WCWC Walkerton Clean Water Centre
An agency of the Government of Ontario

CWAE Centre de Walkerton pour l'assainissement de l'eau
Un organisme du gouvernement de l'Ontario

A case study to find an option to reduce arsenic

Devendra Borikar, Lindsay Ariss, Laura Zettler, Greg Bak, Curtis Parker, Souleymane Ndiongue

May 8, 2019
OWWA Annual Conference & OWWEA Trade Show
Ottawa, Ontario

Outline of Presentation

- Introduction
- Objectives
- Set-up & Experimental Conditions
- Results
- Conclusions

Introduction

- Arsenic (As) is classified as a human carcinogen
  (Health Canada, 2006)
- As of January 2018, the MECP lowered the maximum acceptable concentration (MAC) of As in treated water from 25 µg/L to 10 µg/L
- Any drinking water systems with As levels between 10-25 µg/L need to upgrade
- This case study presents a system serving a population < 10,000
- As levels were 11-11.5 µg/L in the groundwater
- Current treatment includes disinfection and sequestering with CalciQuest to keep iron in its dissolved form

Treatment technologies for As reduction

- Adsorptive processes
  - oxidation followed by adsorption on alumina/iron based adsorbents
- Precipitative and membrane processes
  - oxidation (chlorination) + microfiltration
- Ion exchange processes
  - Uses anionic resins in chloride form, regenerated with salt
  - exchanges all negative ions with chloride ions

Objectives

- The overall objective:

  - To reduce As in the treated water, using a practical solution based on the existing system

- Specific objectives:

  - To reduce As in the treated water to ≤5 µg/L using:

    - Chlorine oxidation followed by adsorptive media
    - Chlorine oxidation followed by cartridge microfiltration

  - To reduce iron in the treated water as low as possible for aesthetic purposes

Set-up & Experimental Conditions

Bench Scale Tests

Jar Test 1

Objectives:

- **To determine the optimum dose of chlorine for As oxidation**
- **To assess filterability of As**

Location: WCWC

Jar Test 2

Objectives:

- **To determine the optimum dose of chlorine for As oxidation**
- **To assess filterability of As**

Location: Well

Jar Test 3

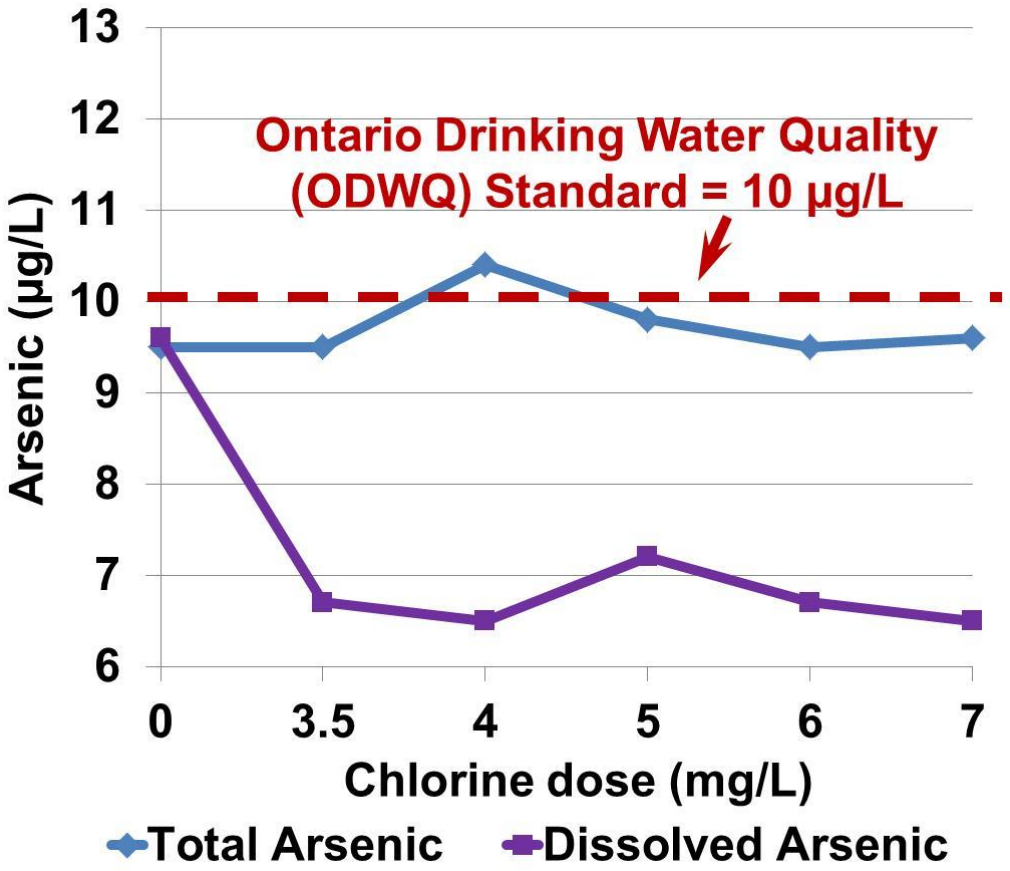
Objectives:

- **To determine if ferric chloride is an effective coagulant for the oxidized As particles**
- **To find an optimum dosage**

Location: Well

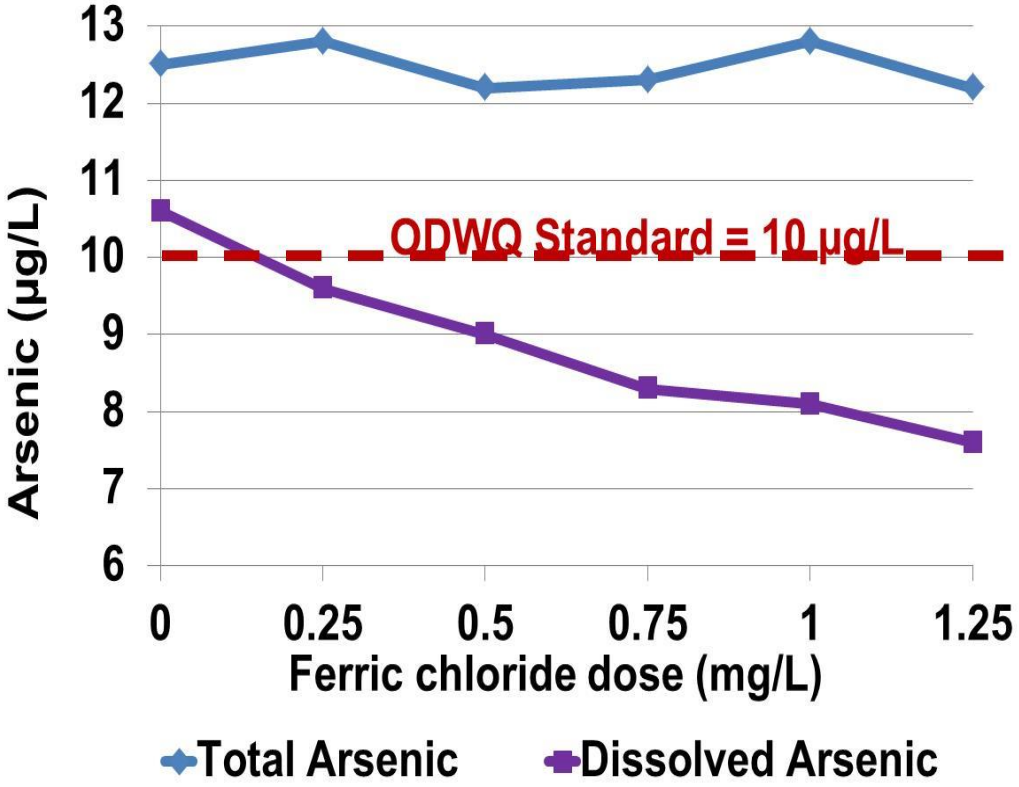
Bench Scale Results

Jar Test 2 : Optimizing chlorine dose



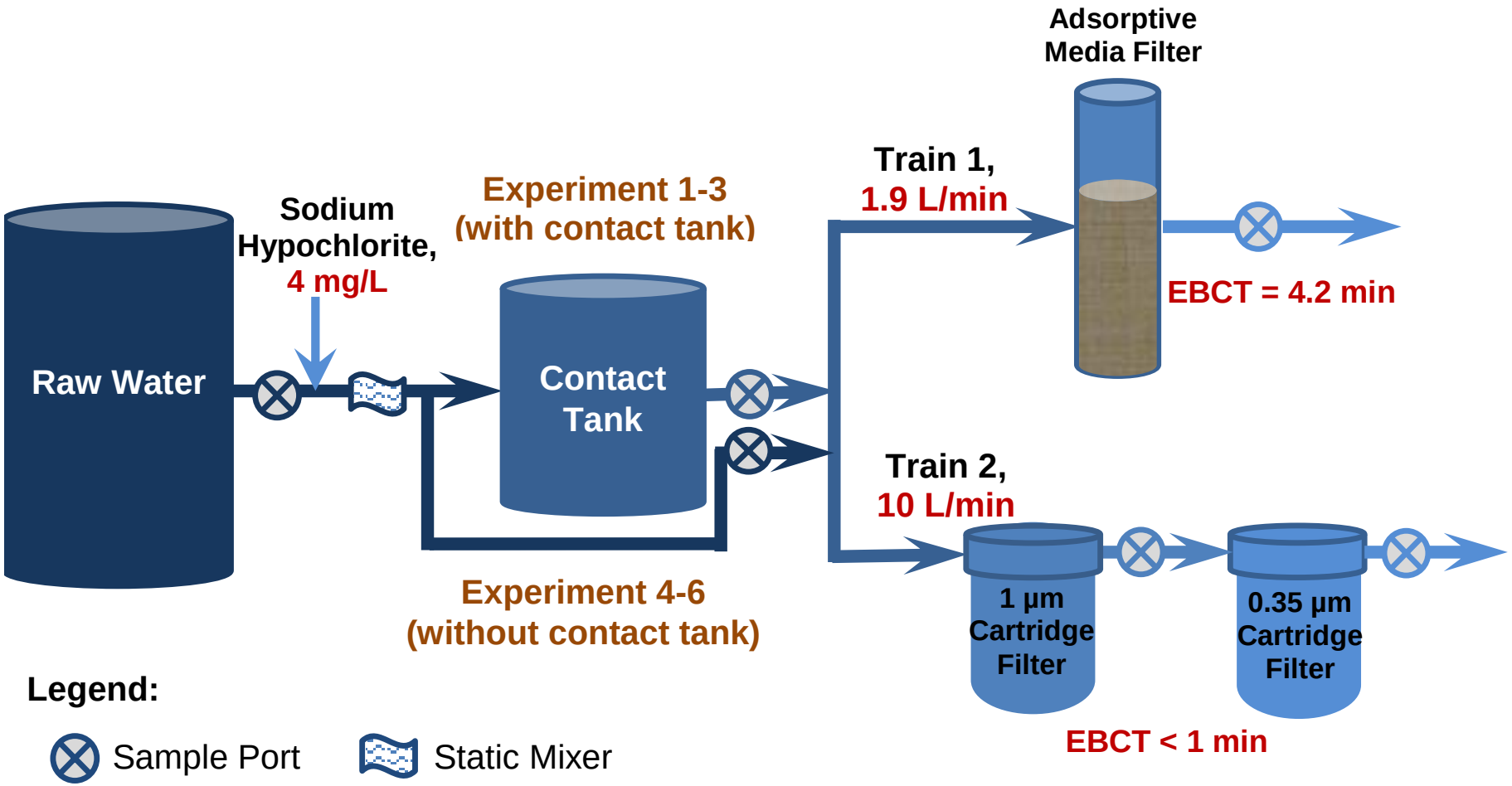
- Lowest **dissolved As level was 6.5 µg/L** @ 4 and 7 mg/L chlorine dosages
- 4 mg/L chlorine dose selected for further testing
- **Iron** was measured at 0.37 mg/L total & 0.34 mg/L dissolved in raw
- In all filtered samples, iron levels **≤ 0.02 mg/L**

Jar Test 3 : Optimizing ferric chloride dose



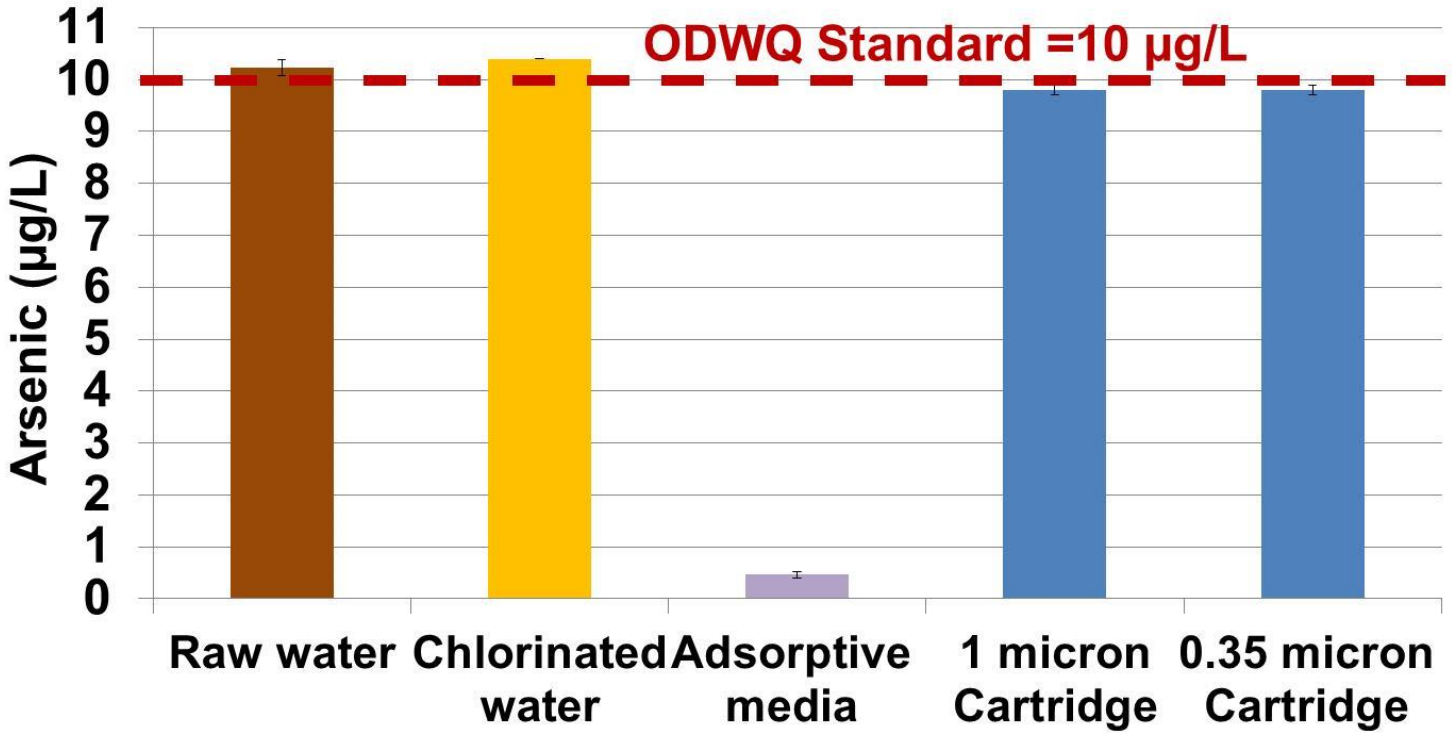
- Addition of 4mg/L ferric chloride following chlorination
- Dissolved As concentration was 10.6 to 7.6 µg/L (up to 28% reduction)
- Total iron in treated water increased from 0.35 to 0.85 mg/L
- In all filtered samples, iron levels ≤ 0.02 mg/L

Pilot Scale Set-up



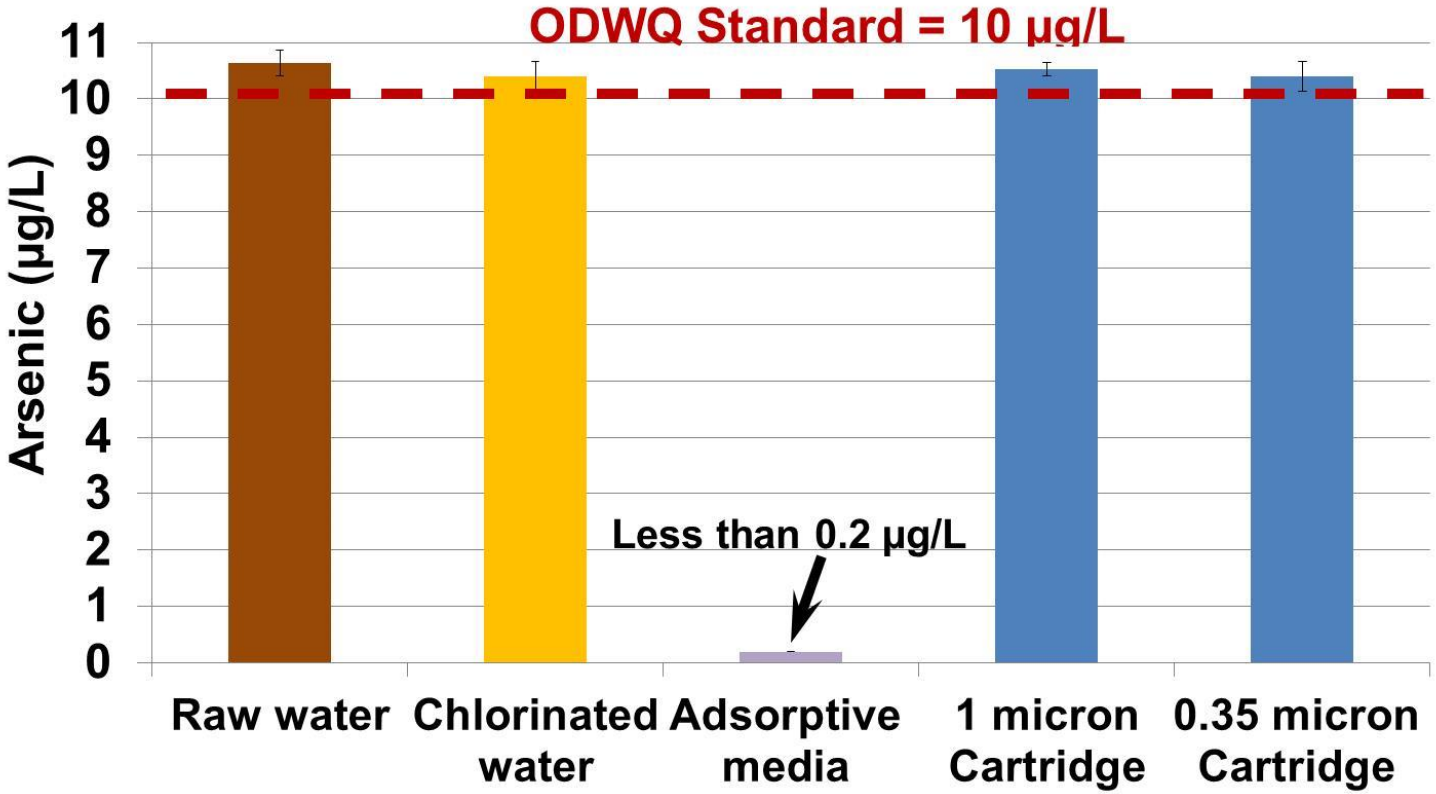
Pilot Scale Results

Experiment 1-3 with chlorine contact tank



- Adsorptive media filter: 0.47 µg/L Total As (95% reduction)
- 1 µm cartridge followed by 0.35 µm cartridge in series: 9.8 µg/L Total As (4% reduction)

Experiment 4-6 without chlorine contact tank



- Adsorptive media filter: ≤ 0.2 µg/L Total As (>98% reduction)
- Cartridge filters in series (1 µm followed by 0.35 µm): 10.4 µg/L Total As (2% reduction)

Iron in treated water

- Raw water was hauled from the well to the Centre to conduct pilot testing
- During transportation and storage the total iron in raw water was reduced from 0.37 mg/L to 0.07 mg/L
- Therefore, the iron reduction capability could not be properly evaluated

Potential Future Work

The following was not evaluated during this project:

- Long term efficacy of the adsorptive media
- Determining the approximate lifespan of the adsorptive media
- Optimizing backwash frequency
- Analyzing As backwash concentrations from the adsorptive media filter and determining an appropriate disposal method

Conclusions – Bench scale testing

- The optimum chlorine dose: 4 mg/L
- Chlorine oxidation reduced As from 9.6 µg/L to 6.5 µg/L (32%).
- Addition of ferric chloride provided an additional 6% reduction of As.
- < 0.02 mg/L of dissolved iron was achieved after filtration.

Conclusions – Pilot scale testing

- Adsorptive media filter provided significant As reduction (≥ 95%).
- Cartridge filters in series (≥ 0.35 µm) were ineffective at removing arsenic (2-4% reduction).
- The addition/omission chlorine contact tank did not provide a significant change in As reduction.

References

1. Ontario Regulation 169/03. Ontario Drinking Water Quality Standards. Available from https://www.ontario.ca/laws/regulation/030169

2. Ontario MOE. Technical support document for Ontario drinking water standards, objectives and guidelines. Ontario Ministry of the Environment, Ontario, 2003. Available from http://www.ontla.on.ca/library/repository/mon/6000/10313601.pdf

Many Thanks