

REVIEW OF THE DRINKING WATER AND GROUNDWATER STANDARDS FOR ARSENIC

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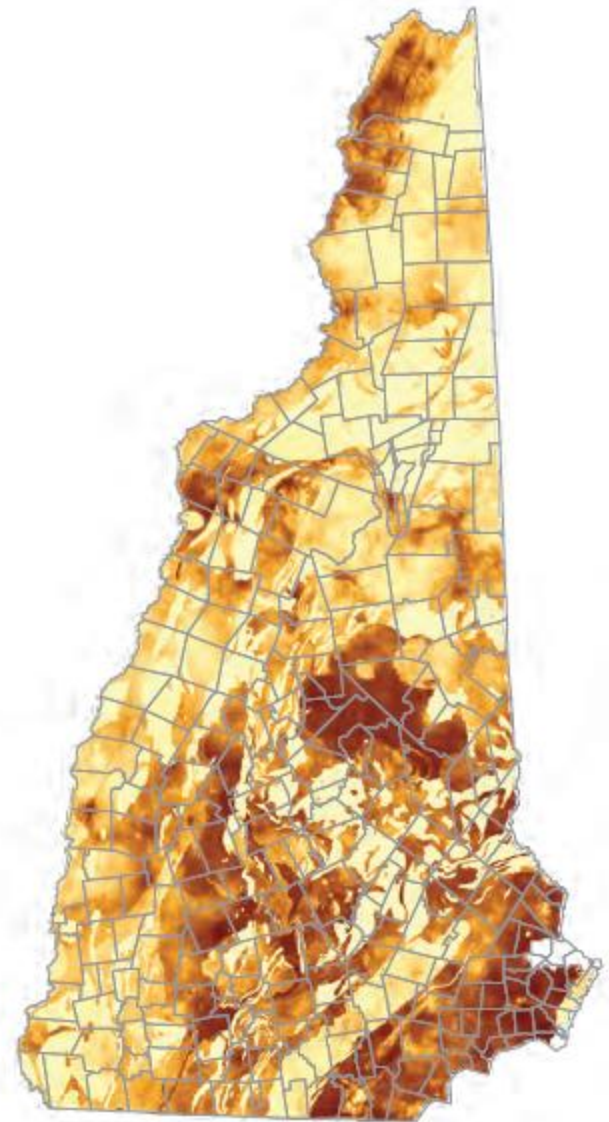
REVIEW OF THE ARSENIC STANDARD

- Why arsenic
 - Current standard (MCL)
 - Recent review
 - Current status
-

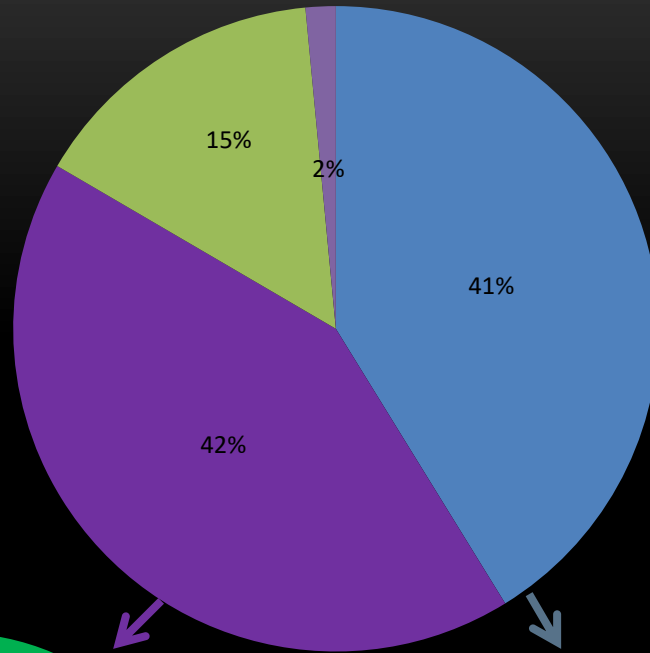
ARSENIC

- New Hampshire the Arsenic State – “primary domestic source for decades”
- Uses: rodenticide, fungicide, insecticide, embalming, medical
- Exposure from water and food
- Mechanism of low-dose toxicity – possible endocrine disruptor

A. Arsenic ≥ 1 $\mu\text{g}/\text{L}$ model

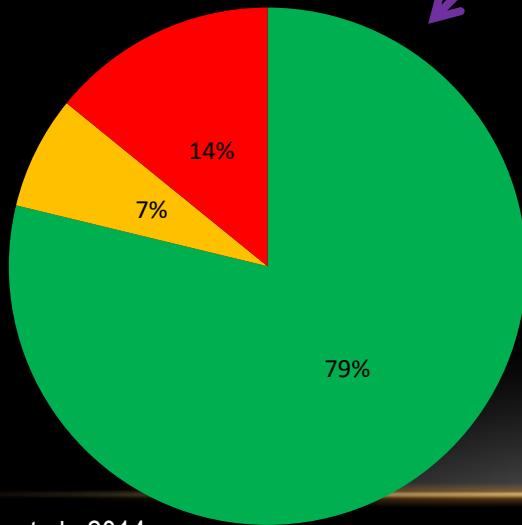


"Main Source of Drinking Water at Home" in NH



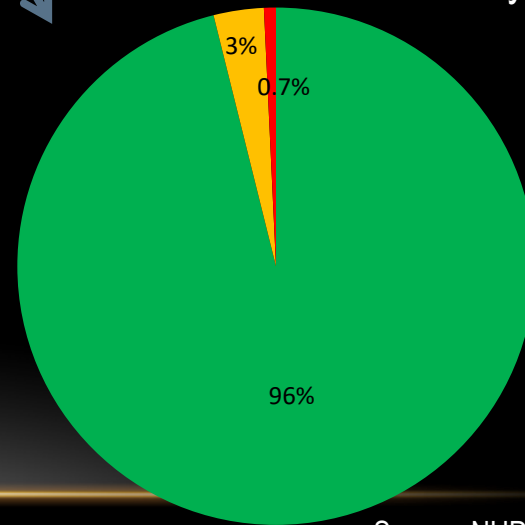
Source: NHDHHS, 2014 BRFSS Survey

Private Wells



Source: Borsuk, et.al., 2014

Public Water Systems



Source: NHDES, DWGB, 2018

Arsenic level after current treatment - by population served

DRINKING WATER STANDARDS FOR ARSENIC

- USEPA - 50 ppb until 2001
- Proposed 5 ppb in 2000
- Adopted 10 ppb in 2001
 - Health effects
 - Treatment cost

- New Jersey - 2001
 - Health effects
 - Treatment feasibility
 - Proposed 3 ppb
 - Adopted 5 ppb
 - Implemented since 2006

California

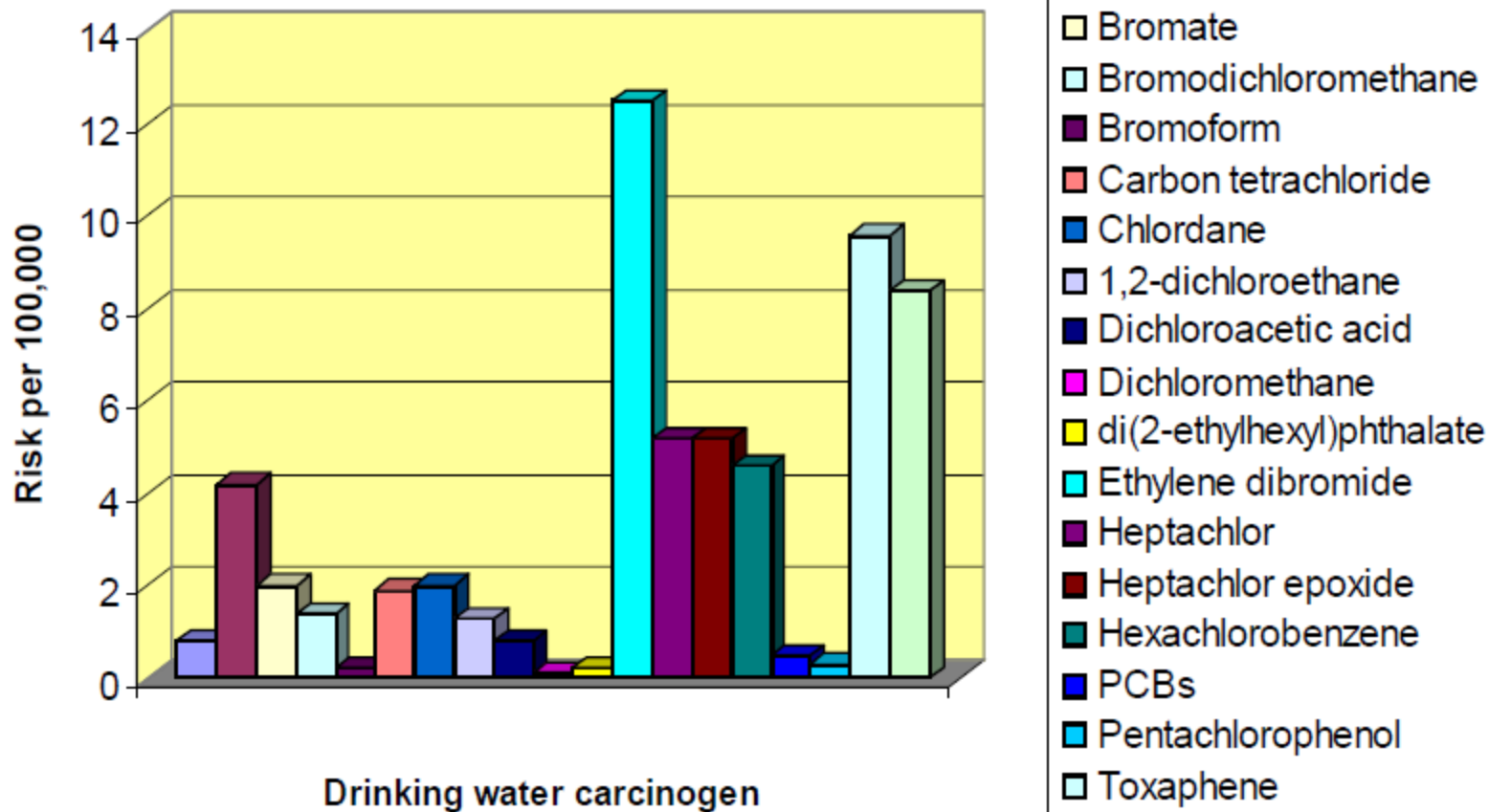
- Health effects
- Treatment affordability
- Adopted 10 ppb

Exhibit 1-1
Total Annual Cost, Estimated Monetized Total Cancer Health Benefits and Non-Quantifiable Health Benefits from Reducing Arsenic in PWSs
 (\$ millions)

Arsenic Level (µg/L)	Total Annual Cost (7%)	Annual Bladder Cancer Health Benefits ^{1,2}	Annual Lung Cancer Health Benefits ^{1,2}	Total Annual Health Benefits ^{1,2}	Potential Non-Quantifiable Health Benefits
3	\$792.1	\$58.2 - \$156.4	\$155.6 - \$334.5	\$213.8 - \$490.9	<ul style="list-style-type: none"> • Skin Cancer • Kidney Cancer • Cancer of the Nasal Passages • Liver Cancer • Prostate Cancer • Cardiovascular Effects • Pulmonary Effects • Immunological Effects • Neurological Effects • Endocrine Effects • Reproductive and Developmental Effects
5	\$471.7	\$52.0 - \$113.3	\$139.1 - \$242.3	\$191.1 - \$355.6	
10	\$205.6	\$38.0 - \$63.0	\$101.6 - \$134.7	\$139.6 - \$197.7	
20	\$76.5	\$20.1 - \$21.5	\$46.1 - \$53.8	\$66.2 - \$75.3 ³	

¹ May 1999 dollars.

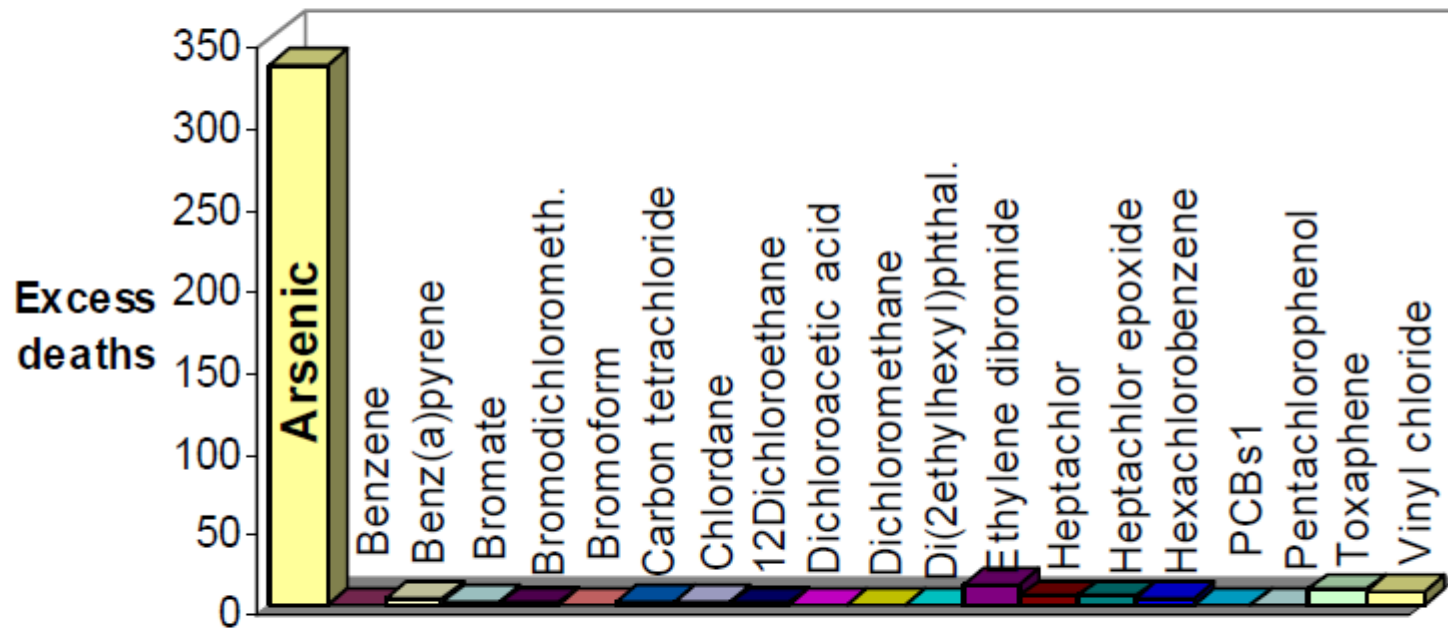
Estimated excess cancer risks per 100,000 people exposed at the MCL



Risks estimated based on cancer potency estimates from IRIS

Source: Craig Steinmaus, MD, MPH; UCSF, UC Berkeley

Figure 1. Estimated cancer risk deaths per 100,000 people exposed at the MCL of each drinking water chemical carcinogen



Risks for arsenic based on NRC 2001 cancer potency estimates

Source: Craig Steinmaus, MD, MPH; UCSF, UC Berkeley

NH 2018 REVIEW OF ARSENIC STANDARD

- 2018 HB 1592 (June): NHDES shall review AGQS & make recommendation
 - Occurrence
 - Ability to detect
 - Ability to treat
 - Public health impact
 - Costs
 - USEPA updating Tox Review since 2003 . . .
 - Dartmouth Birth Cohort Study
 - UNH study: economic value of reduced risk
 - NHDES estimates of costs
-

DOSE-RESPONSE: MOE SCREENING

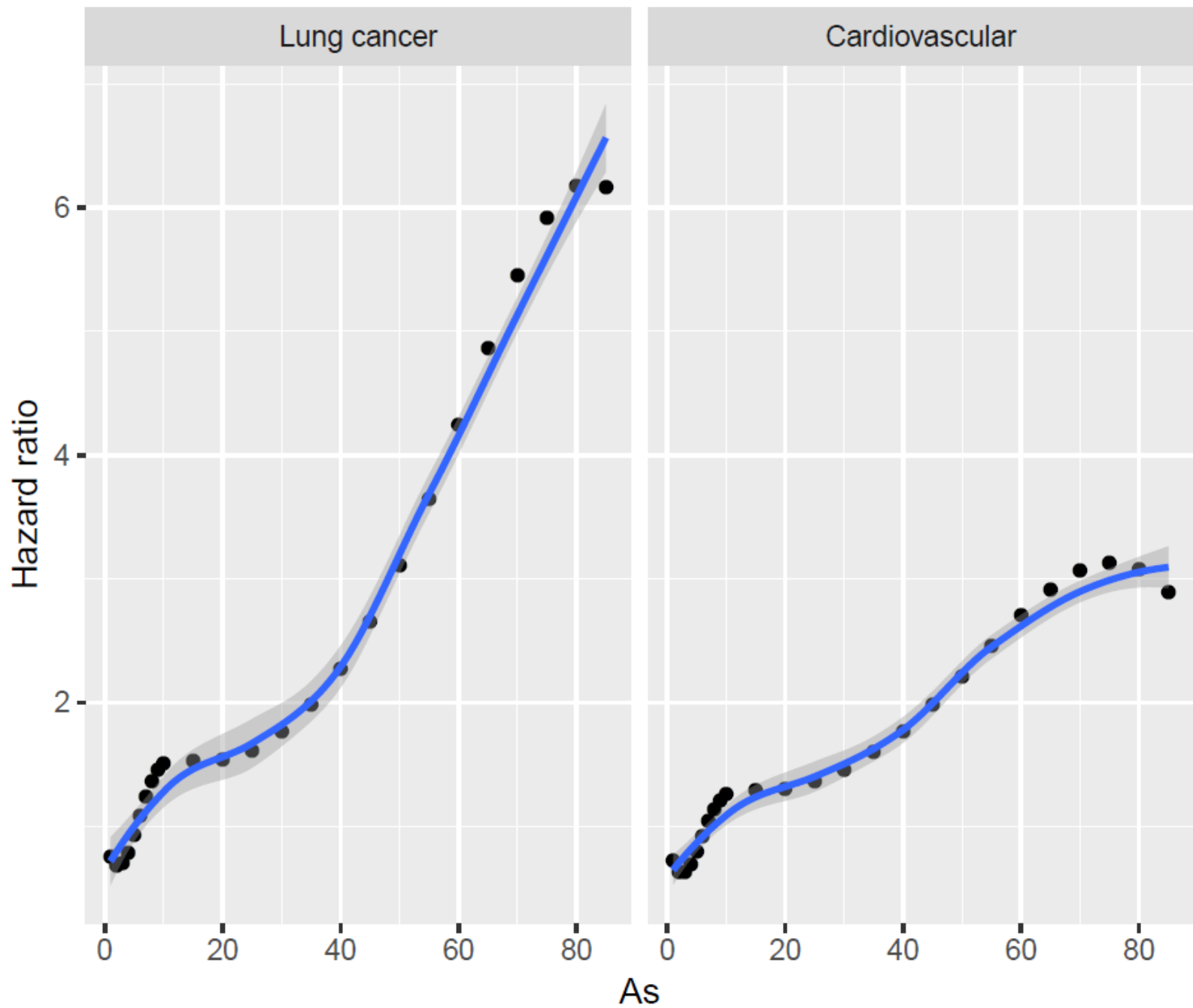
Health outcome category	All HI studies (Starting point)	Studies set aside in initial screen	Studies set aside in second screen	Studies set aside in final screen	Studies included in MOE modeling	Datasets included in MOE modeling
Bladder cancer	64	37	3	6	18	73
Diabetes	49	43	0	2	4	9
Diseases of the circulatory system	105	75	4	9	17	73
Immune effects	20	8	3	9	0	0
Liver cancer	30	27	0	0	3	7
Lung cancer	87	53	8	10	16	37
Nonmalignant respiratory	47	36	3	6	2	5
Pregnancy outcomes	39	25	2	9	3	6
Renal cancer	32	19	5	2	6	19
Skin cancer	38	32	1	2	3	8
Skin lesions	72	61	0	1	10	25
Total Number of Studies or Datasets	415	289	23	47	68	262

^a Studies totals do not equal sum of columns due to study overlap across health outcome categories.

HAZARD IDENTIFICATION – INCLUDED IN MAIN TOXICOLOGICAL REVIEW

Health Outcomes		NRC Tier	Characterization of Evidence	Level of Dose-Response	Place in Assessment	
					HI	DR
Cancer	Bladder	1	Robust	Meta-regression	None	Section 2
	Lung	1	Robust	Meta-regression	None	Section 2
Noncancer	Disease of Circulatory Sys.	1	Robust	Meta-regression	Section 1	Section 2
	Adverse Preg. Outcomes ¹	2 & 3	Robust	Screening and TBD	Section 1	Section 2
	Diabetes ¹	2	Robust	Screening and TBD	Section 1	Section 2
	Neurocognitive effects ¹	2	Moderate	Screening and TBD	Section 1	Section 2

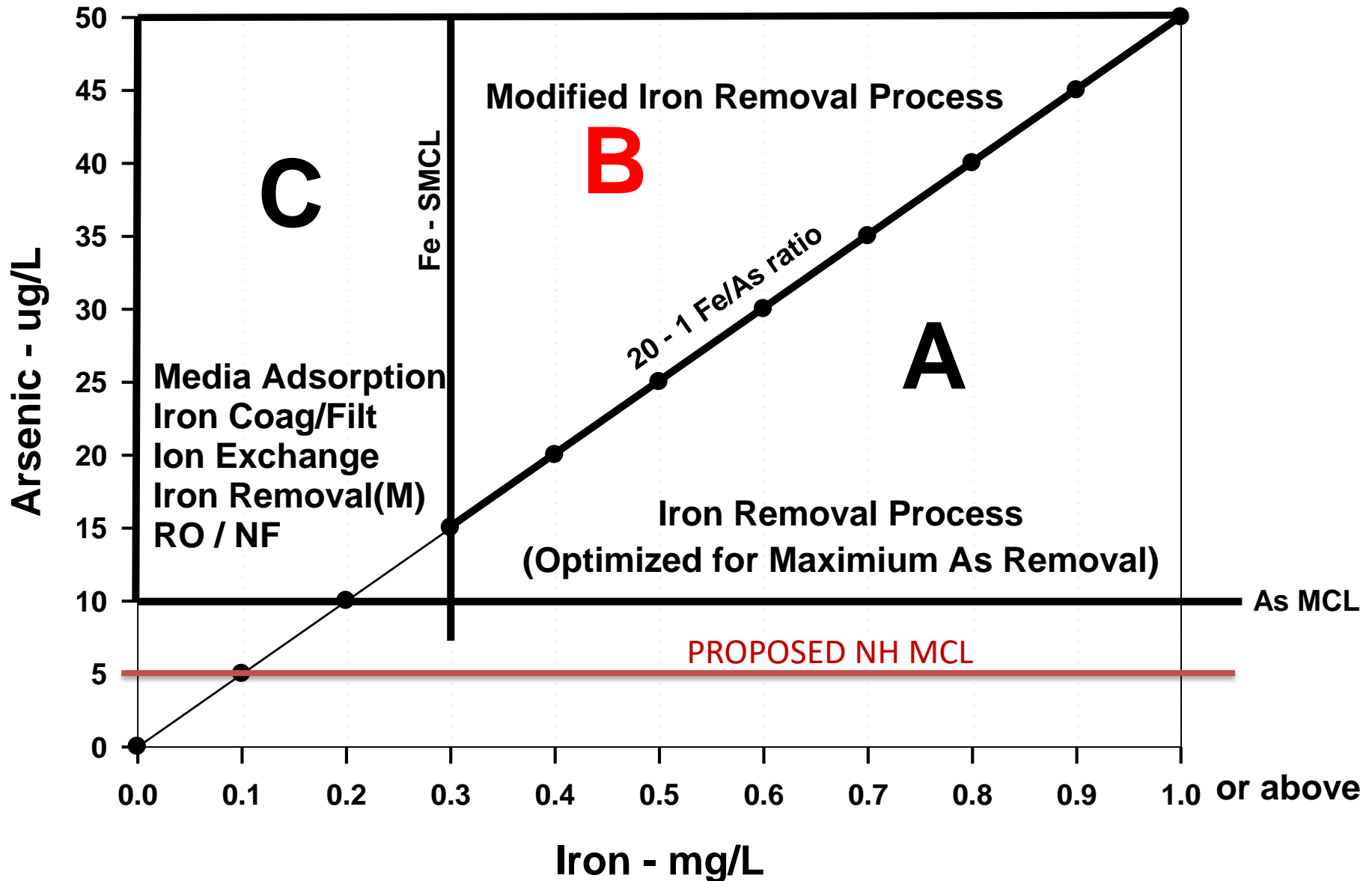
Mortality at first year of residence



Arsenic Treatment Options

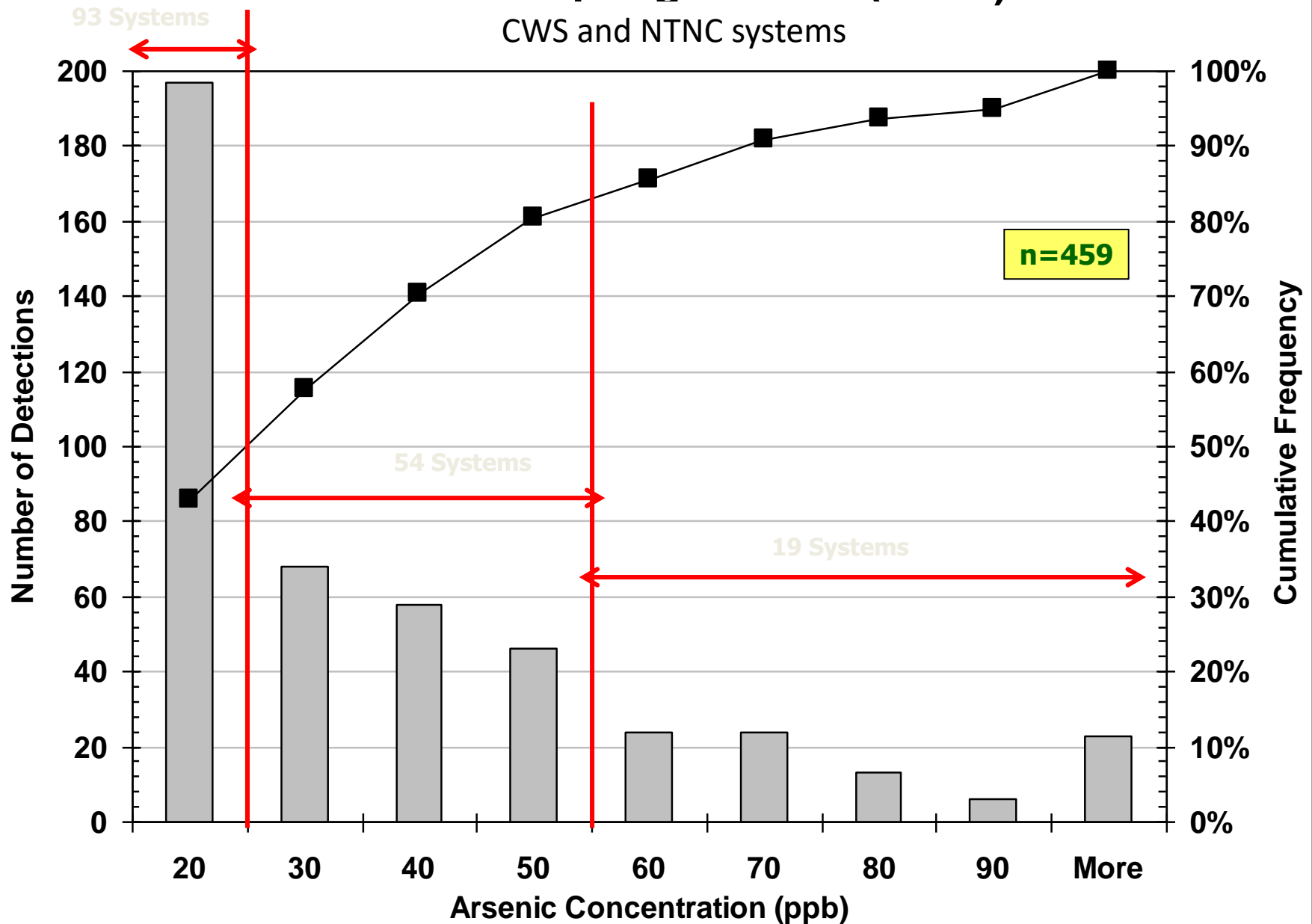


Arsenic Treatment - Process Selection Guide

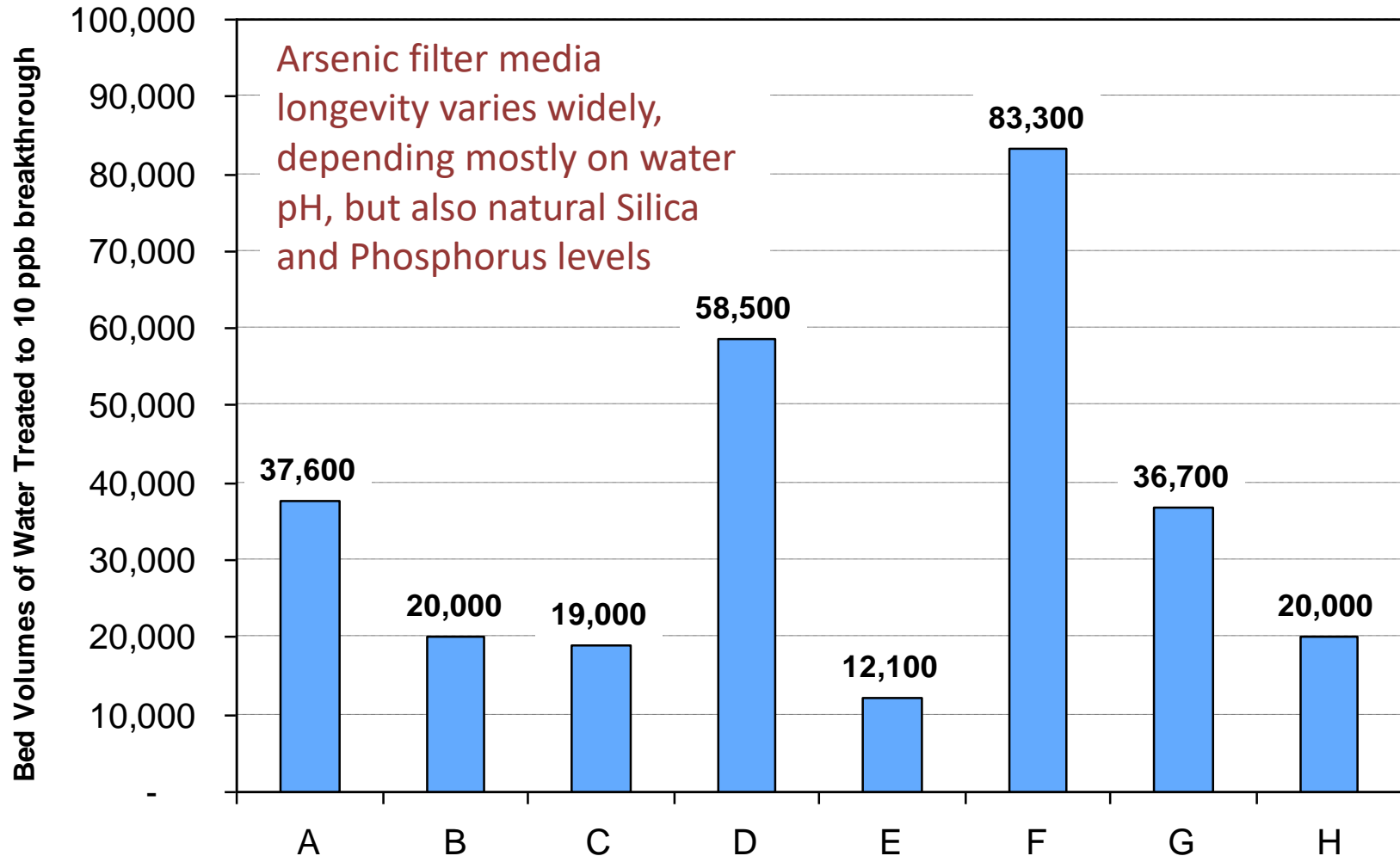


Arsenic Sampling Results (00-05)

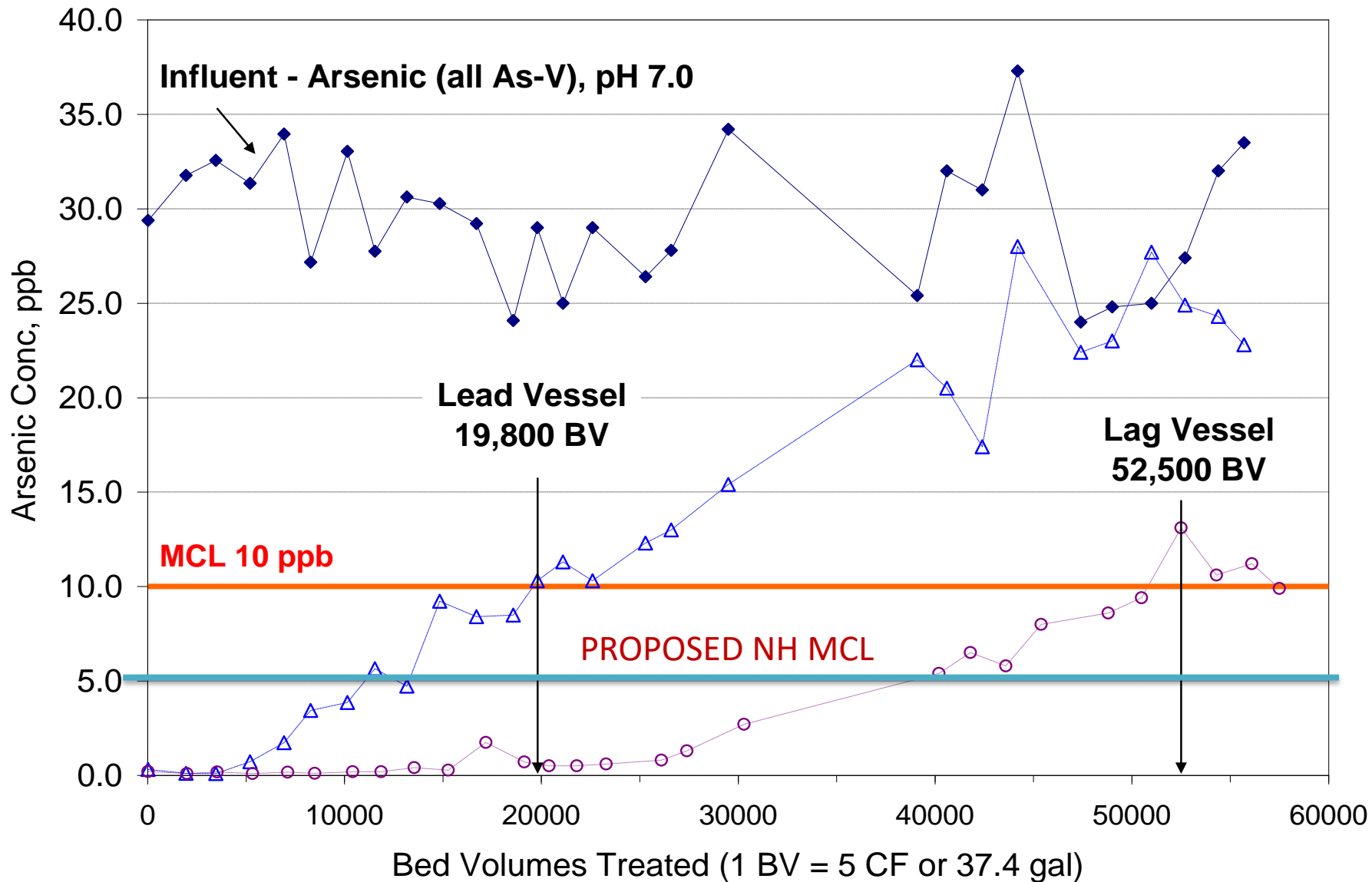
CWS and NTNC systems



Adsorptive Media Bedlife Performance



Arsenic Breakthrough Curve - Goffstown



Treatment Cost Estimates to Meet 5 ppb As MCL

- Existing **Iron-Arsenic** systems – no changes
- Existing **Ion Exchange** systems – no changes
- Existing **Adsorption** systems
 - Assumed 2x filter media changeout vs. current.



- NEW treatment systems for 5 ppb to 10 ppb, assumed \$1,000 per gpm up to ~30 gpm flow, regardless of treatment technology.

COST ESTIMATES

Facility Type	Number of Sites	Total Capital Cost (\$ M)	Total <u>Additional</u> Annual Cost (\$ M)
Public water systems	195+123= approx. 310 (a few currently treating would add treatment)	0.95	3.88
Sewage lagoons and other facilities with groundwater discharge permits	40	2.2	0.5
Landfills	46	0.46 - 0.76 (0.61 +/- 25%)	0.19 - 0.32 (.25 +/- 25%)
Total of Costs Estimated		3.76	4.63

The Economic Benefits of Lowering the Arsenic Maximum Contaminant Level in New Hampshire Municipal Water Supplies

December 10, 2018

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UNH STUDY OF BENEFITS

- Literature review
- VSL based on survey of willingness to pay
 - Difference 10 ppb to 3 ppb
 - VSL: \$5 million
 - Applied to cancer & CVD
- 5.5-point reduction in IQ – impact on lifetime earnings

Risk Level		Risk Type	Prevalence (per 10,000)
High		Heart disease by age 70	4,000
		Skin cancer by age 70	2000
Medium		Automobile accident over 20 years (fatal)	280
		Death from opioid overdose over lifetime	91
		Risk of lung or bladder cancer from drinking water with 10 ppb arsenic on a regular basis for 70 years	67
		Audited by the IRS per year	63
		Victim of cybercrime per year	50
		Death from gun assault over lifetime	35
		Risk of death from lung or bladder cancer from drinking water 10 ppb arsenic on a regular basis for 70 years	34
		Risk of lung or bladder cancer from drinking water with 3 ppb arsenic on a regular basis for 70 years	20
		Death from fire in home over lifetime	18
		Risk of death from lung or bladder cancer from drinking water 3 ppb arsenic on a regular basis for 70 years	10
Low		Death from bicycling accident over lifetime	2
		Risk of cancer from bromate at current drinking water standard of 10 ppb over 70 years	2
		Risk of cancer from vinyl chloride at current drinking water standards of 2 ppb over 70 years	1
		Struck by lightning over lifetime	0.08
		Death from a plane crash over lifetime	0.05

Summary of benefits

Table 6. Estimated Bladder and Lung Cancer Deaths Due to Arsenic Exposure for Lung and Bladder Cancer over a 70-Year Period from New Hampshire Public Water Systems Based on Recent Arsenic Testing Results (2014-2017) and Assuming Specified Maximum Contaminant Levels

MCL (µg/L)	Total Cancer Cases from Table 4	Total Deaths		Cancer deaths avoided by lowering MCL	
		Lung	Bladder	Lung	Bladder
10	33-101	19-37	1-9	-	-
5	27-82	16-30	1-8	3-7	0-1

Table 7. **Annual** willingness to pay (**\$ Million**) for reduced risk of lung and bladder cancer associated with lowering the arsenic MCL

MCL	Lung Cancer Deaths		Bladder Cancer Deaths		TOTAL	
	Low	High	Low	High	Low	High
5	0.216	0.504	0	0.072	0.216	0.576

Reduced IQ (lifetime earnings loss of \$150 – 200 million) **\$2-3 million per year** (section 5.3)

CVD (not in our report but around 50/year, so \$250 million/year)

Lung per D'Ippoliti (7/year or \$35 million/year)

Not quantified:

Cardiovascular disease

Adverse birth outcomes

Infections in infants

Gestational diabetes

NHDES

RATIONALE

- Exposure to levels below 10 ppb increases risk of many diseases
- Possible to estimate magnitude of risk reduction for lung, bladder, skin cancer
- Convincing data on other diseases, etc. but not for quantitative estimates: adverse birth outcomes, infant illnesses, CVD deaths
- Potential for cognitive effects must be considered
- Water treatment feasible down to 5 ppb

CONCLUSIONS

- 5 ppb is the right number
- Costs would be substantial
- Tangible and intangible benefits warrant the added cost
- Costs & benefits of 5 ppb could be addressed with greatest confidence

**Review of the Drinking Water Maximum
Contaminant Level (MCL)**

and

Ambient Groundwater Quality Standard (AGQS)

for Arsenic

