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Phytofiltration of Arsenic from Drinking Water

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As-Accumulating Brake Fern, *Pteris vittata*

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edenfern **Patent, License, and Use**

- **Following its discovery and initial characterization, the University of Florida filed U.S. and international patents**
- **Exclusive license granted to Edenspace for phytoremediation purposes**
- **Marketed for phytoremediation of arsenic under the trade name 'edenfern™'**
- **Field demonstrations have demonstrated the effectiveness of this fern to lower soil As concentrations.**

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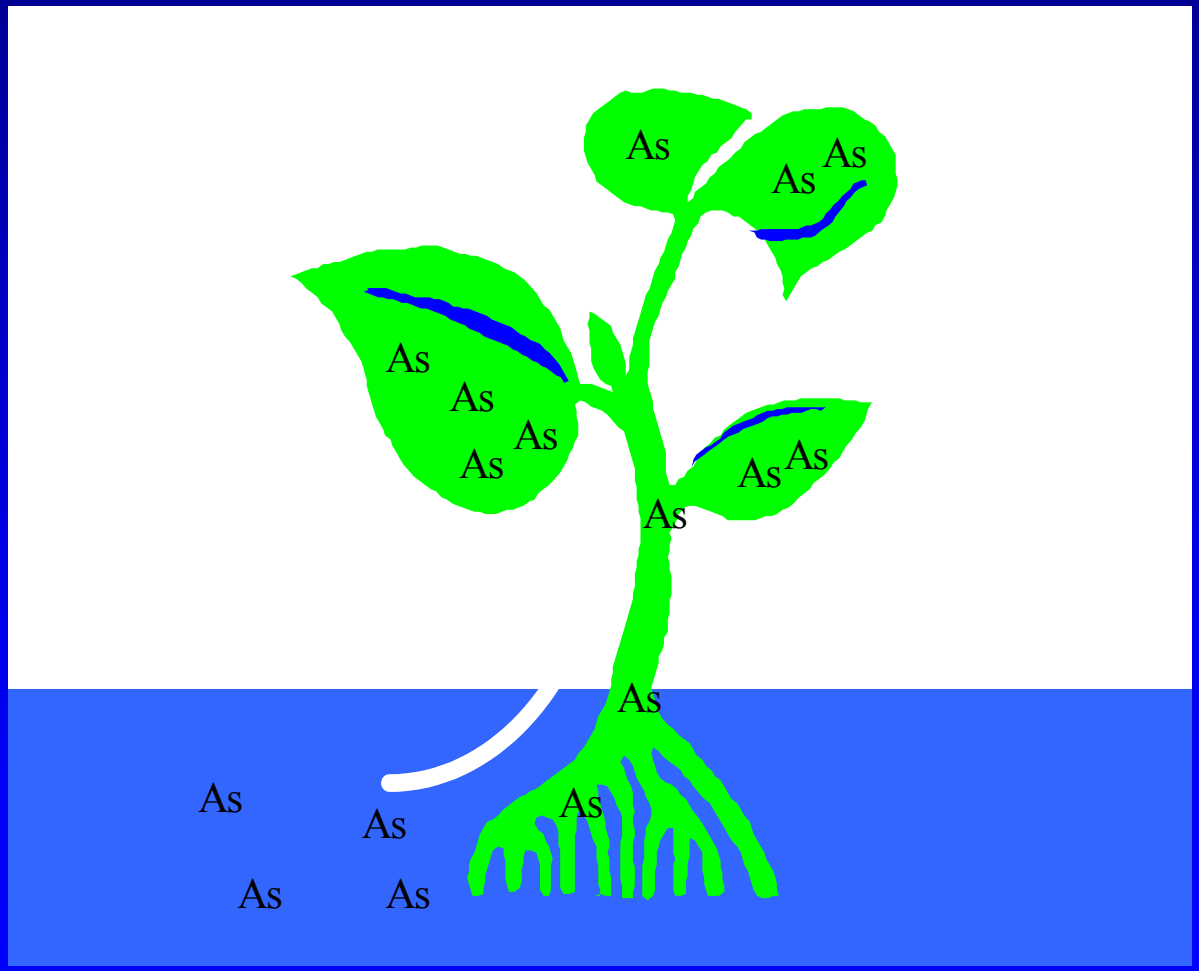
Phytofiltration of As Using the edenfern

- Could the edenfern™ be used to remove arsenic from drinking water?
- NIH funded research to investigate potential treatment methods for arsenic contaminated drinking water.
- Arsenic taken up by roots, transported to and stored in shoots.



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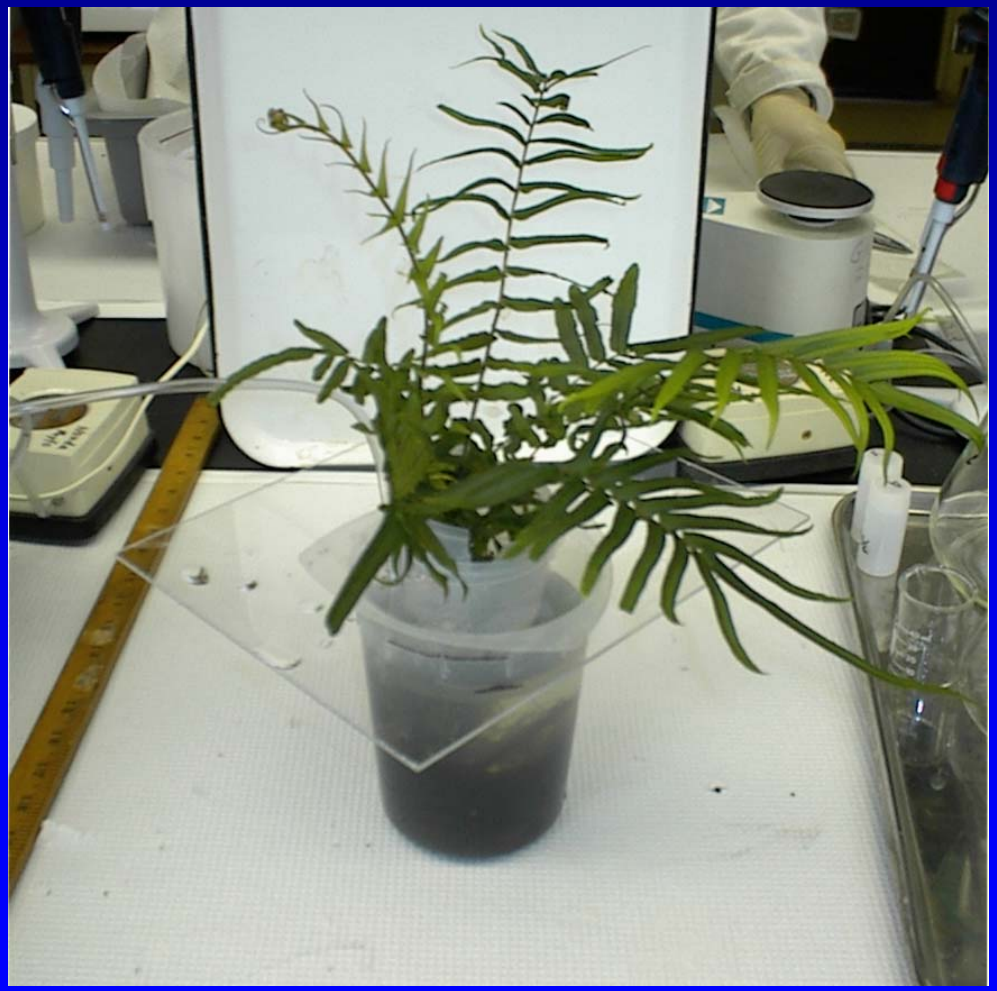
Bench Scale Study



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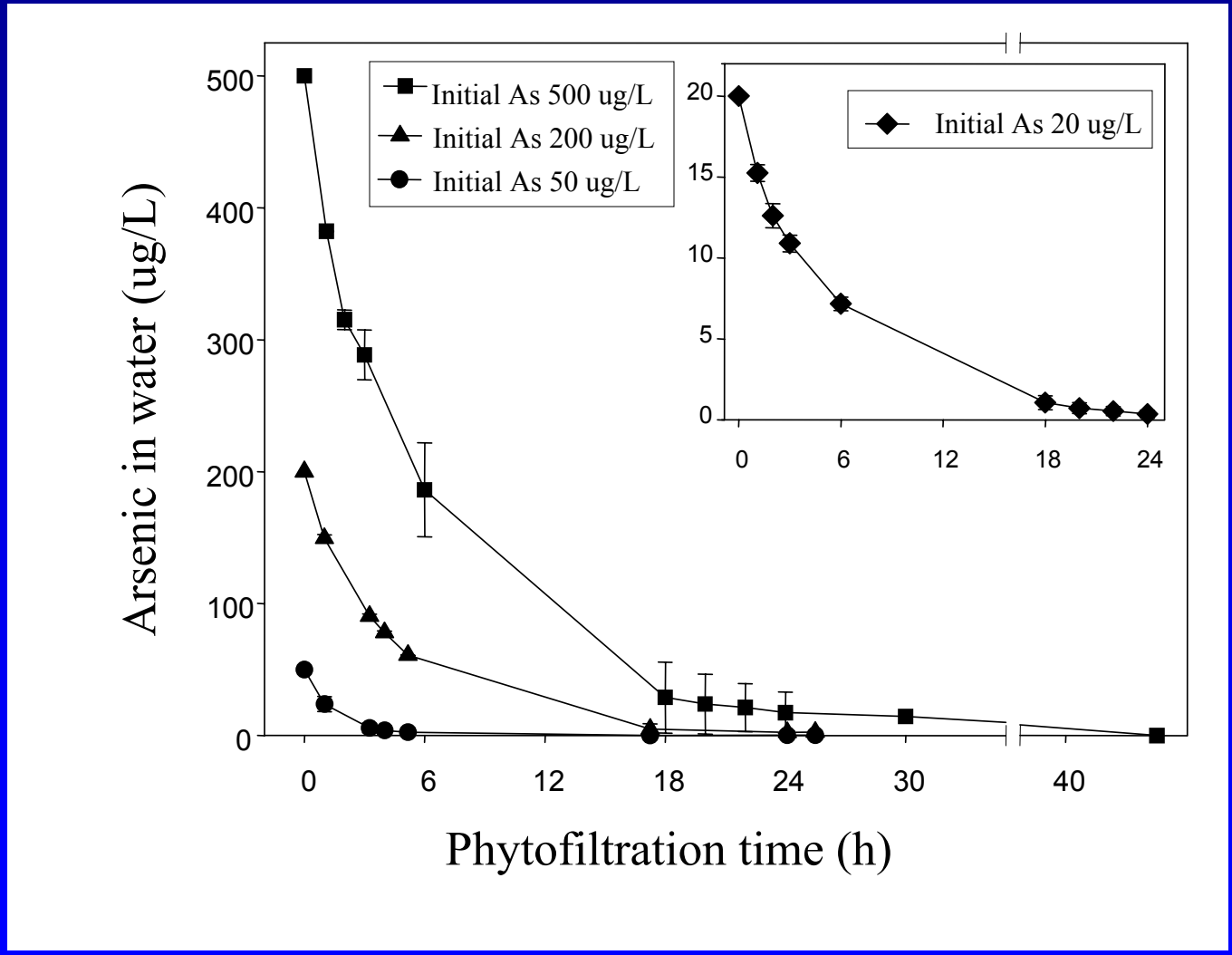
Effect of Initial [As] on Phytofiltration Performance



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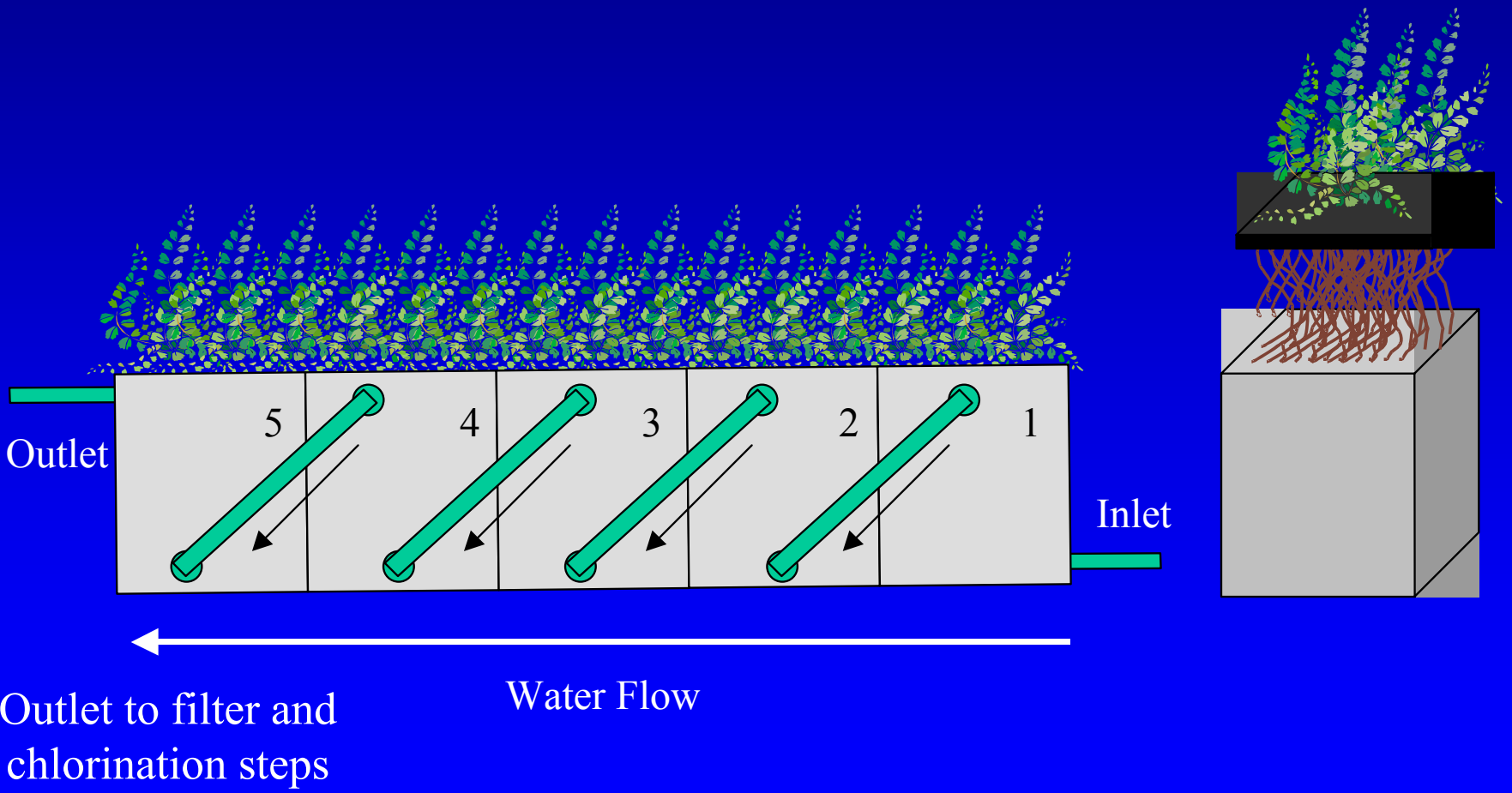
Design of Phytofiltration Unit



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Phytofiltration Nursery System

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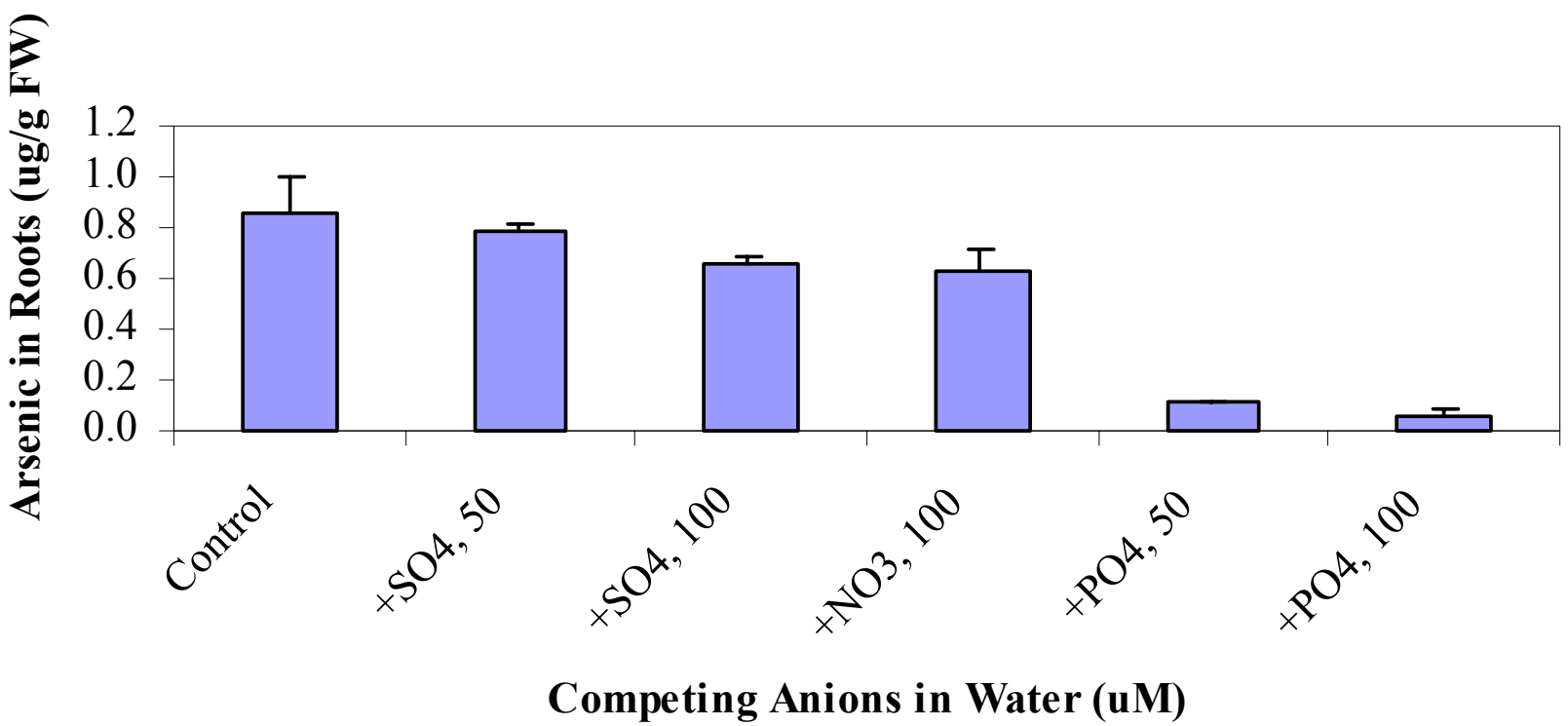
Effect of Water Chemistry on Arsenic Uptake in Roots



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Power and Site Requirements

- Greenhouse is lowest cost model
- Temperature requirements - may need heating / air conditioning
- Lighting requirements - may need additional lights
- Water flow may be pumped or gravity-fed
- May need aeration pumps.

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Residuals & Waste

- Arsenic is accumulated in the fern shoots, not the roots
- Two strategies for operating system:
  - Harvest shoots before they become hazardous
  - Use plants for maximum time then dispose
- Possibility of recovering arsenic from fern shoot material to recycle and re-use in industrial processes
- Minimal waste water generated

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Target Population for Phytofiltration Technology

- Small distributed systems
- Traditional treatments are generally not cost-effective for small drinking water systems
- Modular system can easily be scaled to meet requirements of community

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Pilot Systems

- Northern Virginia - arsenic
- Albuquerque, New Mexico - arsenic
- Ashtabula, Ohio - uranium
  - successfully cleaned water with fluctuating inflow concentration to below regulatory levels over 8 week period.

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Cost comparison of activated alumina to phytofiltration for removal of arsenic from drinking water

Cost Parameter	Activated Alumina	Phytofiltration
Capital Cost	$92,700	$119,500
O & M Costs	$34,300	$15,334
Waste Disposal	$1,200	($0?)

All costs assume a design flow of 160,000 GPD
Approximately $0.26 per 1,000 G

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Summary

- **The edenfern shows promise as a means to address arsenic contamination in waters with the following advantages:**
  - Minimal effect of sulfate or other constituents of water on phytofiltration performance.
  - Hazardous waste can be minimized.
  - Potential to recycle recovered arsenic
  - No harsh chemicals or pre-treatment required.
  - Low level of operator training required.
  - Modular design - scale up as needed.
- Other preliminary results
  - Promising results with arsenite as well as with arsenate, reducing the need for an oxidizing pretreatment.
  - Operates well over wide pH (4-10), thereby reducing the need for pH adjustments.

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Acknowledgements

- **Funding**
  - **NIH SBIR Phase I Grant (1 R43 ES11065-01) and Phase II Grant (2 R44 ES11065-02) entitled "Phytofiltration of Arsenic-Contaminated Drinking Water"**
- **Personnel**
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