
Arsenic Risk Management in Atlantic Canada

Issues and Solutions

presented to

Contaminated Properties Conference 2003

by

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Presentation Outline

- Background
- Begin with the end in mind
- Apply Sound Science
- See the forest and the trees
- Manage appropriately

Background

- Background levels of arsenic are high compared to risk based clean up objectives

CCME Guideline = $\left[\frac{RsD \times BW}{AF \times IR} \right] + BSC$

Risk based component = 10% of guideline
2 ppm

Background soil concentration = 90% of guideline
10 ppm

2 ppm + 10 ppm = 12 ppm

The diagram illustrates the CCME Guideline formula: $CCME\ Guideline = \left[\frac{RsD \times BW}{AF \times IR} \right] + BSC$. The fraction $\left[\frac{RsD \times BW}{AF \times IR} \right]$ is circled in red and labeled as the 'Risk based component = 10% of guideline', which corresponds to 2 ppm. The 'BSC' (Background Soil Concentration) is also circled in red and labeled as 'Background soil concentration = 90% of guideline', which corresponds to 10 ppm. A yellow arrow points from the risk-based component box to the fraction in the formula, and another yellow arrow points from the BSC box to the BSC term in the formula. Below the boxes, the calculation 2 ppm + 10 ppm = 12 ppm is shown.

Begin With the End in Mind

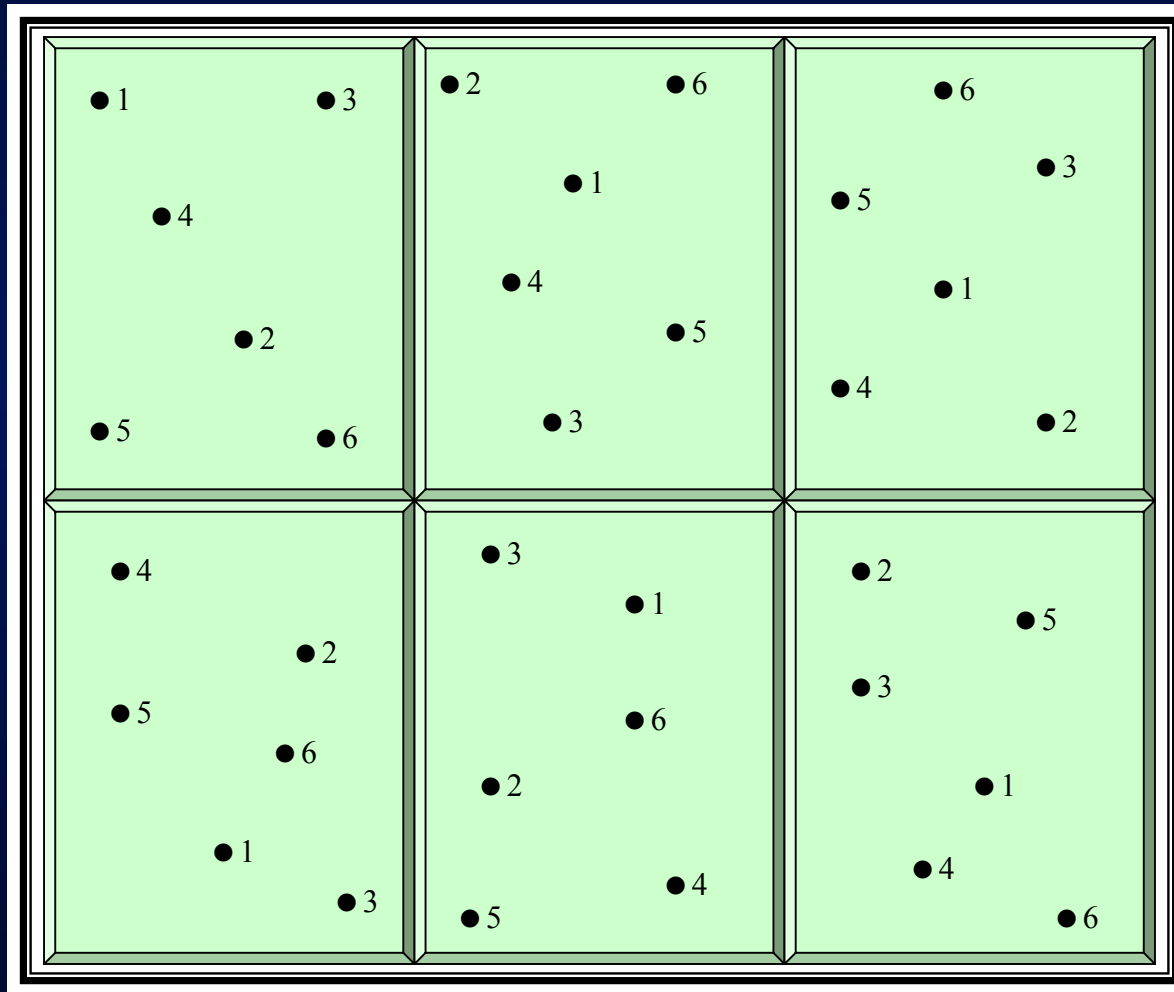


- Case Study 1
 - ❖ former industrial property in downtown development area
 - ❖ initial Phase II ESA, targeted at hydrocarbons included limited grab samples for metals
 - ❖ arsenic soil results high (>CCME)
 - ❖ implication that all fill on site impacted
 - ❖ potential remedial cost (excavation and off-site disposal) of >\$1,000,000
 - ❖ re-development proposal in question

Exposure Area Sampling Program

- US EPA soil screening guidance (1996) successfully adopted by Canada Lands at the Moncton Shops
- Divide site into exposure areas (EAs)
 - ❖ EA has random contaminant distribution and random occupancy
 - » residential development - EA could be the lot size
 - » recreational development - EA could be the field size
- Intensive sampling program to characterize the EA, with a focused lab program
- Manage the distribution, not the “hot spots”

Exposure Area Sampling Program (US EPA Soil Screening Guidance, 1996)



Case Study Conclusions

- All results met the statistical objectives of the sampling protocol
- No further risk management recommended
- No remedial costs
- Development proposal proceeded

Key Considerations

- Base the sampling program on the future development proposal
- Manage the distribution not the maximum
- Use statistics
 - ❖ US EPA Max Test
 - ❖ Upper 95% confidence limits

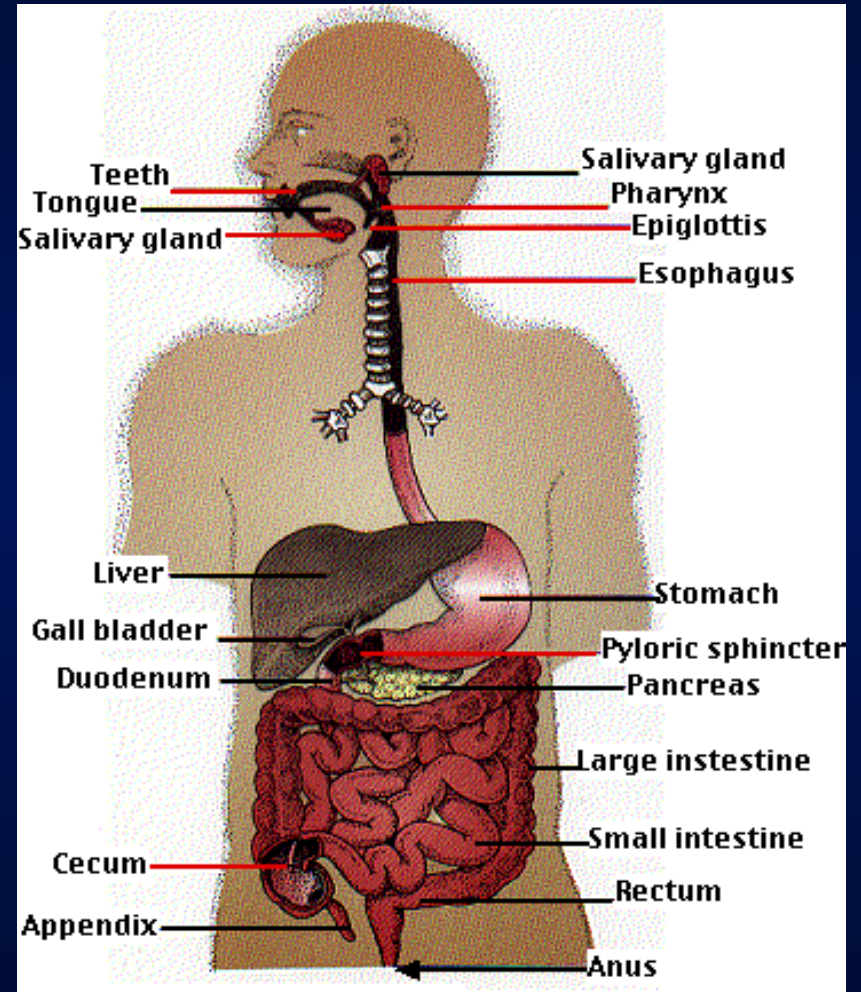
Apply Sound Science

- Applicability of the Atlantic RBCA toolkit for metals:
 - ❖ current limitations:
 - » indoor vs outdoor soil / dust exposure
 - » life-time age adjustment
 - » background soil concentration
 - » oral bioavailability
- At this time, CCME protocols more developed for metals

Bioavailability

Bioavailability: Oral
bioavailability is defined as the fraction of an administered dose that reaches the central (blood) compartment from the gastrointestinal tract.

Bioaccessibility: The oral
bioaccessibility of a substance is the fraction that is soluble in the gastrointestinal environment and is available for adsorption.



Gastric Fluid Extraction



Soil Sample



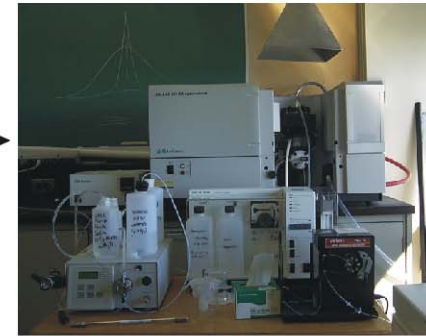
Gastric Conditions

pH 1.8 (HCl)
pepsin,
sodium citrate,
malic acid,
glacial acetic acid



Intestinal Conditions

pH 7.0 (using Na_2CO_3)
bile extract
pancreatin



Analysis

HPLC-HG-AAS

A Case Study: Arsenic in Yellowknife



Bioaccessibility

Sample Category	Arsenic (ppm)	GFE Arsenic (ppm)	% Bioaccessible
Rock	3170 ± 5220	110 ± 127	5.0 ± 3.6
Tailings	4570 ± 4420	116 ± 112	2.9 ± 1.7
Mine Organic	850 ± 1020	164 ± 211	20 ± 11
Residential	142 ± 128	72 ± 112	31 ± 28

Implications of Arsenic Bioaccessibility on Risk Assessment

$$\text{Hazard Quotient} = \frac{\text{chronic daily intake (CDI)}}{\text{oral reference dose (RfD)}}$$

where RfD = 0.3 ug/kg-d

If HQ>1 then there is a potential risk to human health

Soil Type	Total Arsenic (ppm)	% Bioaccessible Arsenic	Traditional Hazard Quotient	Bioaccessible Hazard Quotient
Rock	3180	5.0	1.8	0.088
Tailings	4580	2.9	2.5	0.73
Mine Organic	850	20	0.47	0.094
Residential	142	31	0.078	0.024

Bioaccessibility - Summary

- Incorporation of bioaccessibility/bioavailability into risk assessment models allows for a better indication of actual risk posed to the organism.
- Determination of total arsenic concentrations may not be a sufficient level of information for conducting human health and ecological risk assessment and may significantly overstate the risk.

See the Forest and the Trees

- Regional conditions
- National exposures

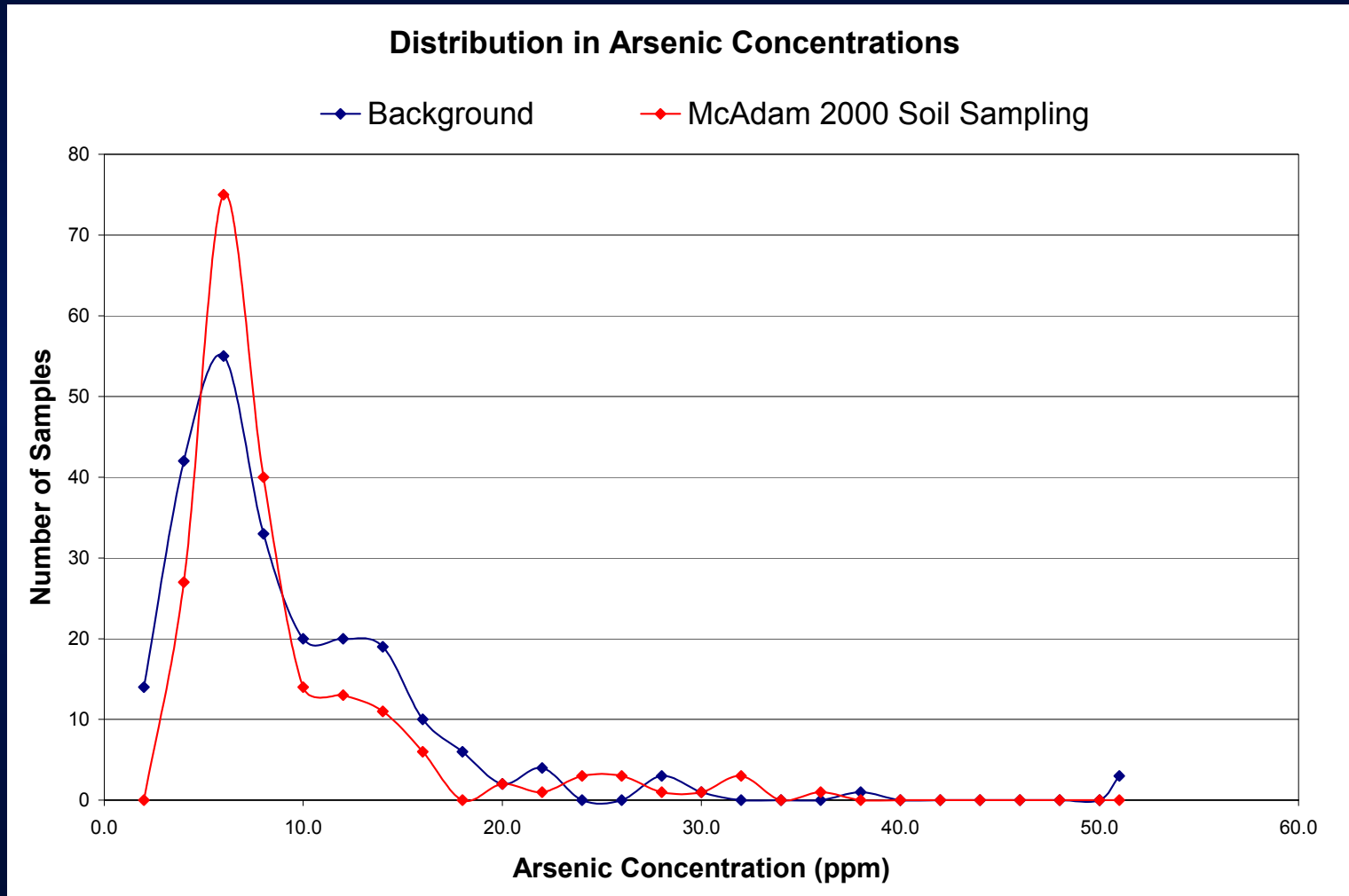


Village of McAdam, New Brunswick

- Residential properties in various areas of the village possibly impacted by metals
- Detailed soil, dust, water, and paint sampling program undertaken
- Arsenic concentrations in McAdam found to vary between <1 ppm up to 55 ppm.

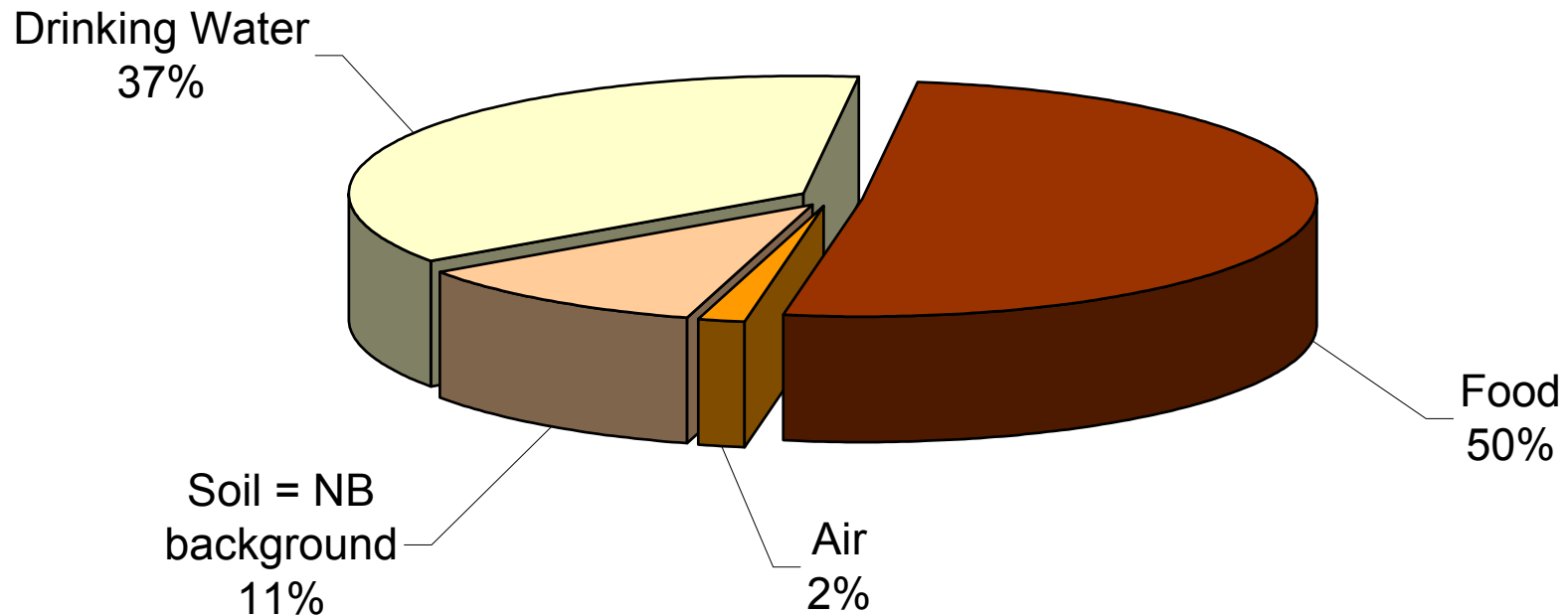
CCME guideline = 12 ppm

Village of McAdam, New Brunswick



National Exposures

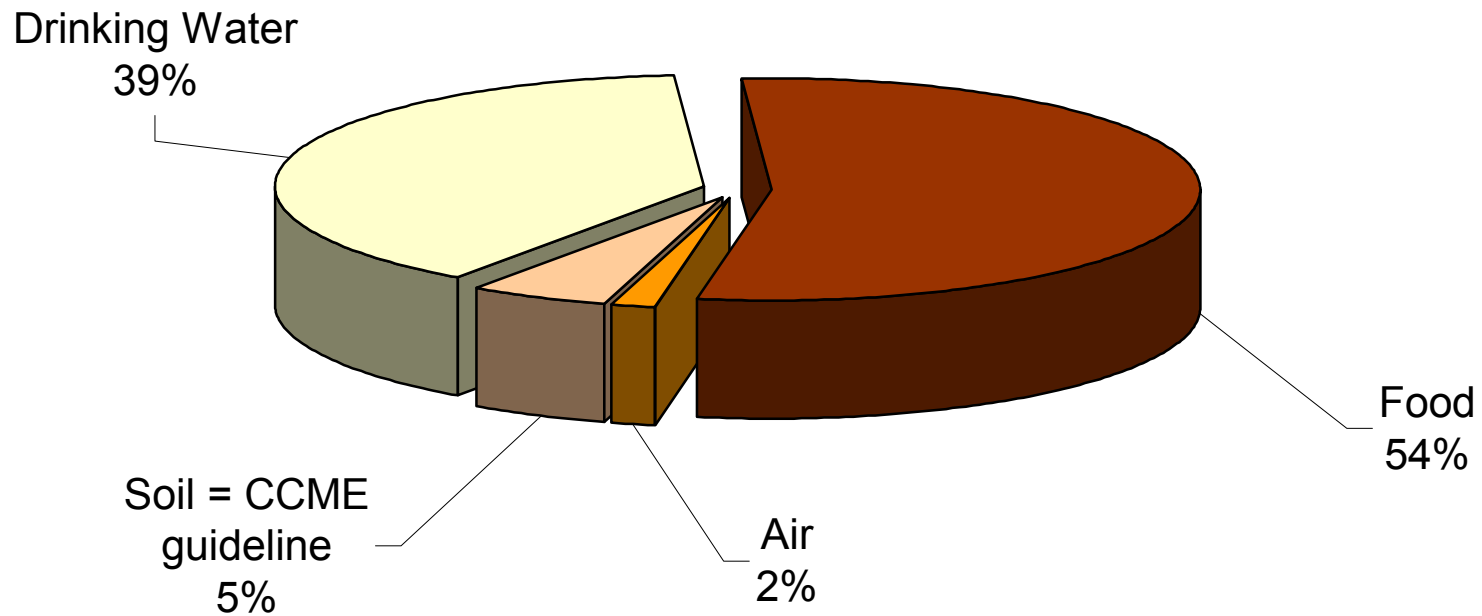
Relative Contribution to Lifetime Cancer Risk from Arsenic Exposures



Cumulative Risk from Arsenic Exposure = 3.2×10^{-4}

National Exposures

Relative Contribution to Lifetime Cancer Risk from Arsenic Exposures



Cumulative Risk from Arsenic Exposure = 3.0×10^{-4}

Manage Appropriately

- 2 Case Studies
 - ❖ CN Shops, Moncton
 - ❖ Village of McAdam

CN Shops, Moncton

- Low level metals impacts
- Arsenic > CCME guidelines
 - ❖ possibly associated with rail ballast
- Sampling programs followed US EPA protocols with Exposure Areas based on future development
- Optimized re-use of materials on-site

CN Shops, Moncton

Soil management cells engineered to contain impacted soil and wood waste



Village of McAdam

- Arsenic results not statistically distinguishable from natural background distribution.
- Management strategy focused on simple residential landscaping recommendations and community education/communication



Lead-Safe Yards

Developing and Implementing a Monitoring, Assessment, and Outreach Program for Your Community



Village of McAdam



Mulch beds around the house



Stone walkways



Lattice barricades

Summary

- **Begin with the end in mind.** Understand the future development proposal and plan the environmental characterization and risk management accordingly.
- **Apply Sound Science.** Good science will underpin successful communication and should be conducted with the future development and potential risk management solutions in mind.
- **See the Forest and the Trees.** Regional and national issues are as important if not more important than site-specific issues.
- **Manage Appropriately.** Arsenic risk management must have a sound appreciation of cost/benefit in terms of risk reduction achieved. Soil removal and replacement is rarely an effective solution.



CHEERS!