

Perceptions and Risks in Water Monitoring

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Common Drinking Water Health Risks

- 1) Gastrointestinal illness from drinking water
- 2) Metals in drinking water
- 3) Perception of poor drinking water quality
– water “washed” disease





Risk 1: Gastrointestinal Illness from Drinking Water



Gastrointestinal Illness



Diarrhea, nausea, bloating, discomfort that can be caused by waterborne pathogens present in drinking water



Gastrointestinal Illness - Walkerton, Ontario

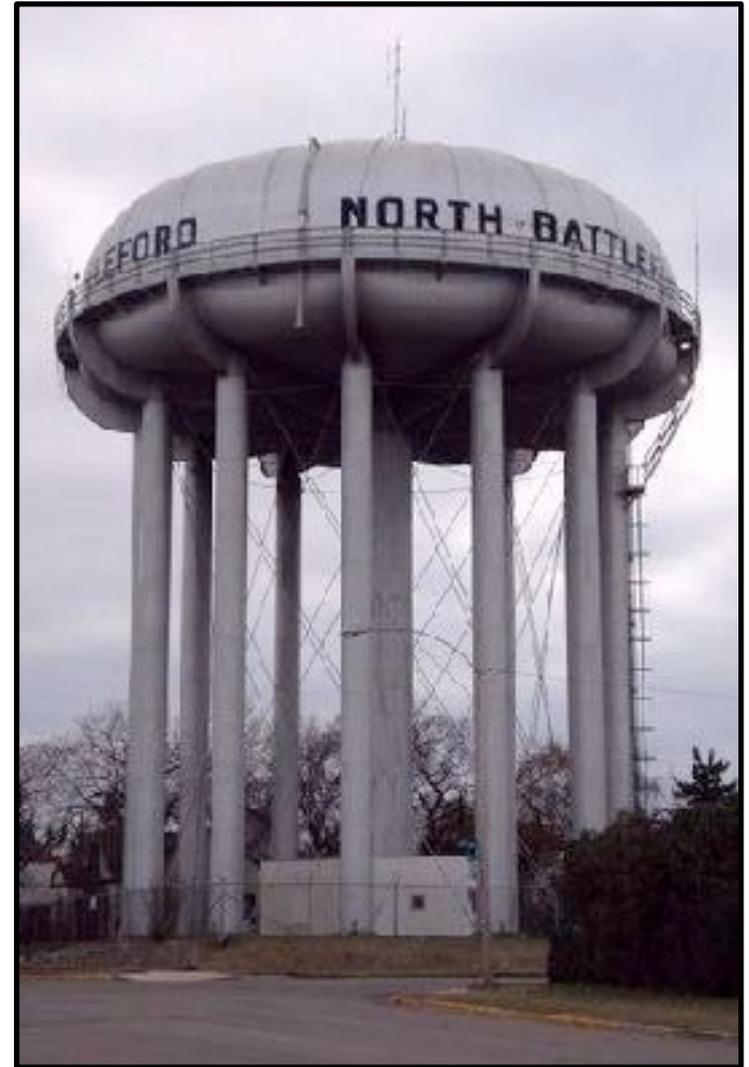
May 2000

- 7 deaths and an estimated 2,300 experienced gastrointestinal illnesses
- Drinking water was contaminated with E. Coli 0157:H7



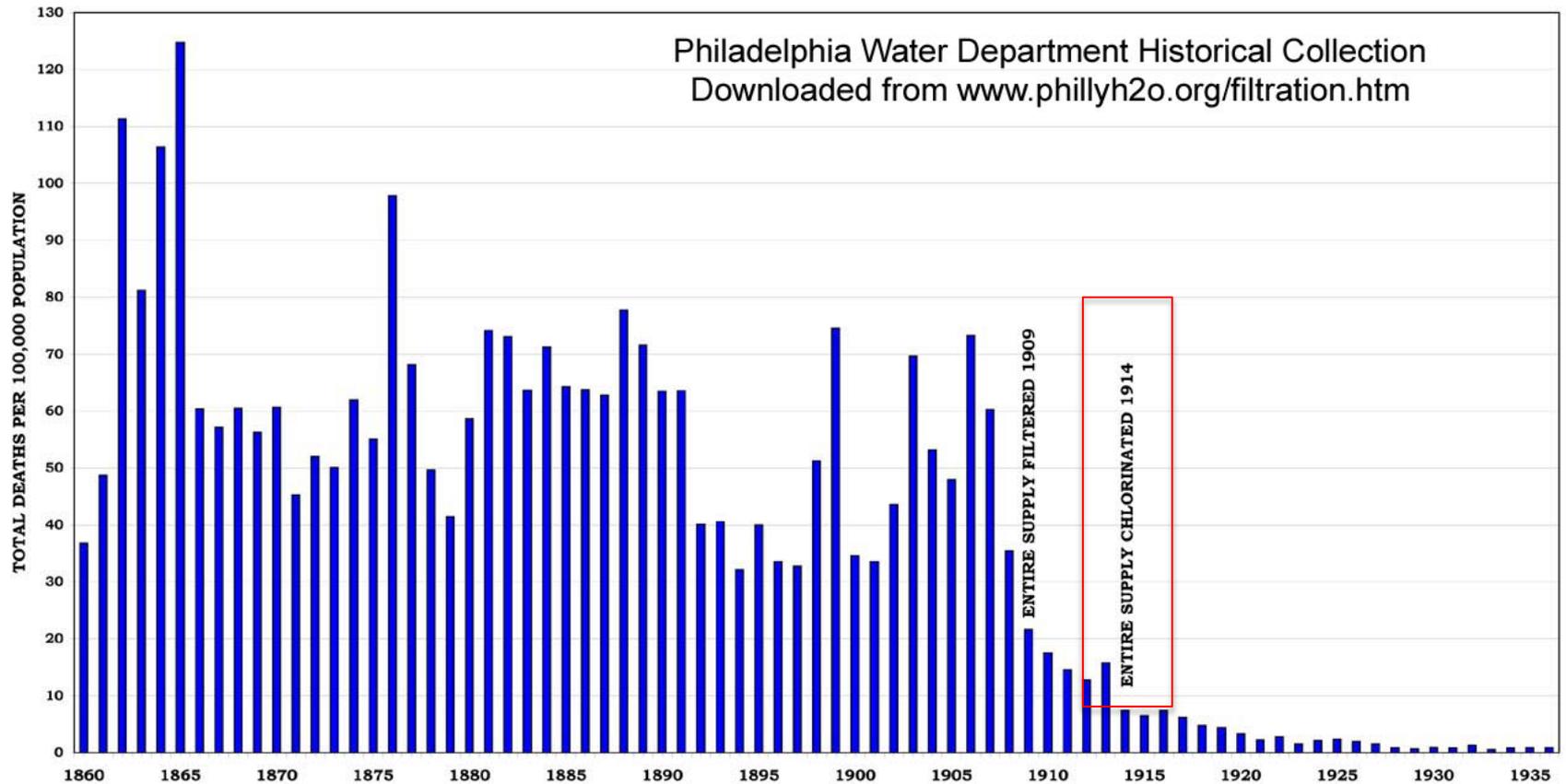
Gastrointestinal Illness - North Battleford, SK

- Only 11 months after Walkerton outbreak
- More than 6000 sick, 60 hospitalized
- Drinking water contaminated with *Cryptosporidium*
- Malfunctioning drinking water plant 3 km downstream of sewage outfall



Importance of disinfection in preventing waterborne illness

Death Rate from Typhoid Fever in Philadelphia 1860-1936





Toronto's "Palace of Purification" 1941

Source: <http://www.panoramio.com/photo/22961731>

Common waterborne pathogens and their significance in water supplies

Bacteria	Health significance	Effectiveness of chlorine disinfection
E. Coli	High	High
Legionella	High	High
Salmonella	High	High
Viruses		
Adenovirus	Moderate	Moderate
Norovirus	High	Moderate
Protozoa		
Cryptosporidium	High	Low
Giardia	High	Low

Removed via filtration

How Important Are Water Operators and Monitors?



2000

Key Pieces of Problem:

Koebel brothers

- failed to add chlorine
- mis-reported information

Outcome:

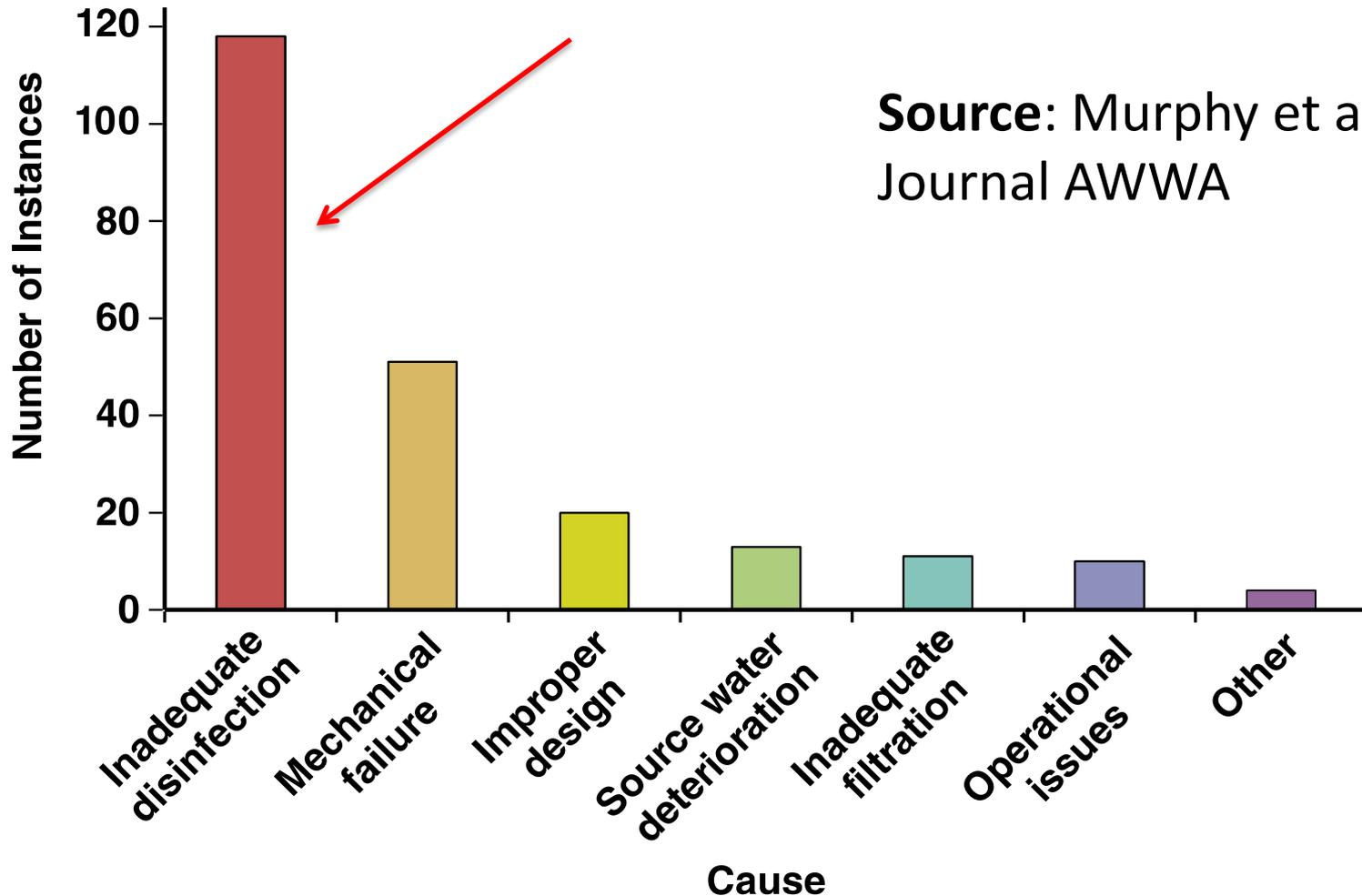
E. coli O157:H7 was not disinfected

5 Children died

2300 (half population) were sick

Some people still have kidney problems today

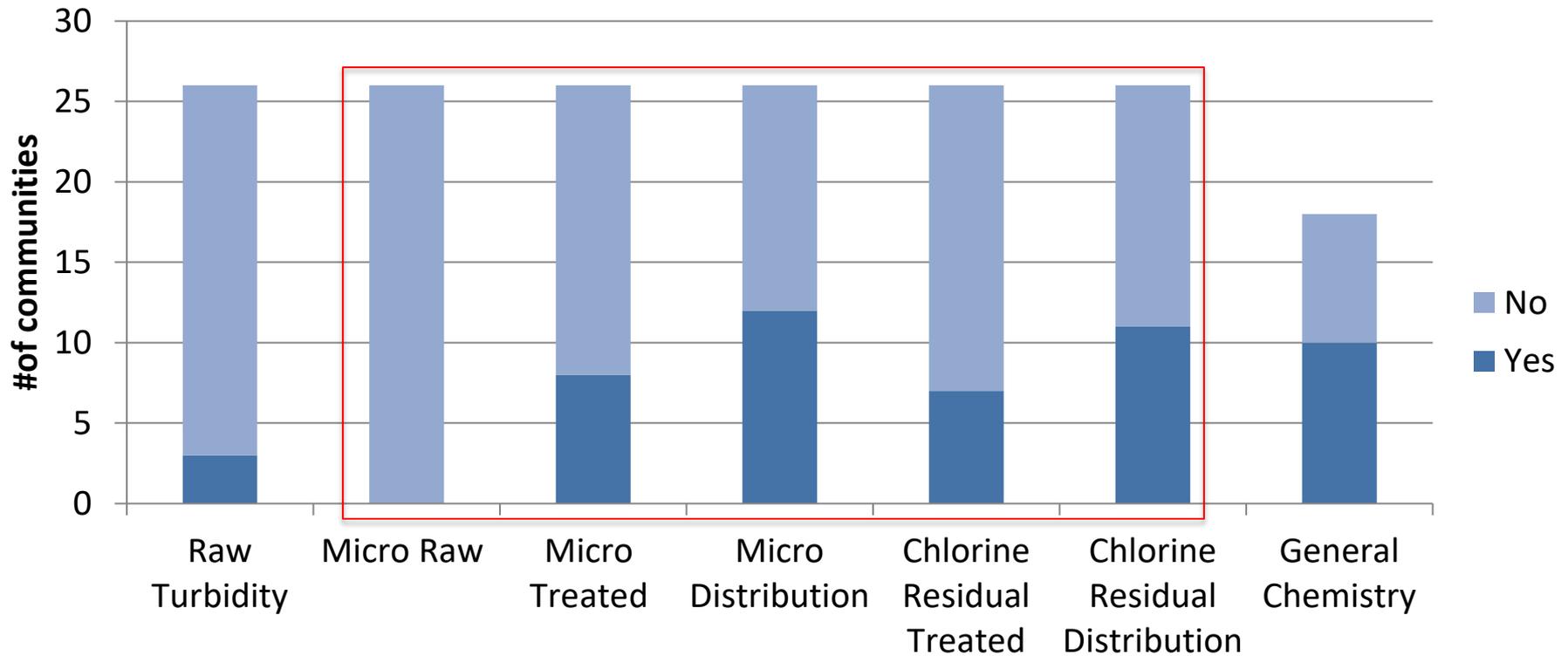
Causes of drinking water advisories in Canadian First Nations



Source: Murphy et al. 2016
Journal AWWA

Neegan Burnside (2010) Report

Water Quality Monitoring





Protocol for Safe Drinking Water in First Nations Communities

(Standards for Design, Construction, Operation, Maintenance, and
Monitoring of Drinking Water Systems)



Monitoring Requirements for Drinking Water Systems

Parameter	Small Community	Community
Microbiological	Surface: 5/month ^a Ground: 9/month ^b	16/month ^c
Chlorine Residual	Daily for treated water + one distribution sample/week	Continuous for treated water + one distribution sample/week
Turbidity	1/month for raw water + Continuous for each filter effluent line (if applicable)	1/month for raw water + Continuous for each filter effluent line (if applicable)

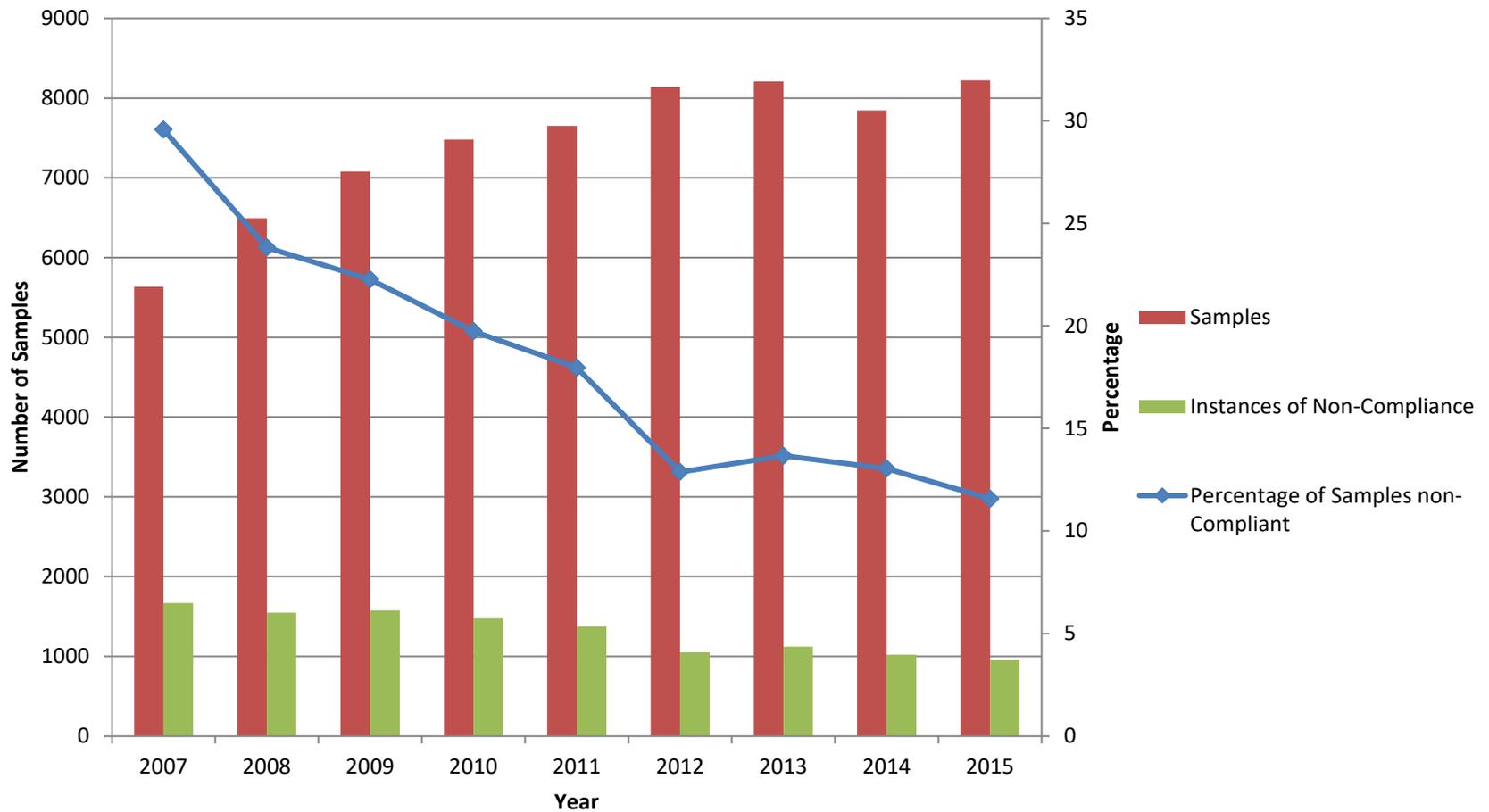
^aOne raw water sample per month and one distribution sample per week

^bOne raw water sample per well per month, one treated water sample per week and one distribution sample per week

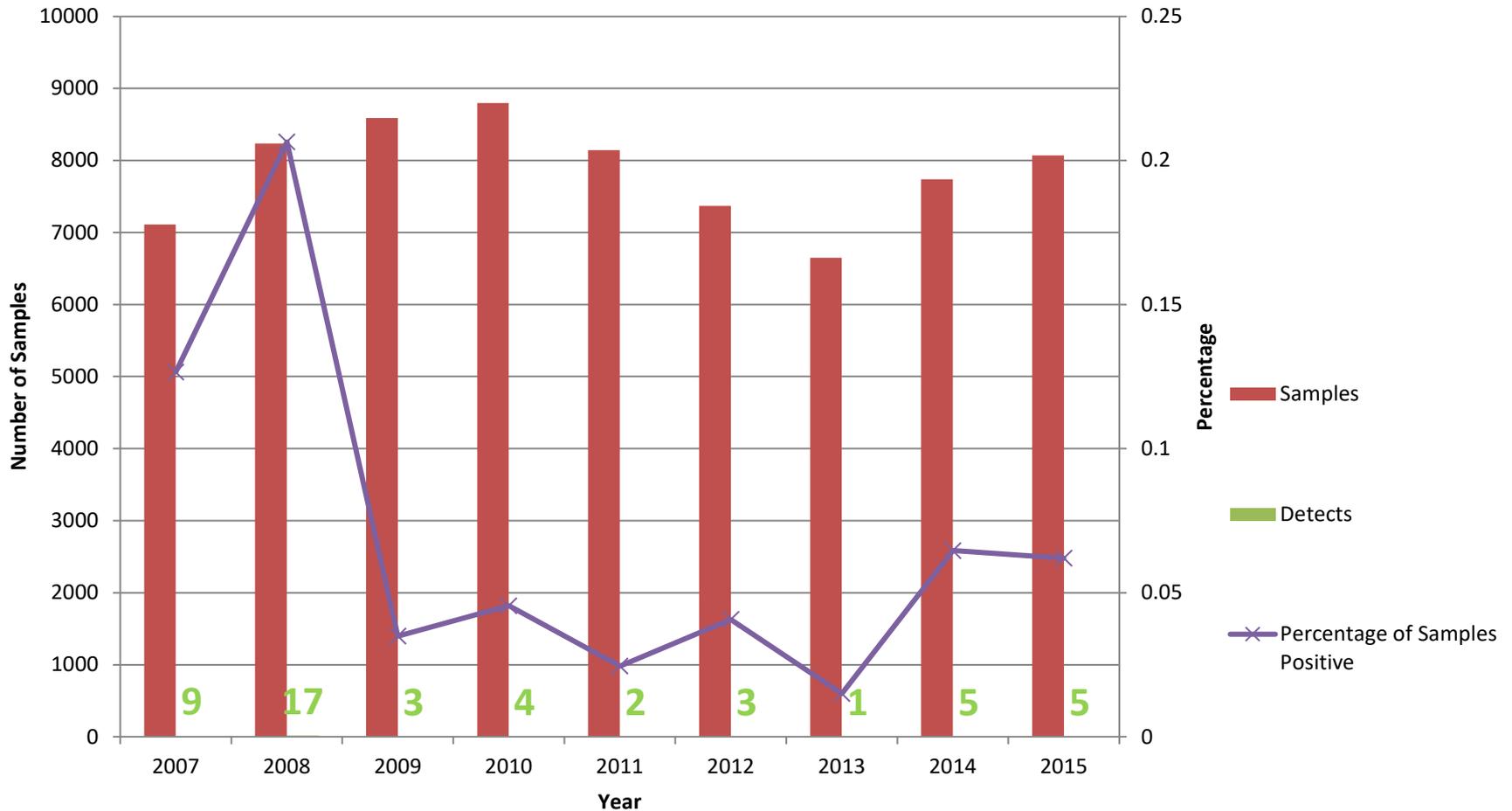
^cOne raw water sample per week or one raw water sample per well per week, one treated water sample per week, and eight distribution system samples per month

Chlorine Monitoring

Atlantic First Nation Communities



E. Coli Monitoring Atlantic First Nation Communities



Common perceptions on chlorine

- Chlorine is bad because
 - It tastes bad
 - It smells bad
 - It's bad for my health, it's toxic/poisonous

- Chlorine is necessary to provide adequate disinfection and prevent waterborne illness
 - It does not remain in tap water once exposed to air
 - Stirring can help reduce chlorine smell/taste, OR
 - Keep a jug of tap water in your fridge can help dissipate the chlorine taste/smell



GI & Water in Atlantic First Nations

On-going “threat” for all drinking water systems

Can be managed through disinfection and proper monitoring





Risk 2: Metals in Drinking Water



Dirty Water – Should I care?

Dirty or colored water is often caused by metals present in drinking water

- Manganese
- Iron
- Lead

Often causes undesirable aesthetic problems

- Taste and odor issues
- Stained clothing
- Undesirable for drinking, cooking and bathing



Photo credit: Ni Zhu *in* Pelley, J.
Chem. Eng. News. **2016**, July 25.

Potlotek First Nation – Example of metals in drinking water





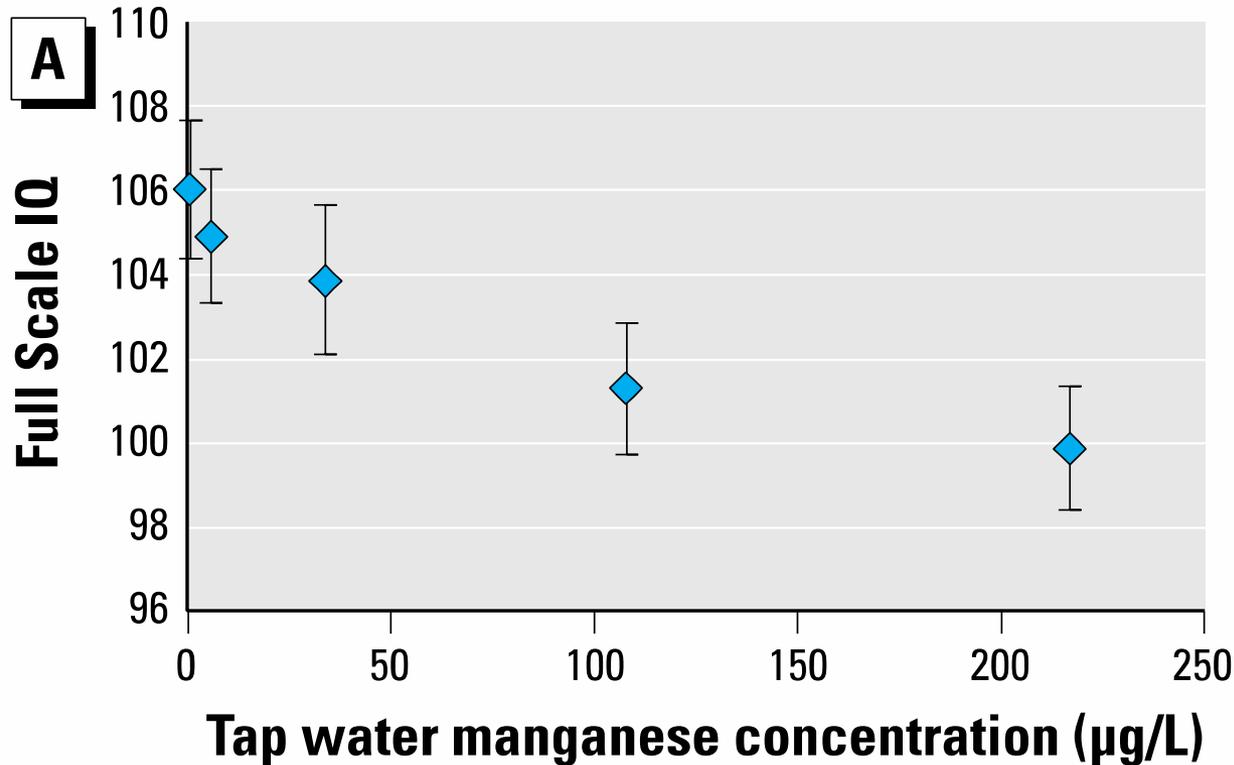
Sources of Iron and Manganese in Water

- Surface water (lakes)
 - Lakes can “turnover” in the fall causing high manganese and iron concentrations (e.g. Potlotek)
- Groundwater
 - Many groundwater sources naturally have higher iron and manganese concentrations
- Distribution System
 - Iron and manganese can build up on pipe walls over time and can be released during system disruptions



Public Health affects of Mn

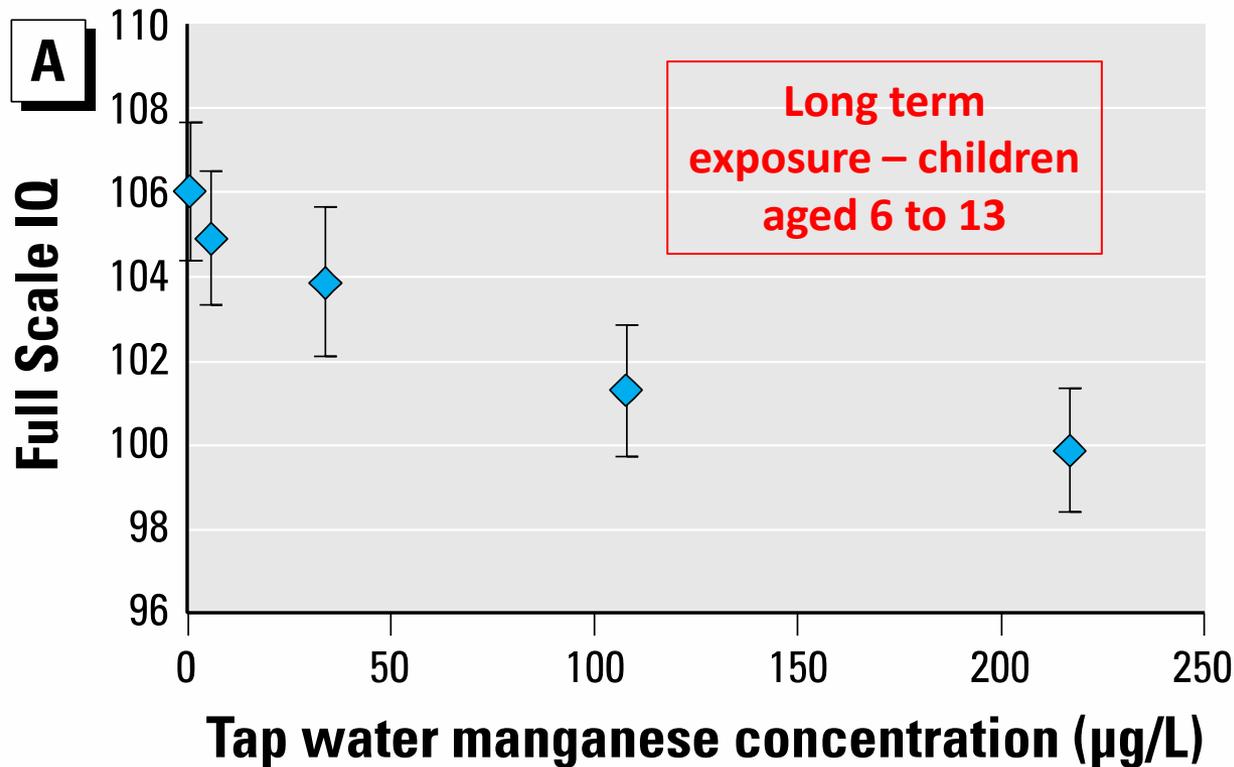
Impacts on IQ



Bouchard, M., et al. (2010). "Intellectual impairment of school-aged children exposed to manganese from drinking water." *Environ. Health Perspect.*, 119(1). 138-143.

Public Health affects of Mn

Impacts on IQ



Concentration of Mn in Potlotek



Date	Concentration ug/L
Oct-14	1200
Oct-15	1400
Oct-16	1000
Oct-16	300

Potlotek First Nation, September 2016

Photo: CBC News



Regulatory Perspective on Manganese

Mn causes **black** staining

Current Guideline is **Aesthetic Objective** of
0.05 mg/L

Health Canada is proposing to change to
health-based parameter

0.1-mg/L (or 100-ug/L) health based level



Potlotek First Nation to get new water system to fix dirty, discoloured water



CBCnews | Nova Scotia

It could take several years for the new system to be completed, but McDonnell said a discussion is already underway to deal with the discoloured and foul-smelling water in the current system.

"The working group is actually looking at the possibility of quickly adding a limestone bed treatment part to the existing system, which will decrease the manganese levels," said McDonnell.





Risk 3: Water Washed Disease – Perceptions of Poor Water Quality



Water Washed Disease



What is water “washed” disease?

- **Water-washed** diseases are infections that are caused by poor personal hygiene resulting from inadequate **water** availability that can be driven by poor water quality



Hand washing basin in Alaska



Bathing and Washing is Critical

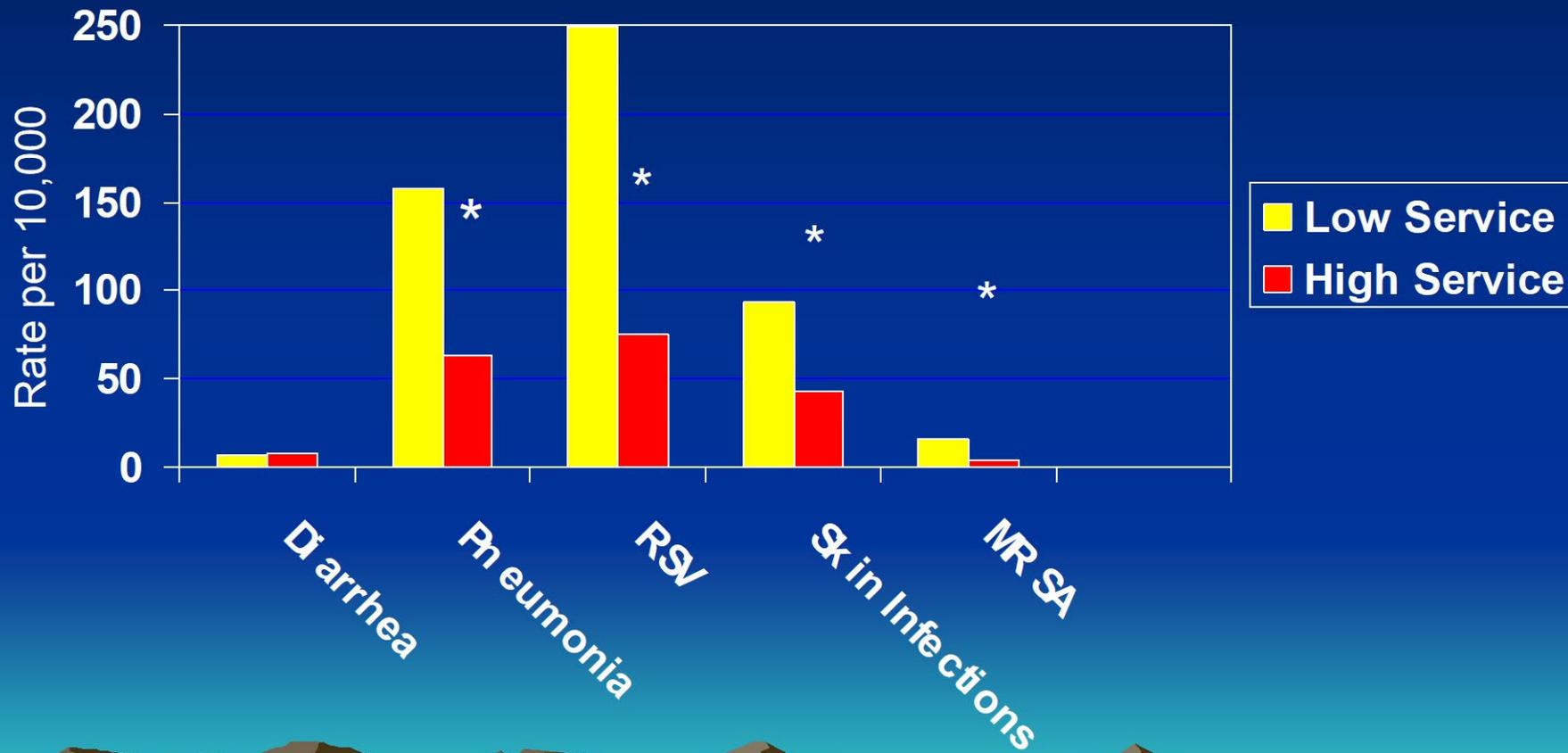
In-home water service is an important determinant of health

In Alaska and other remote regions, lower levels of water services were associated with a higher burden of:

- Pneumonia
- Influenza
- Skin infections



Hospitalization Rates for “High” and “Low” Water Service Regions, Alaska, 2000-2004





How does water quality affect water washed disease?

- If water quality is perceived to be poor, residents won't want to use it for
 - Drinking
 - Bathing
 - Hygiene purposes (e.g. washing hands)
- This can start a cycle that leads to “water washed disease”
 - People become ill, but aren't washing hands, due to lack of water or poor water quality
 - People use “washing basins”
 - People get sick and disease can then be spread





While discoloured water is something Potlotek residence have been facing annually, Marshall said this year it started earlier — the colour change began in late August — and the water is darker than normal with a strange smell and texture.

She said people have been getting skin rashes and some of the community's elders are convinced it is causing cancer.

"Mothers are concerned for their children. If they don't bathe their children they're sending their kids to school dirty and in the back of their mind they're thinking it will (Mi'kmaq Family and Children's Services) be an issue here," Marshall said.



Take Home Messages

Main water quality risks are

- Gastrointestinal illness from inadequate chlorination
- Metals in drinking water (iron, manganese)

Can be managed through disinfection and proper monitoring

Clean drinking water is critical for cooking, bathing and drinking

- Perceived poor water quality can cause residents to not use their water
 - This can lead to water “washed” diseases if WQ issues aren’t managed

Proper management (operations, monitoring) of drinking water systems is fundamental for long term success





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