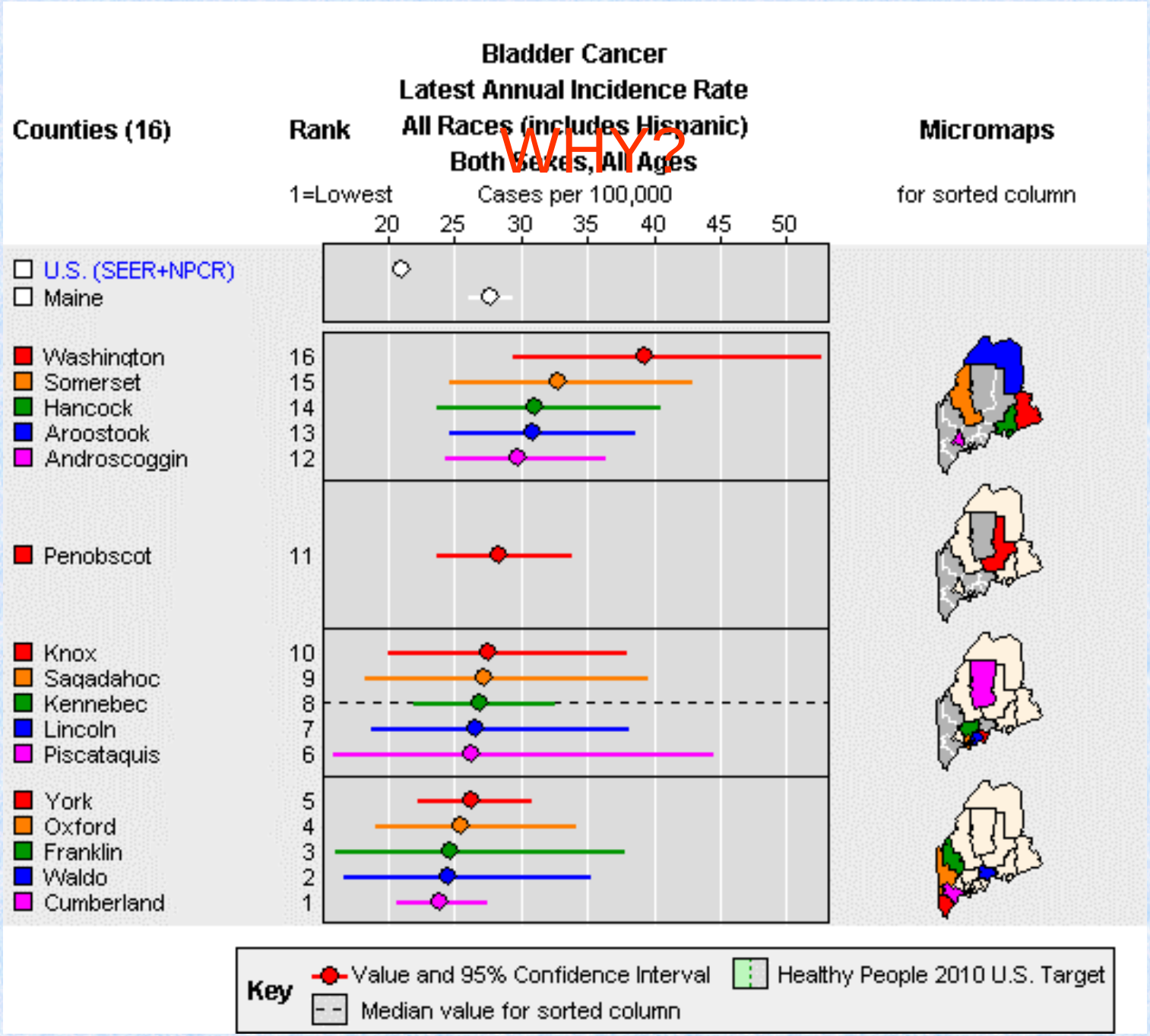
Estimating the Production of Arsenic-Bearing Residuals (ABR) From Maine's Drinking Water

John M. Peckenham

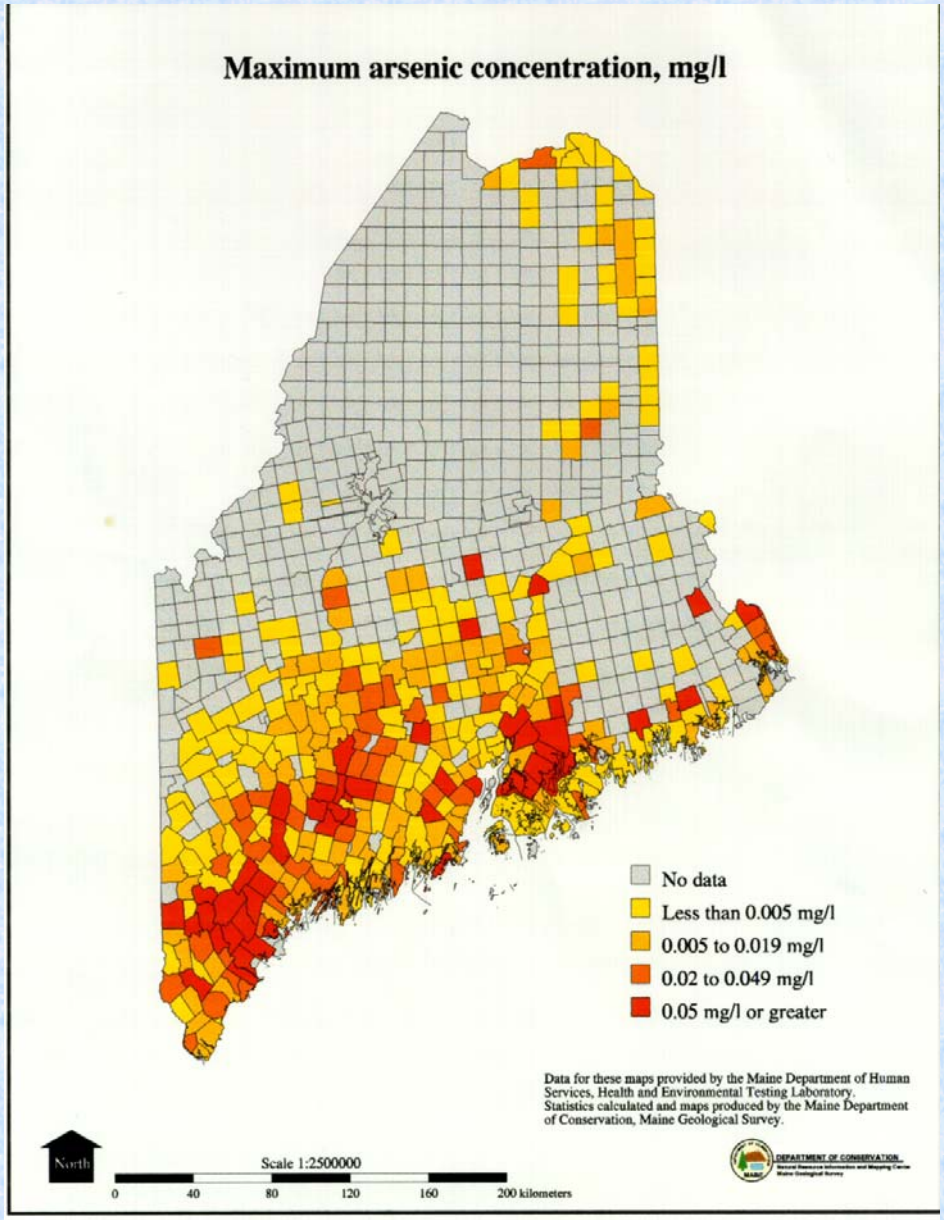
Senator George J. Mitchell Center for Environmental & Watershed Research

University of Maine



Map courtesy of SEER, 2006

ARSENIC IN MAINE'S GROUND WATER



Review of Statewide

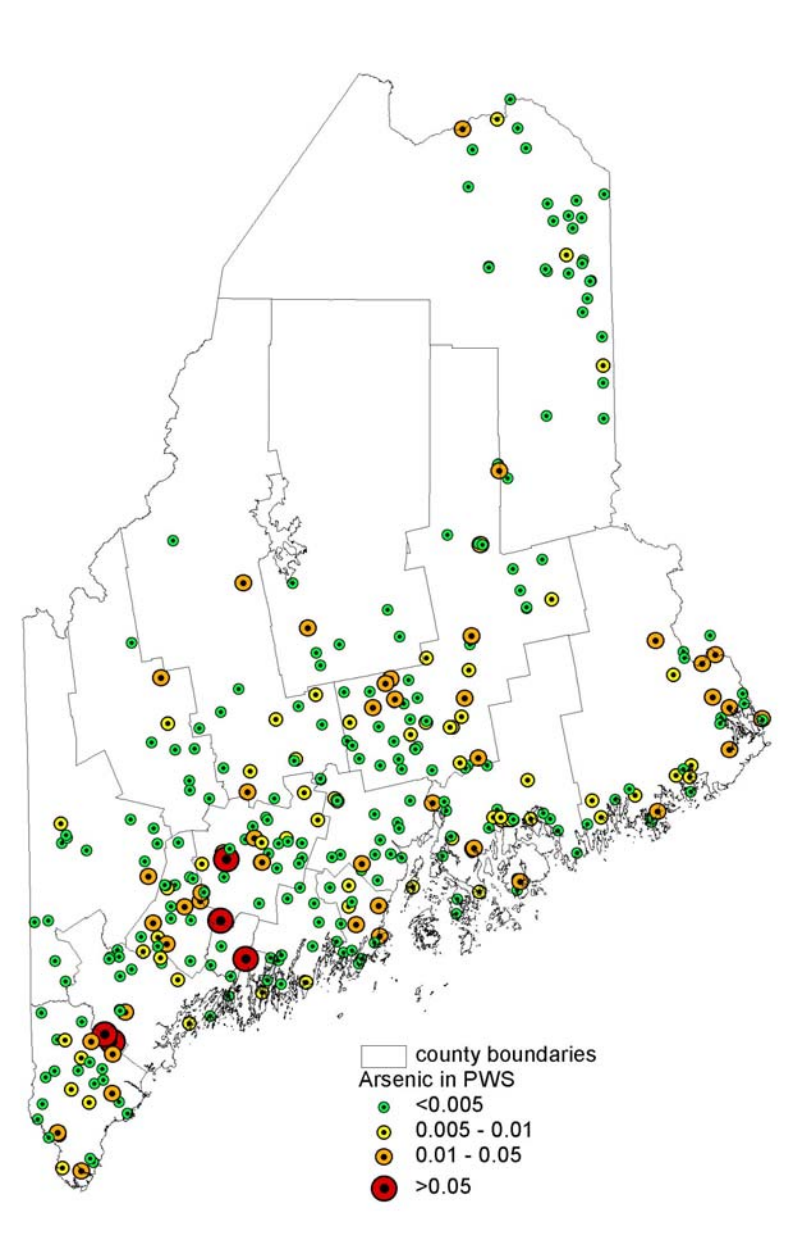
Private Well

Test Data

1991 - 1994

- 13 % > 50 ppb
- 35 % > 10 ppb
- 46 % > 5 ppb

ARSENIC IN MAINE'S GROUND WATER



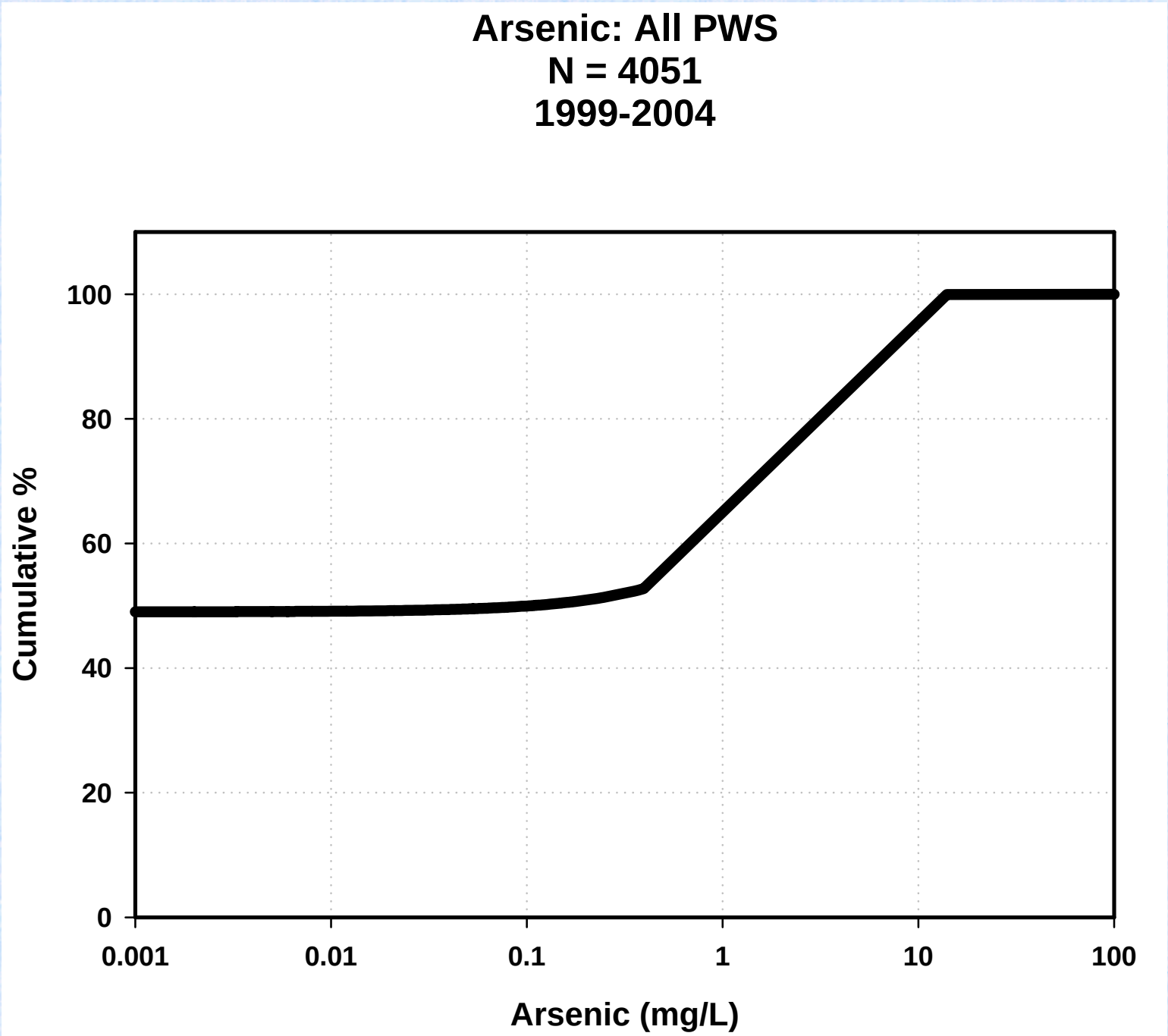
Review of Statewide

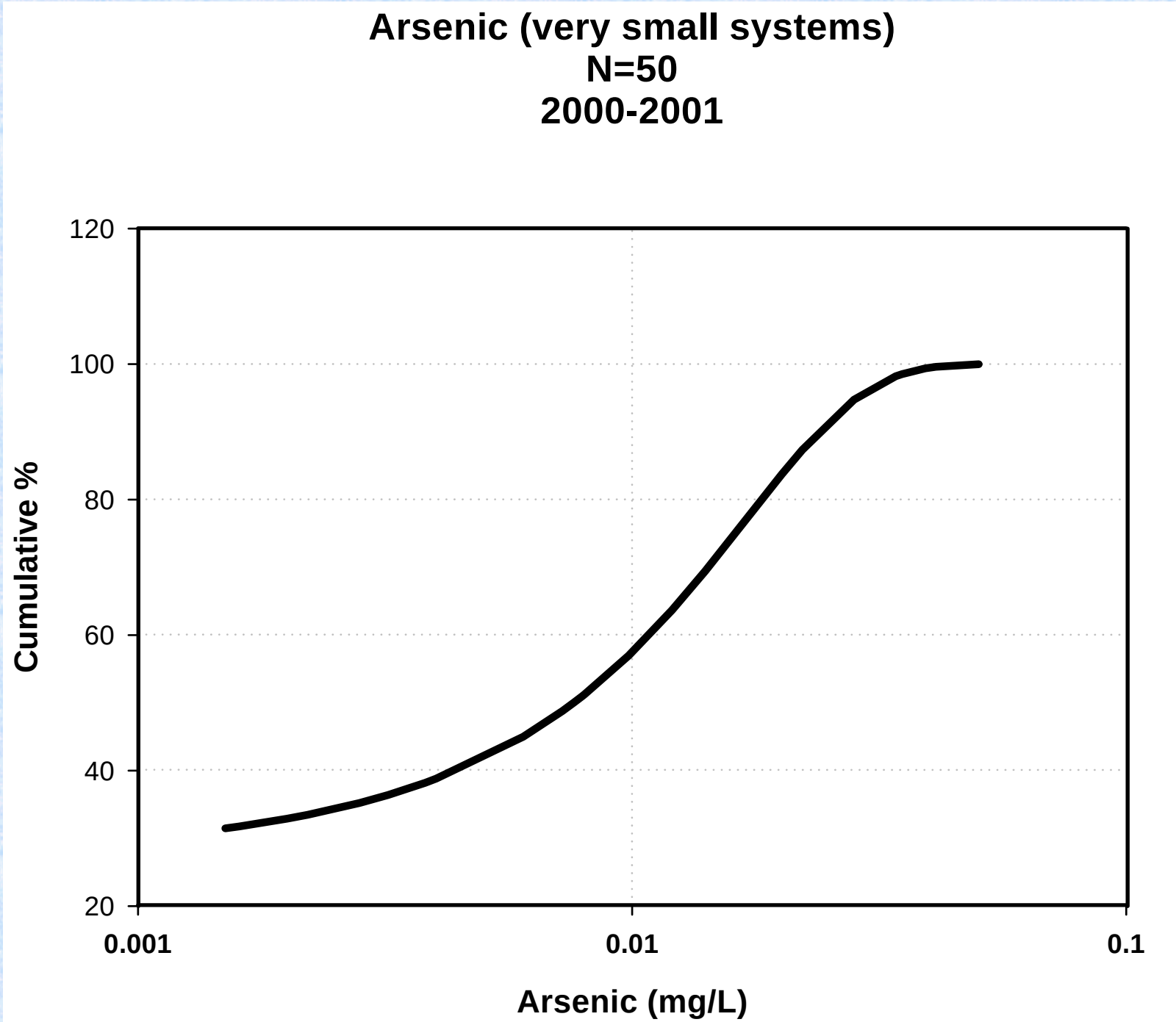
Public Well

Test Data

Source Water

- 2 % > 50 ppb
- 16 % > 10 ppb
- 36 % > 5 ppb


Arsenic: All PWS
N = 4051
1999-2004
Cumulative %
100
80
60
40
20
0
0.001
0.01
0.1
1
10
100
Arsenic (mg/L)

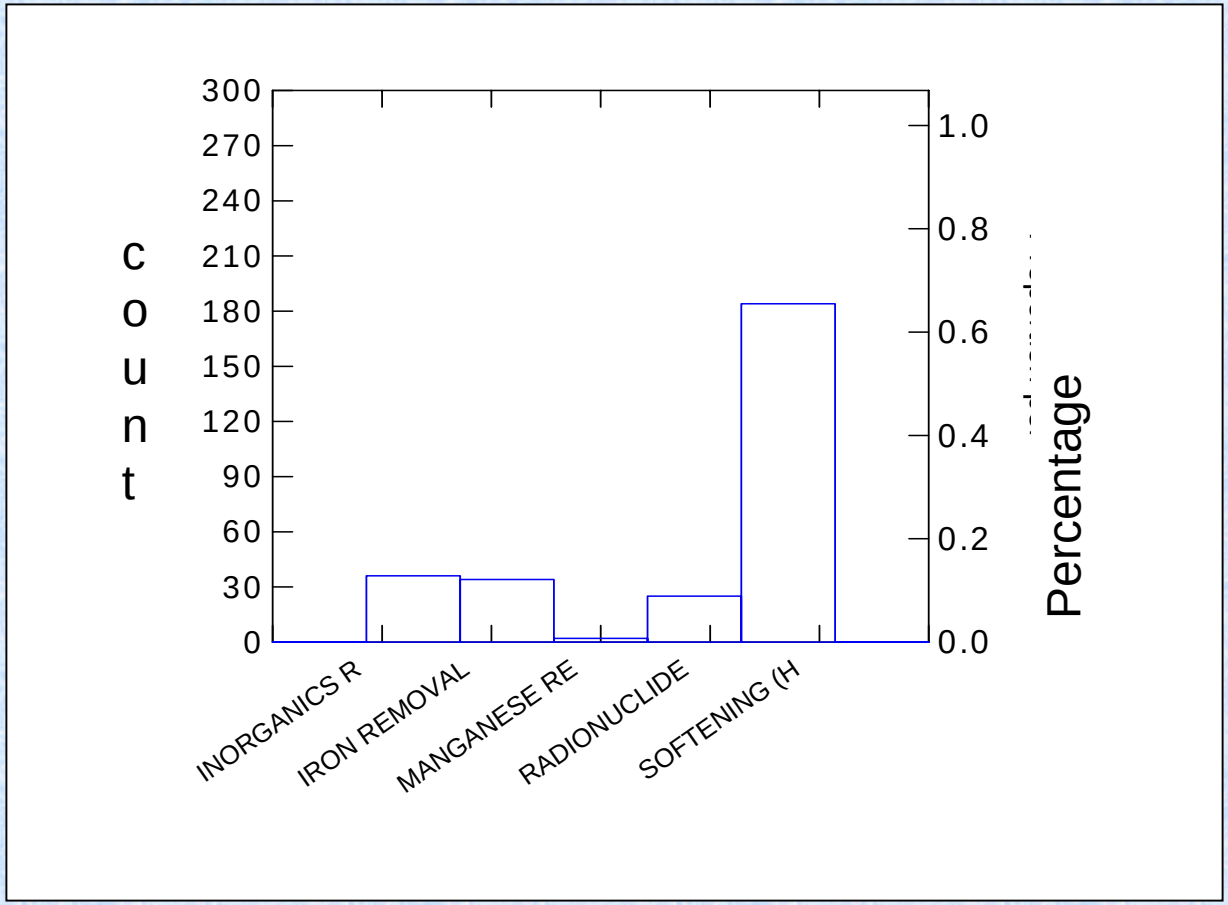

Arsenic (very small systems)
N=50
2000-2001
120
100
80
60
40
20
Cumulative %
0.001
0.01
0.1
Arsenic (mg/L)

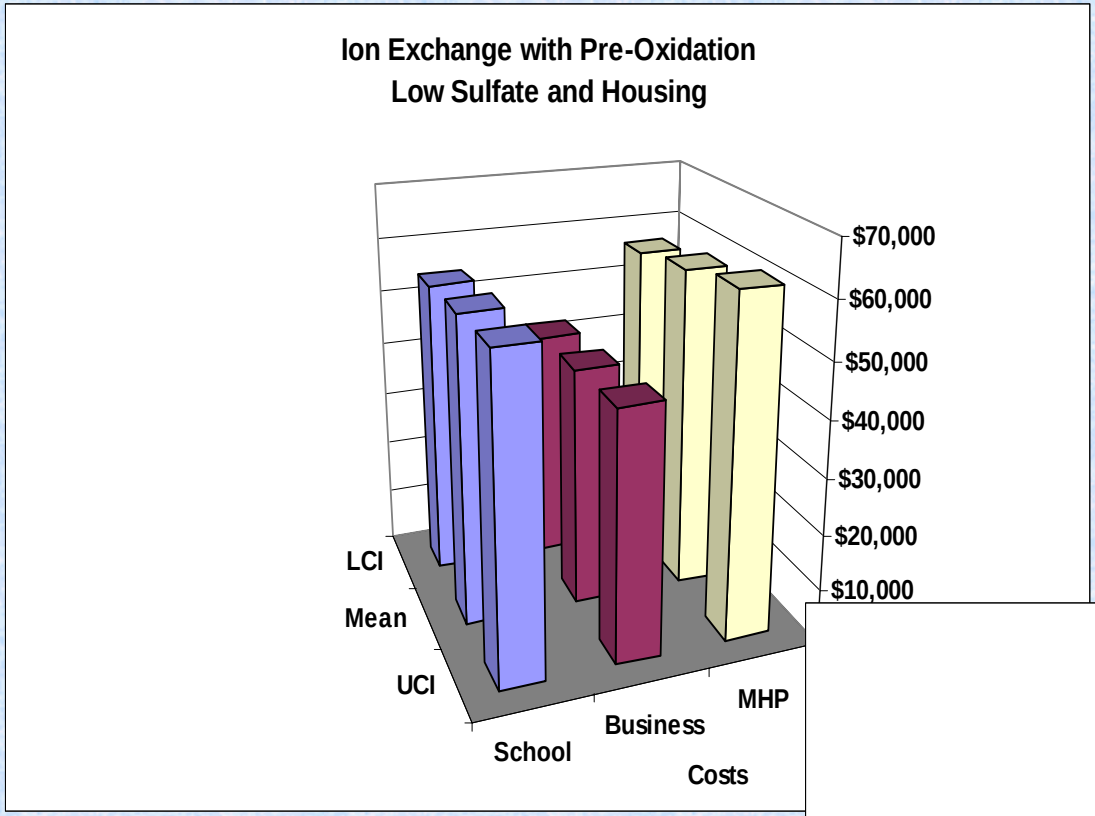
TECHNOLOGIES USED IN MAINE

Type	Location	Capital Cost	O/M Cost	Life Cycle (years)
Activated Alumina	POU	$600	$1,000	~
Reverse Osmosis	POU	$900	$150	3-5
Reverse Osmosis	POE	$9,000+	~	3-5
Iron Based Sorbent	POU	$450+	$100+/-	2-4
Iron Based Sorbent	POE	$1,750+	$100+/-	2-4

$\Rightarrow$Costs Drive Technology Selection

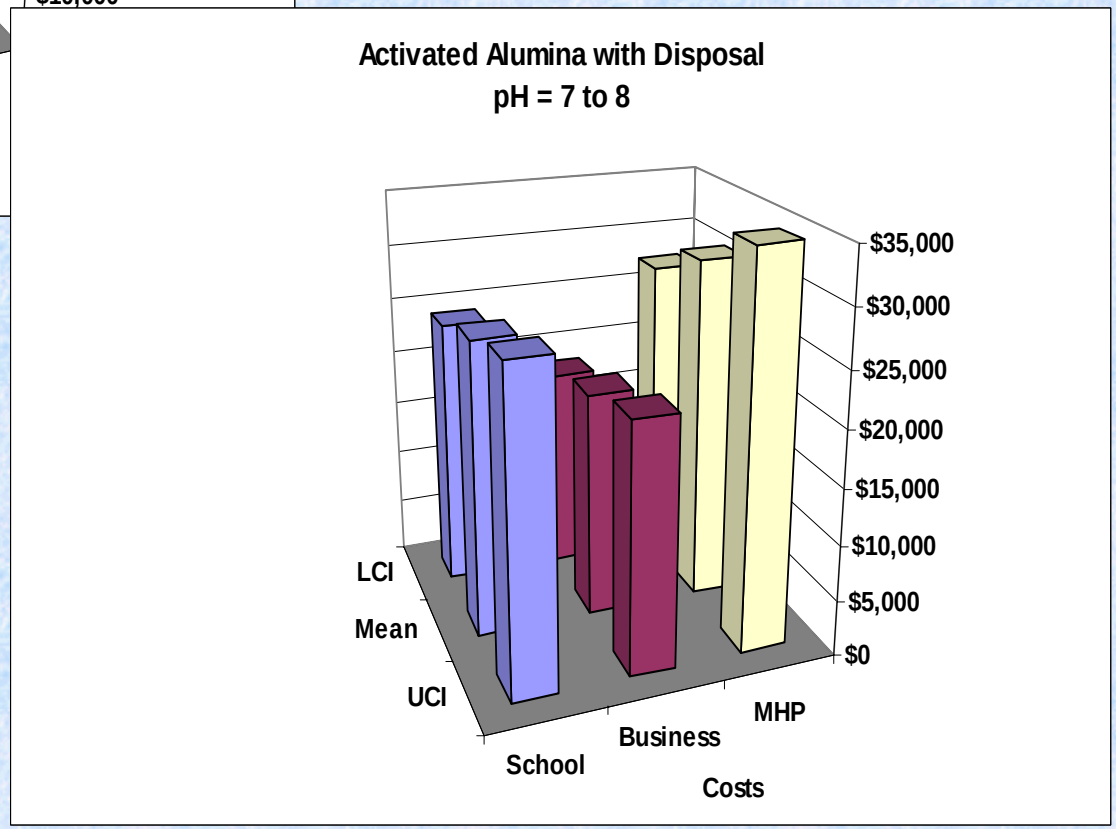
Removal Techniques in PWS (N = 281)





Arsenic Removal Costs for Small PWS

$20,000 to $60,000/year.



Maine 2005 Census Estimates

- Population: 1,320,505
- Households: 518,200

- PWS supply ~ 500,000 people
  - ~200,000 households

- Private Wells: ~300,000

WATER USE

Schools = 20 gallons/person/day

Businesses = 15 gallons/person/day

Mobile Home Parks = 65 gallons/person/day

Based on USGS Estimates.

ABR 1st Approximation Private Wells

- 35% of wells >0.01 mg/L As
- 65 gpd/person = 163 gpd/household
- 300,000 households
- Range of Arsenic 0.01 to 0.05 mg/L

Low Estimate = **0.65** kg/day
High Estimate = **3.2** kg/day

ABR 1st Approximation
Small Public Supplies Using Wells

- 16% of wells >0.01 mg/L As

- N = 59 Community Supplies
- N = 72 Non-Community Supplies

- Mean Community Arsenic = 0.033 mg/L
- Mean Non-Community Arsenic = 0.023

Small Community Estimate = **1.5** kg/day
Non-Community Estimate = **0.027** kg/day

Sources & Sinks

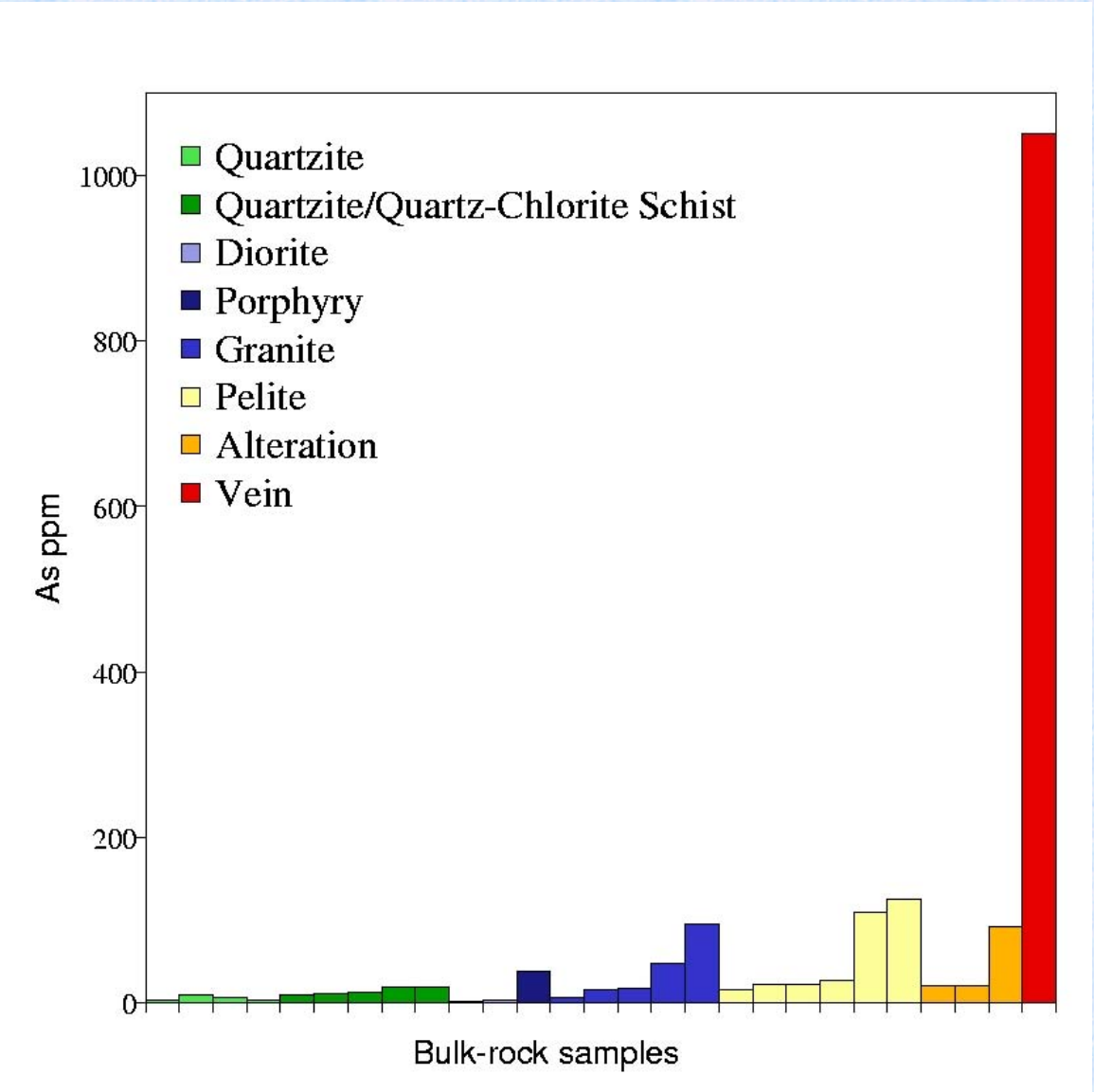
(research needed)

- Sources
  - Native Geology
  - Secondary Mobilization
    - Agriculture (former use of pesticides & biosolids)
    - Land Disposal of Arsenical Materials

Sinks

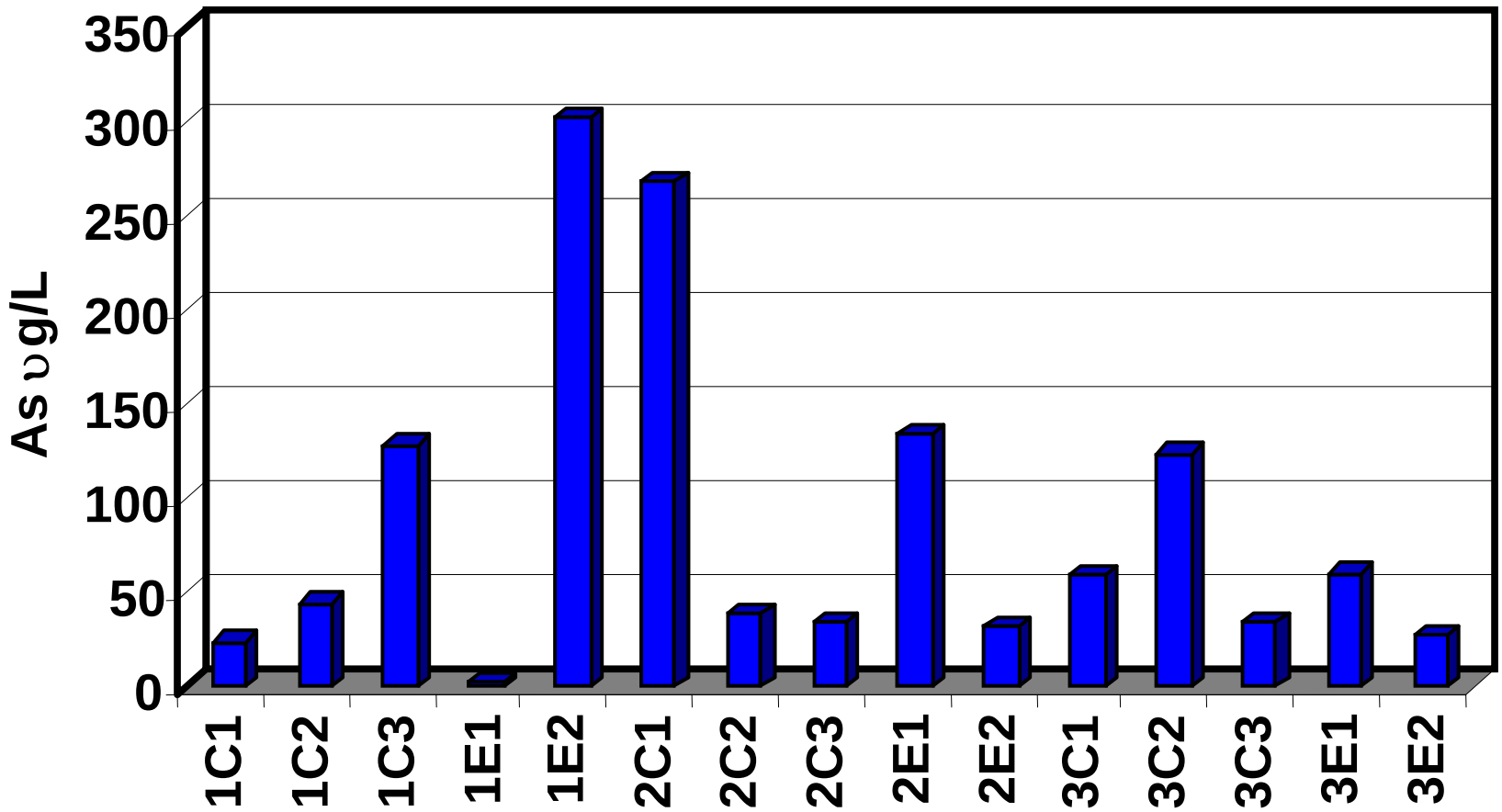
Septic Systems (20 to 100%)
WWTP (up to 100%)
Landfills (20 to 80% diverted from POU/POE)

Bulk-rock As concentrations (Northport, Maine)



Courtesy of Gail Lipfert, 2006

Lysimeter Results 6/03 Arsenic



Lakehurst Acres

- Arsenic Removal System Installed (25 unit complex, ~ 40 residents).
- Arsenic Concentrations Were Reduced (RO).
- Lead went from 8 ppb to 3200 ppb!!! (MEG=10)
- Daily backwash to lessen load to POTW, alkalinity stripped by frequent backwash.

Closing Thoughts

- Total Daily Arsenic Passing Through Private Homes and Schools.

2.2 to 4.7 kg/day

Amount of Arsenic needed to affect

one household for 1 year ≅ 2.25 g.

Based Upon Mass Balance,

If ABR Recycles in the Environment

1,000 + Additional Households/Year Will Be Affected.

Plus: Fe, Mn, U, Ra,…

Information and Support Provided by:

Maine Drinking Water Program
U.S. EPA Region 1
Maine Department of Environmental Protection
Maine Geological Survey
U.S. Geological Survey (Charlie Culbertson)
Maine Waste Water Control Association

UMaine Research Colleagues-
Aria Amirbahman, Kathleen Bell, Kevin Boyle, Gail Lipfert, Jean MacRae, and Andy Reeve.

CONTRACTORS SUPPLYING INFORMATION

Advanced Quality Water Solutions

Air and Water Quality, Inc.

Aroostook Water Care, Inc.

Everett J. Prescott, Inc.

Haskell's Water Treatment

Lowry Aeration Systems

Main Source Water Treatment

Norlens Water Treatment

Quot Homines, Tot Sententiae
(Publius Terentius Afer).