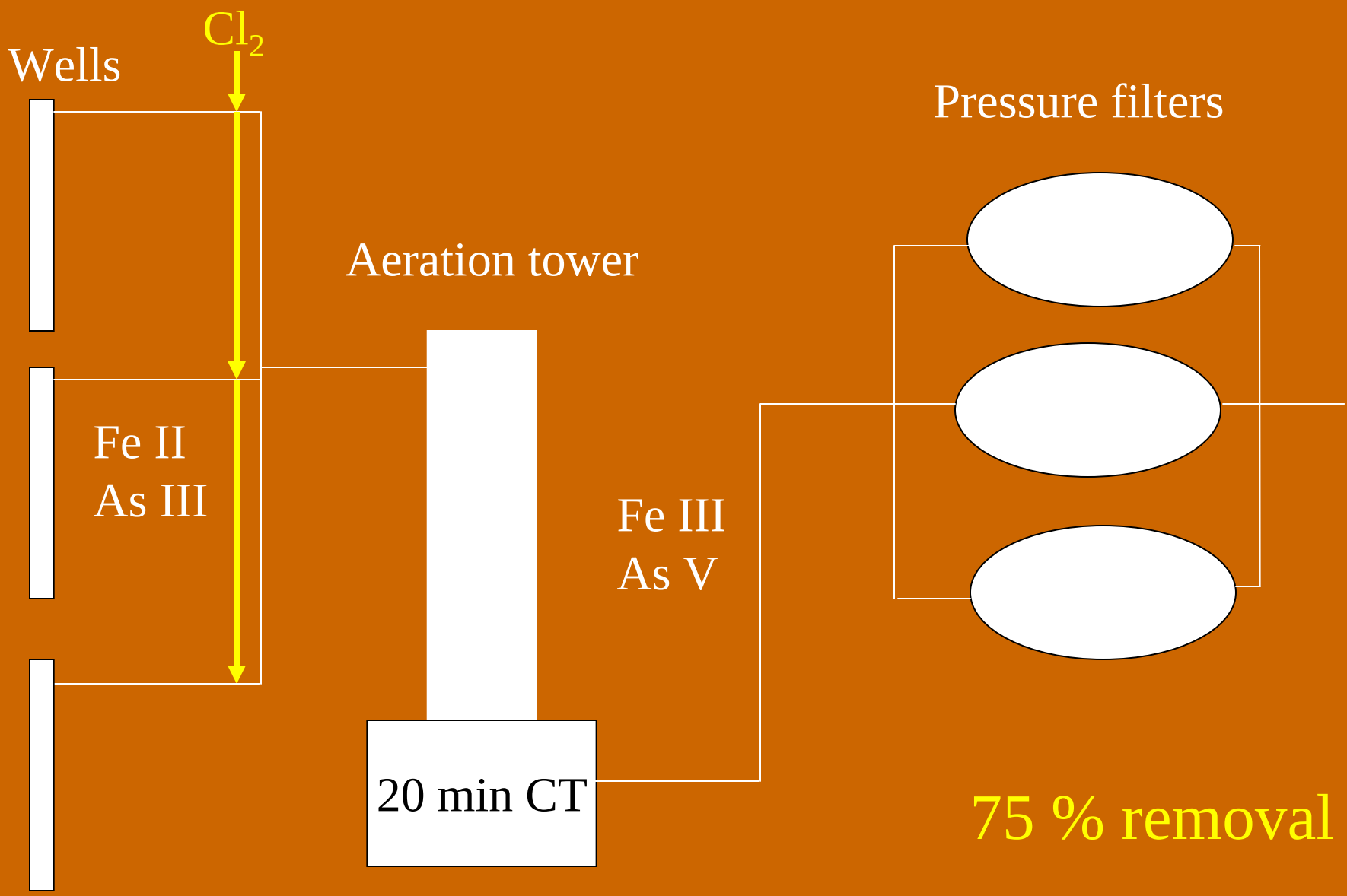
Iron Removal System - Holly, MI
Source Water Quality

Arsenic	**0.019 - 0.024**
As III	**95 %**
As V	**5 %**
Calcium	74 - 84
Magnesium	30 - 33
Iron	0.5 - 0.6
Manganese	0.02
Sulfate	50 -60
Silica	12 - 13
pH	7.1 - 7.3

Iron Removal System - Holly,MI



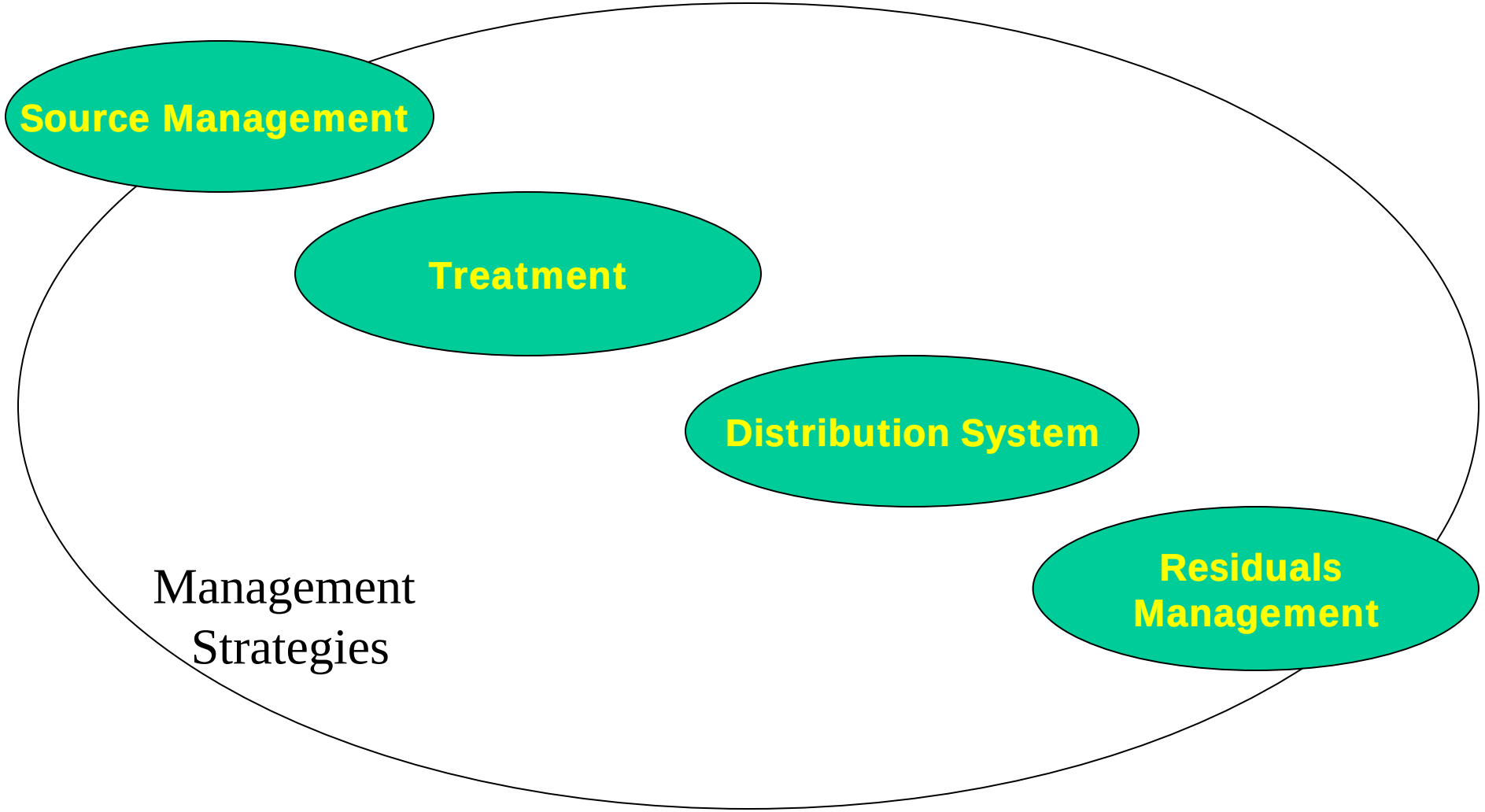
Iron Removal System - Holly,MI




CHLORINE
SOLUTION

Drinking Water Contaminant Management Framework

Drinking Water Contaminant Management Framework



Schmelling and Gutierrez, 2002

Arsenic Rule Implementation Research Program

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FY03 Congressional Appropriation

- $5 million for small system arsenic removal research.
- Strongly encourage use of funds for demonstrations of implementation of low-cost treatment technology.
- Report to Congress required August 15, 2003.

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FY04 Congressional Appropriation

- $5 million for small system arsenic removal research for a total of $11.7 million.
- Report to Congress required April 7, 2004.

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Arsenic Treatment Research Program

Objectives

(1) Identify and evaluate new cost-effective technologies

(2) Demonstrate/verify performance of existing and new commercially available technologies

(3) Provide technical guidance to small communities, regulators and consulting firms on selection and design of cost-effective systems to meet the arsenic MCL

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Major Elements

- Innovative Technology Development
- Treatment Technology Demonstrations
- Environmental Technology Verifications
- Enhanced base research program
- Training and technical assistance

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Small Business Innovation Research (SBIR)

Purpose – Promote development of new treatment technologies

Solicitation for arsenic treatment technologies released early in 2002

Fifty proposals received for Phase I

Awarded 8 bench level studies – Phase I/II awards

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SBIR Emerging Technologies

Filtration

Sorbents (24)

Biological

Oxidation

Co-precipitation

Other

Monitoring

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Phase II SBIR Technologies

- VEETech, P.C.
  - Arsenic Removal Using a Novel Hybrid Sorbent
- ADA Technologies, Inc.
  - Arsenic Removal System for Residential Point-of-Use Applications
- Hydro Tech Engineering
  - Limestone-based Material for Arsenic Removal

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Science to Achieve Results – New Technologies

- Novel Ion Exchange Process for Selective As V Removal – Zhao
- Novel Adsorption Technology – Assaf-Anid
- Modified Natural Zeolite Selective Sorbent – Sen Gupta

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Demonstrations

- $12 - $15 million targeted to this effort
- Full-scale, long-term (1 year) in scope
- Focused on commercially ready technologies or engineering approaches
- Fill in scientific gaps

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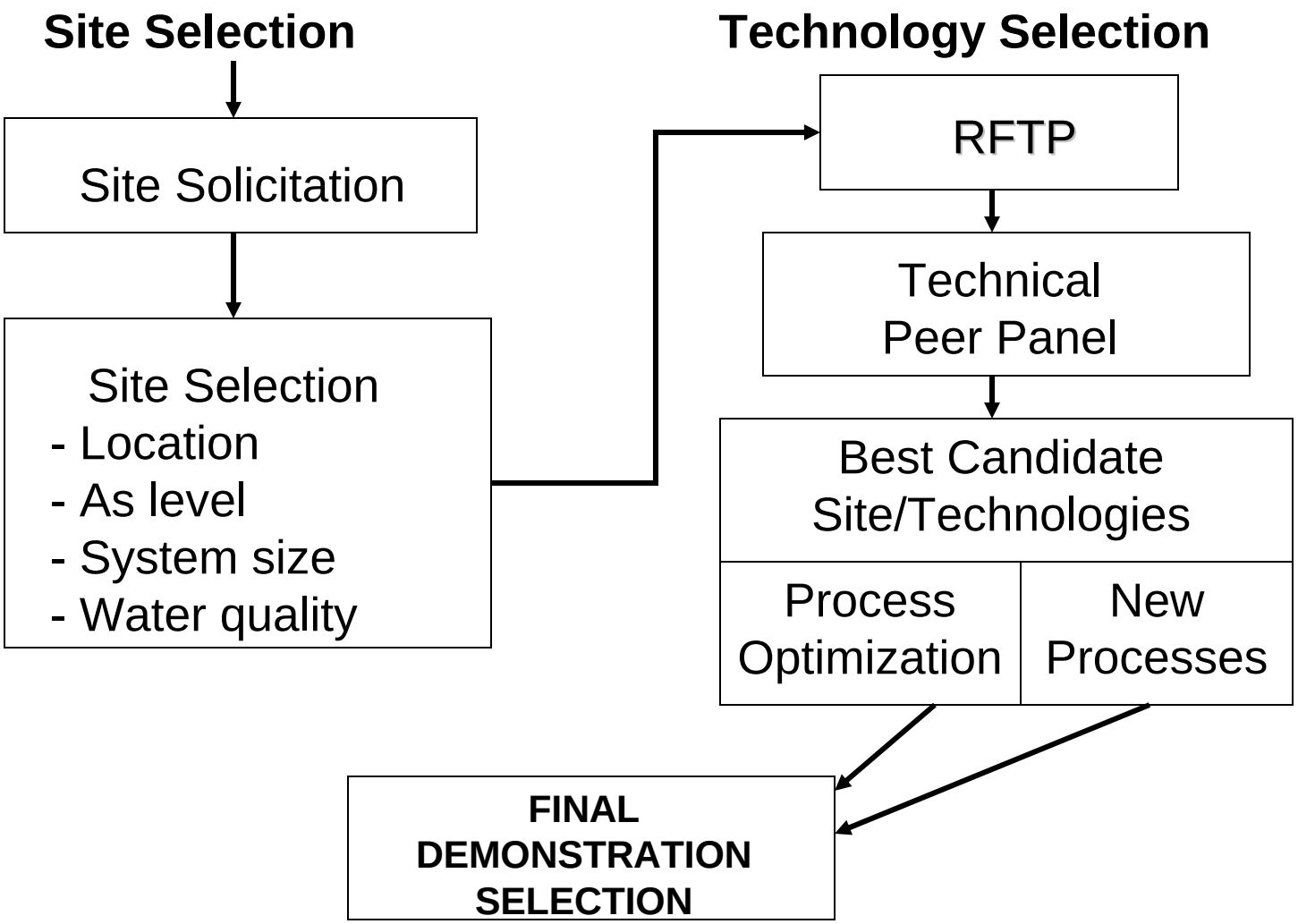
General Goals of Demo Projects

- Determine and document construction and operational costs
- Determine and document performance of the technology for 1 year in achieving compliance
- Determine operational and maintenance requirements
- Characterize residuals produced by the process
- Evaluate effectiveness of residuals disposal process

Arsenic Demonstration Program



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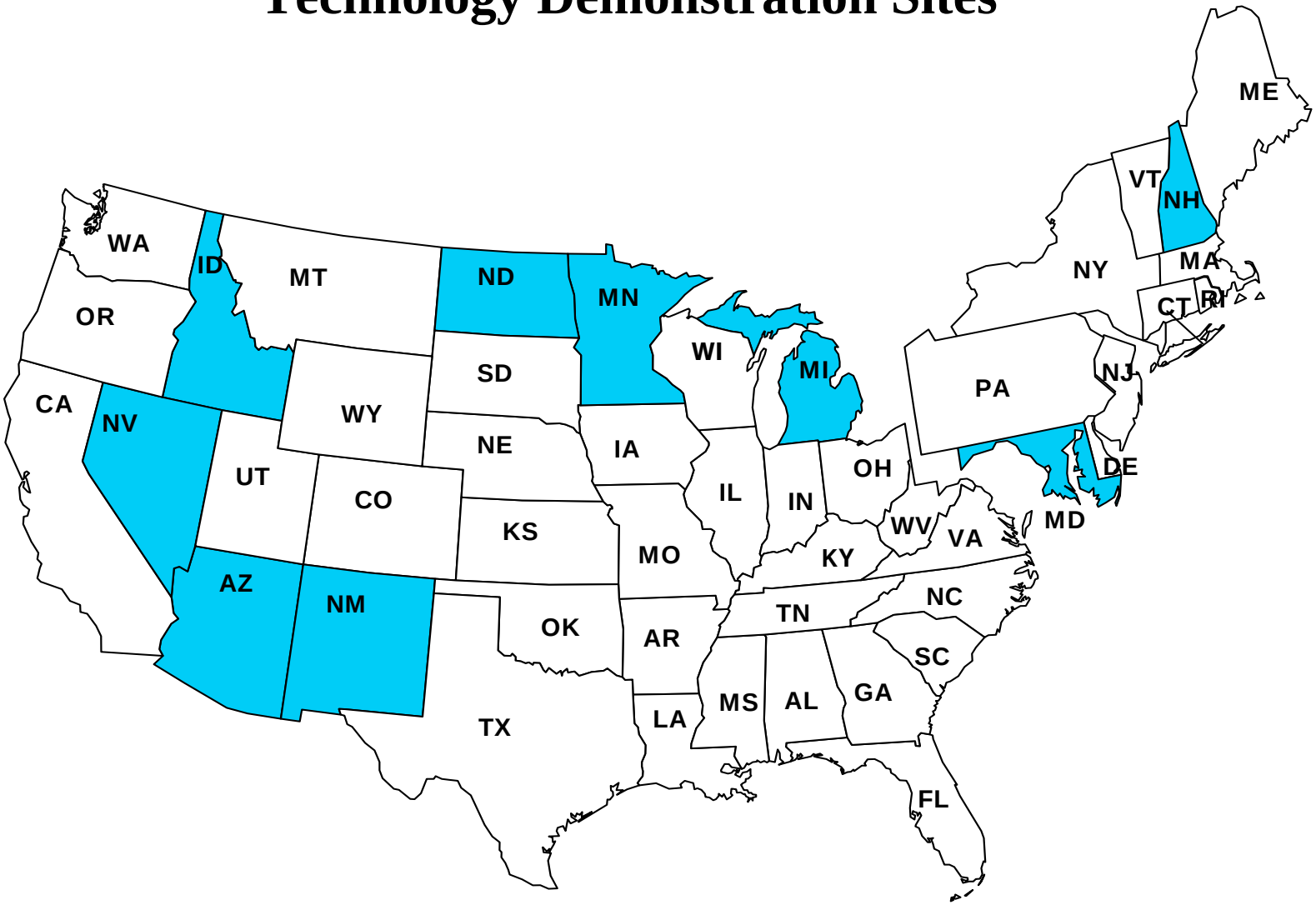
Funding Ground Rules

- **EPA Funds**
  - Technology/System
  - Engineering/permitting
  - Installation
  - System operation for 1 year
  - Performance study costs

- **Utility Funds**
  - New facilities (shelter)
  - Waste disposal system
  - Operators
  - Electricity

Round 1 - Arsenic Treatment Technology Demonstration Sites



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Round 1 Arsenic Treatment Technology Demonstration Sites

Site	Technology to be Demonstrated
Rimrock, AZ	AdEdge Iron Media
Valley Vista, AZ	Kinetico Activated Alumina
City of Fruitland, Fruitland, ID	Kinetico Ion Exchange
Queen Anne's Co, Stevensville, MD	Severn Trent Iron Media
Brown City, Brown City, MI	Severn Trent Iron Media
Town of Climax, Climax, MI	Kinetico Oxid/CoPrecip/Filtration
Lidgerwood, ND	Kinetico Modified Treatment
Bow, NH	ADI Iron Adsorption /Regeneration
Rollinsford, NH	AdEdge Iron Media
Anthony, NM	Severn Trent Iron Media
Nambe Pueblo, NM	AdEdge Iron Media
South Truckee Meadows, Reno, NV	US Filter Iron Media

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Technologies Selected

- **New Technologies**
  - 9 Adsorption media system
  - 1 Anion exchange system
  - 1 Iron removal system
- **System Modification**

  Iron removal process – Fe addition

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Desert Sands MDWCA (Anthony), NM

Population served – 1,886

System flow rate (well # 3) – 320 gpm

Water quality

- As - 23 ug/L (97% As III)
- pH - 7.7
- SiO_2 - 35 mg/L
- PO_4 - < 0.10

Technology

- Media adsorption-E 33,Severn Trent
- Two 64” x 86” tanks
- 160 ft3 media (total)

Desert Sands MDWCA (Anthony), NM

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Rollinsford, NH

Population served – 450 connections

System flow rate (Well # 3 & 4) – 100 gpm

Water quality

- As - 36 ug/L (56% As III)
- pH - up to 8.4
- SiO_2 - 14 mg/L
- PO_4 - < 0.10

Technology

- Media adsorption (AD 33, AdEdge)
- Two 36” x 72” tanks
- 54 ft3 media (total)
- pH adjustment w/CO_2 to 7.0
-

Rollinsford, NH

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Round 2 Solicitation Information

Title: Treatment Technologies for Arsenic Removal for Small Drinking Water Systems FY2004

Opened - September, 2003

Closed - January, 2004

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Round 2

Changes from Round 1

- Includes non-transient non-community water systems (NTNCWS)
- Allows for demonstration of Point-of-Use/Point-of-Entry Approaches
- Multi-contaminant treatment

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Round 2 - Sites

32 Sites Selected

States - 19

CWS – 28

NTNCWS – 4

Multi contaminant sites – 4

(Uranium, gross alpha, nitrate)

Size – 7 gpm to 600 gpm

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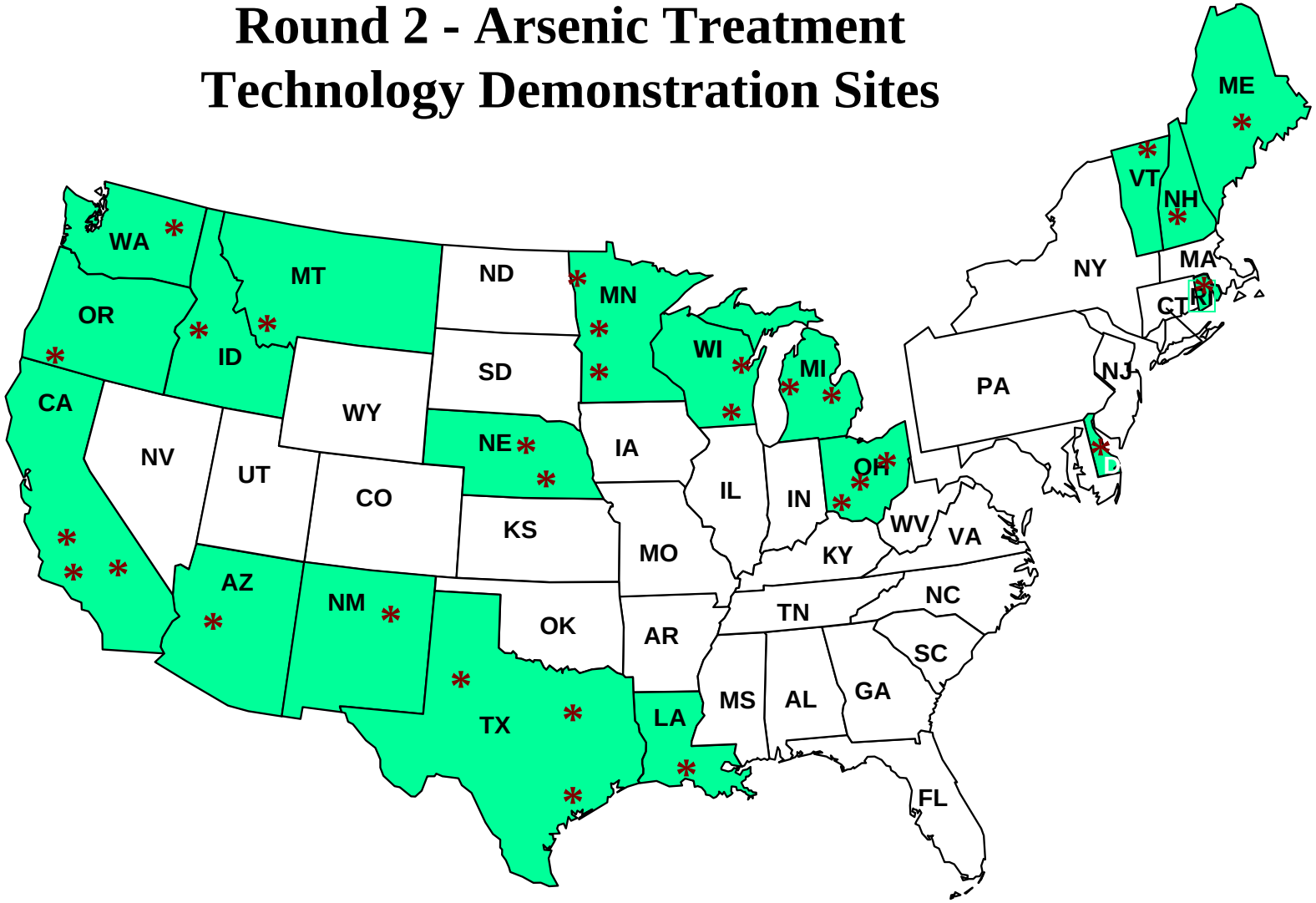
Round 2 Sites by Geographical Area

East	Central MW	Midwest	Far West
Felton, DE	Sauk Centre, MN	Breaux Bridge, LA	Susanville, CA
N. Springfield, RI	Sabin, MN*	Arnaudville, LA	Lake Isabella, CA
Goffstown, NH	Stewart, MN	Stromsburg, NE	Klamath Falls, OR
Dummerston, VT	Springfield, OH	Lyman, NE	Taos, NM
Wales, ME	Grove City, OH	Wellman, TX*	Homedale, ID
	Newark, OH	Alvin, TX	Okanogand, WA
(5)	Greenville, WI*	Bruni, TX	Three Forks, MT
	Sandusky, MI		Techachapi, CA*
	Pentwater, MI	(7)	Tohono O'odham, AZ (Sells)*
	Delavan, WI		Vale, OR
	(10)		(10)

* Site selected, but not funded in Round 1

Round 2 - Arsenic Treatment Technology Demonstration Sites



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Technical Proposals

- Proposals received – 148
- Companies – 24
- Proposals per site – 2 to 8

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Technologies Proposed

- *Adsorption technologies*
- Oxidation / filtration
- Iron Coagulation / filtration
- Reverse osmosis
- Ion exchange
- Process modification
- Dissolved air flotation / filtration
- Distillation

- POUs (included in above technologies)

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Round 2 – Next Steps

- Technology selection for each site – May/July, 2004
- Contracts with vendors/engineering firm – Fall of 2004
- Installation of systems – January/June, 2005

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Major Elements

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Environmental Technology Verification Program

- Program verifies the performance of treatment technologies according to established test protocols
- Short term tests, commercial ready technologies
- NSF is EPA cooperator for drinking water verifications

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ETV Arsenic Verifications

Hydrauntics – Reverse Osmosis Membrane Element Module

Kinetico, Inc – Macrolite Coagulation and Filtration System

Koch Membrane Systems – Reverse Osmosis Membrane Module

Watermark Technologies, Coagulation and Filtration Systems

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Enhanced Base Research Program

- Treatment Optimization Studies
- Distribution System Recontamination
- Residuals Management
- Source Control
  - Hot spot location using isotope hydrology
  - Hydrogeological approach to arsenic distribution

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Major Elements

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Training and Technical Assistance

- Working with the Office of Ground Water and Drinking Water
- University of Nebraska funded to investigate well pumping approach for arsenic control
- Support to State of Arizona for preparation of master plan for arsenic

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Resource Manuals Available

- Arsenic Removal from Drinking Water by Coagulation/Filtration and Lime Softening Plants
- Arsenic Removal from Drinking Water by Iron Removal Plants
- Arsenic Removal from Drinking Water by Ion Exchange and Activated Alumina Plants
- Treatment of Arsenic Residuals from Drinking Water Removal Processes
- Oxidation of As(III) by Aeration and Storage
- Laboratory Study on the Oxidation of As III to As V
- Regulations on the Disposal of Arsenic Residuals from Drinking Water Treatment Plants

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NEW MANUALS

- Design Manual: Removal of Arsenic from Drinking Water by Adsorptive Media
- Removal of Arsenic from Drinking Water by Ion Exchange
- Arsenic Treatment Technology Evaluation Handbook for Small Systems

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Further Information

Website

www.epa.gov/ORD/NRMRL/arsenic/

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