

# Water Safety Plans

*Managing Risks to Achieve Safe Drinking Water*

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April 17, 2019



# Planning for Clean Water





# Organization of Presentation

A. Setting the stage for safe water

B. Understanding Water Safety Plans

C. Applying Water Safety Plans

D. Summary Thoughts

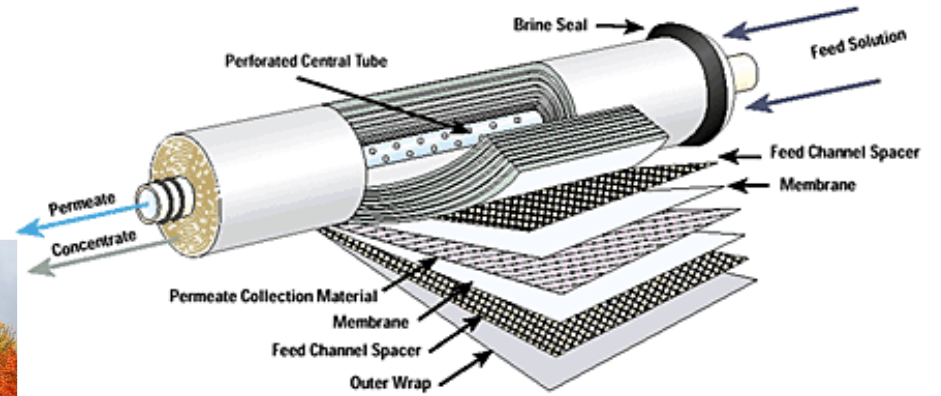




# **A. Setting the Stage for Safe Water**

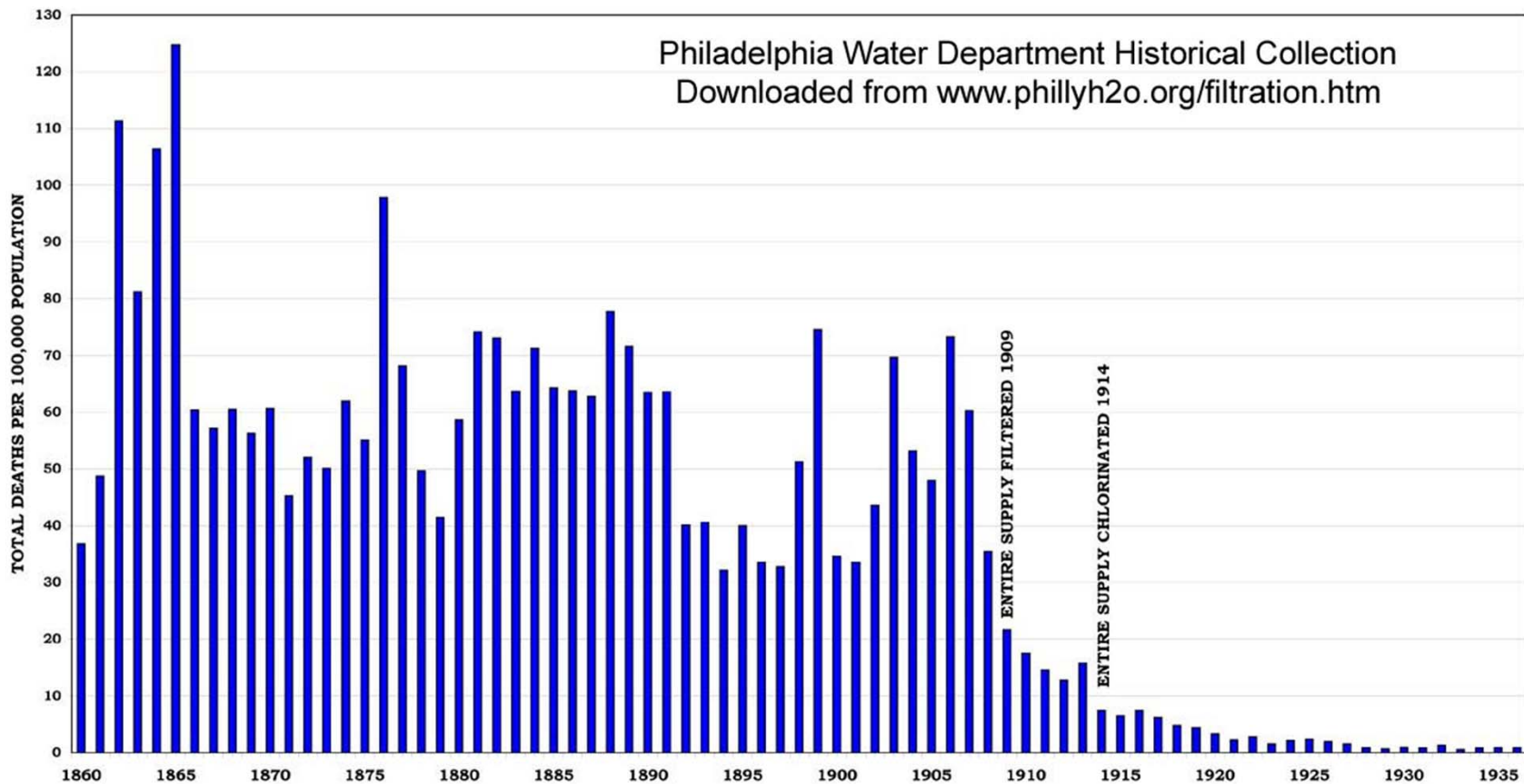


# A. Setting the Stage for Safe Water Technology

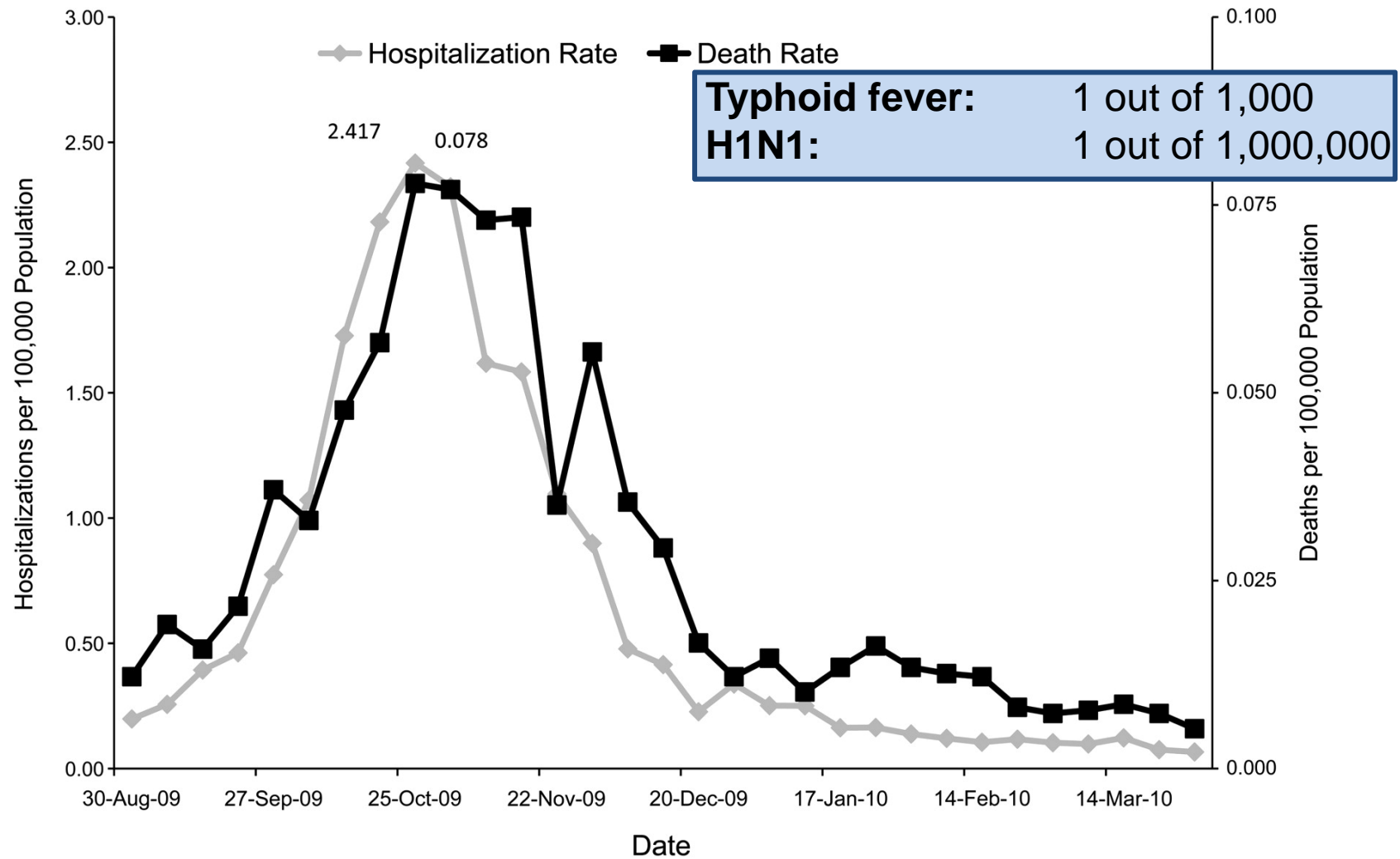


# A.1 Overcoming a Significant Technical Challenge

Death Rate from Typhoid Fever in Philadelphia 1860-1936



# A.1 Placing Clean Water in Perspective of H1N1



Jhung M A et al. Clin Infect Dis. 2011;52:S13-S26



Palace of Purification -1941  
1-BLD



•

## A.2 Setting the Stage for Safe Water Planning & Management

Reactionary

Proactive



## A.2 Common Planning Tool

### *Boil Water Advisory*

*“The primary intent of a boil water advisory is to protect consumers from potential health risks related to drinking water of an unacceptable microbiological quality.”*

#### **Emergency BWA**

*E. coli*

#### **Precautionary BWA**

Operational

Monitoring

Source



## A.2 Boil Water Advisory Case Studies

British Columbia

Nova Scotia

Newfoundland &  
Labrador

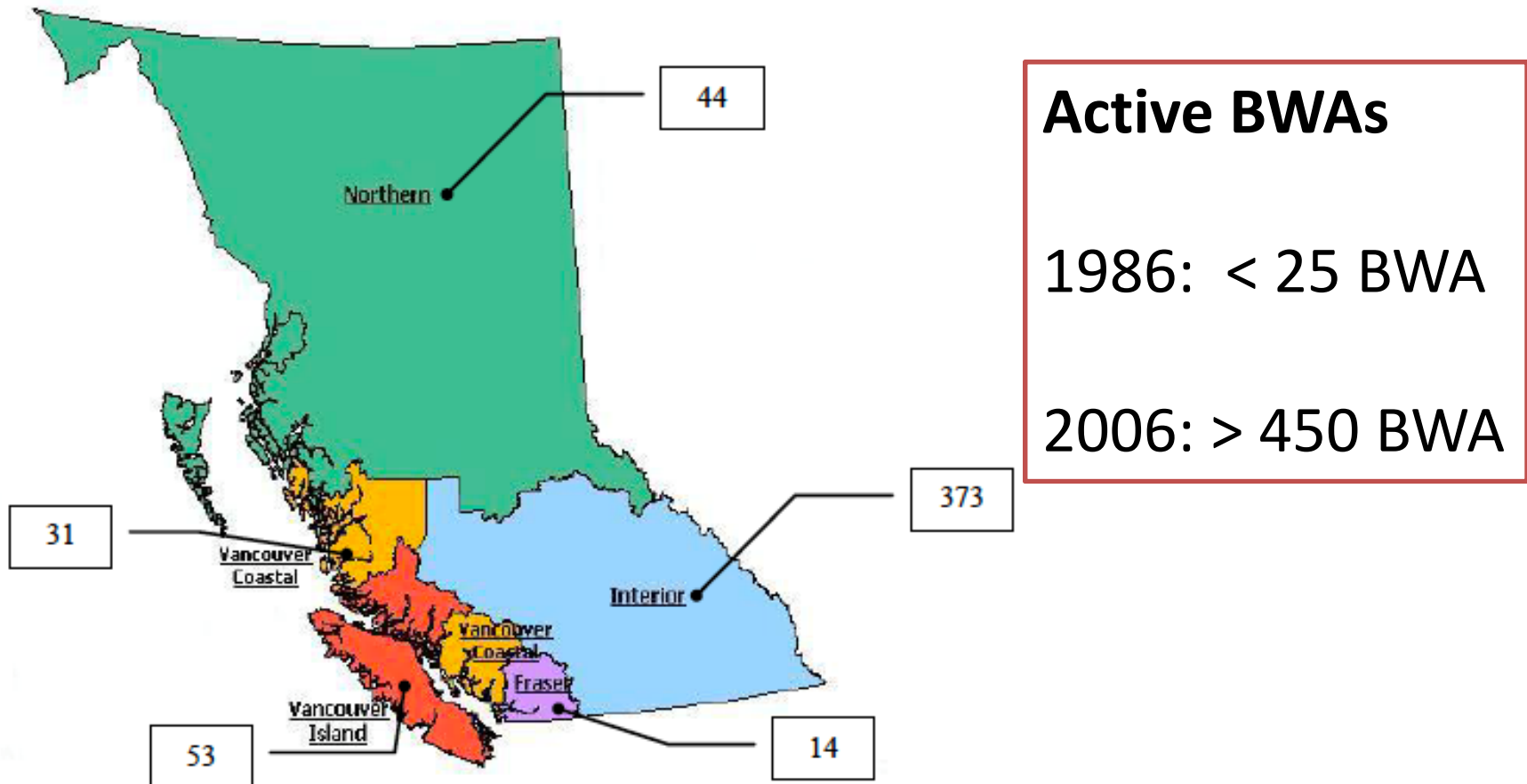
What are traits?

How can we use  
BWAs to improve  
management?



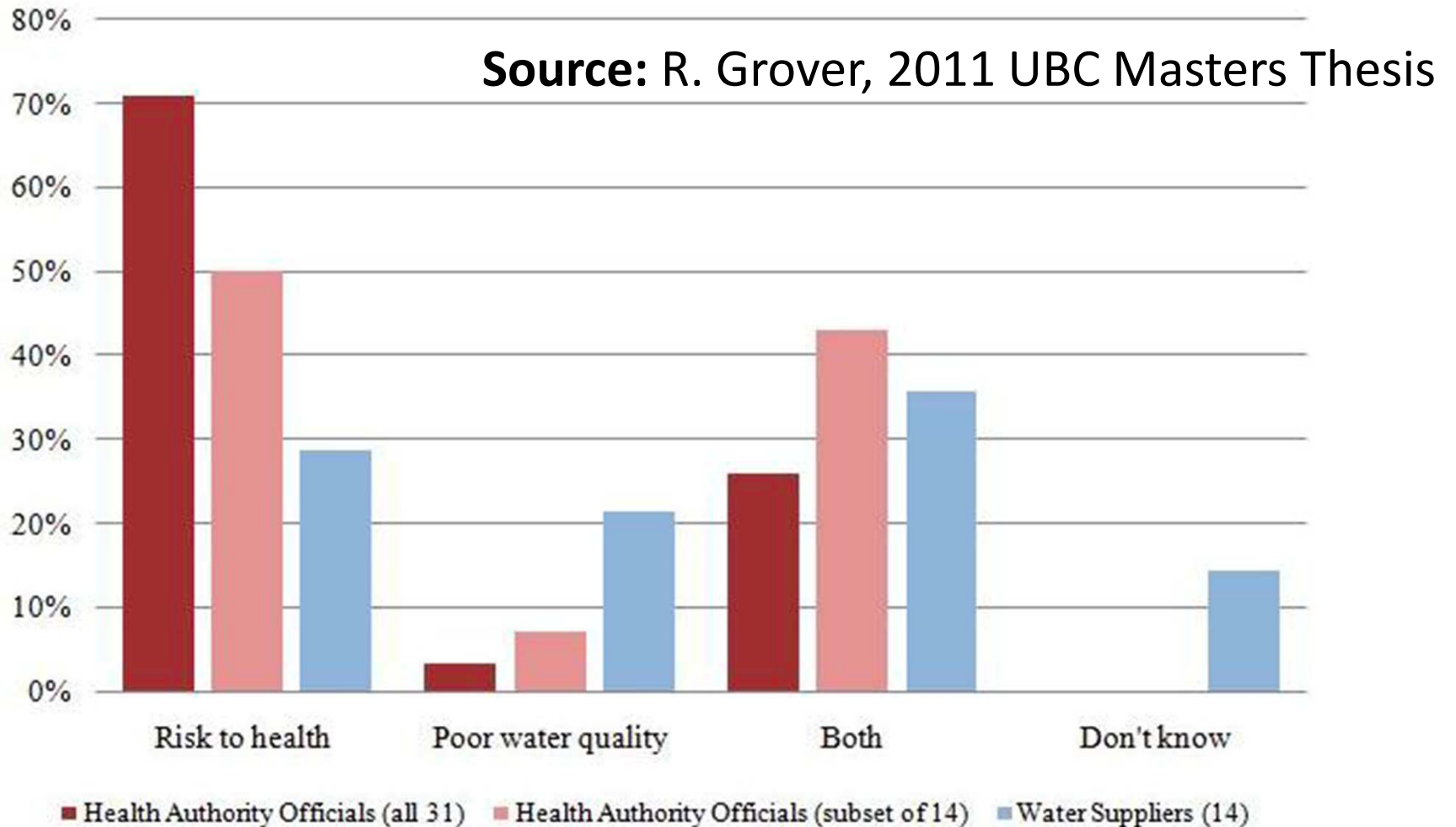
## A2. Understanding Boil Orders in BC

Source: R. Grover, 2011 UBC Masters Thesis



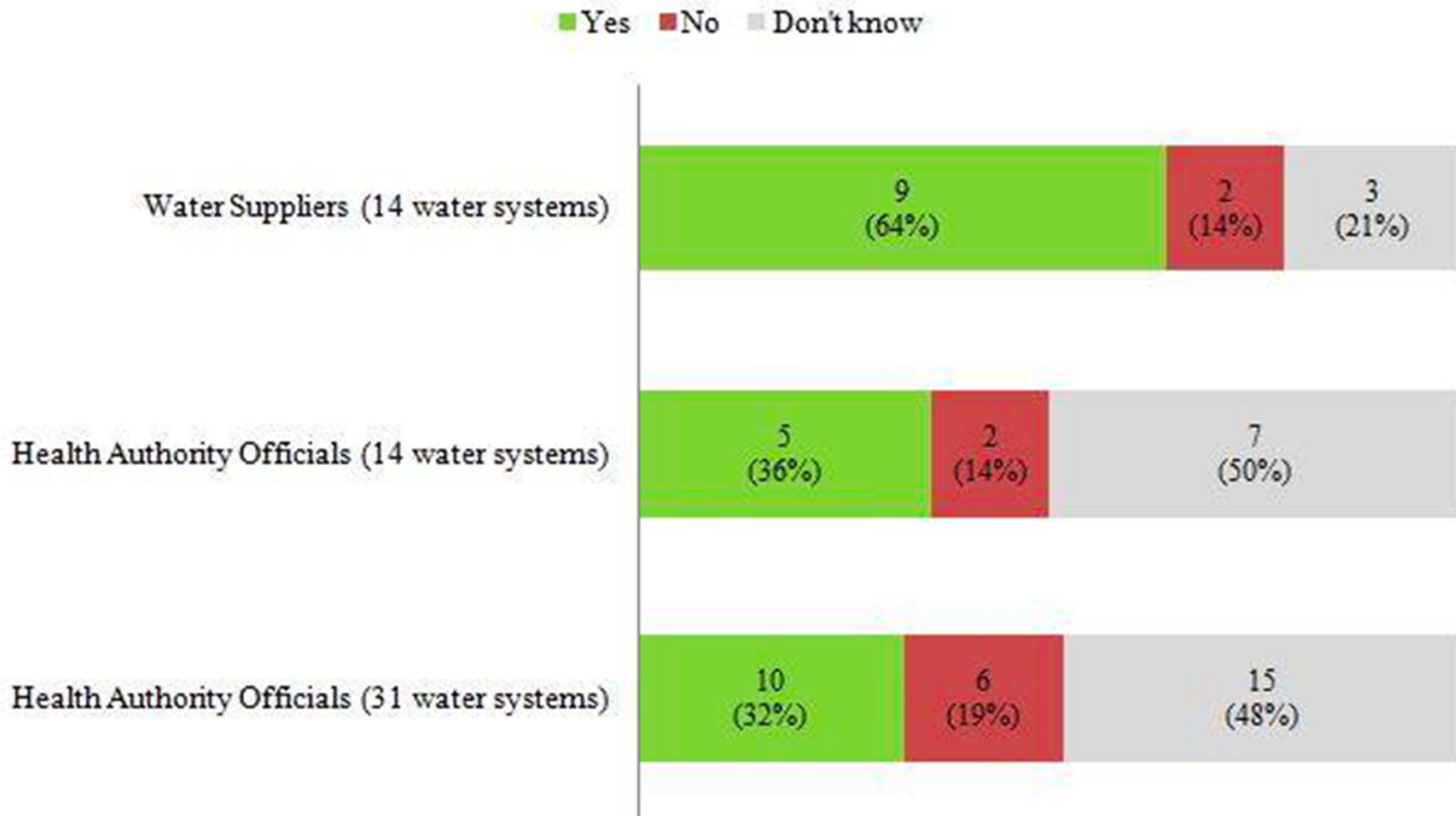
## A.2 BC Case Study

Why are boil water advisories primarily issued?

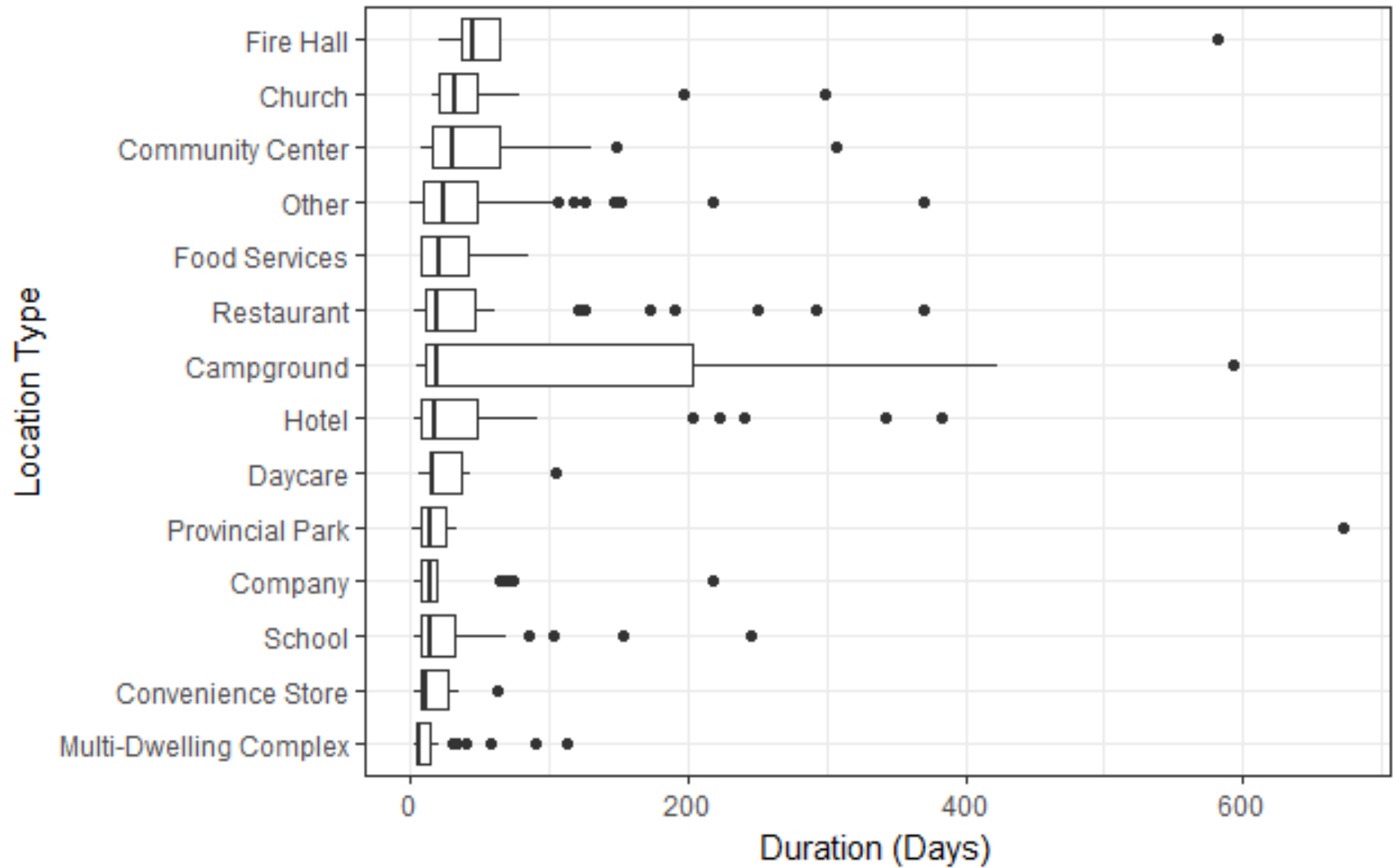


## A.2 BC Case Study

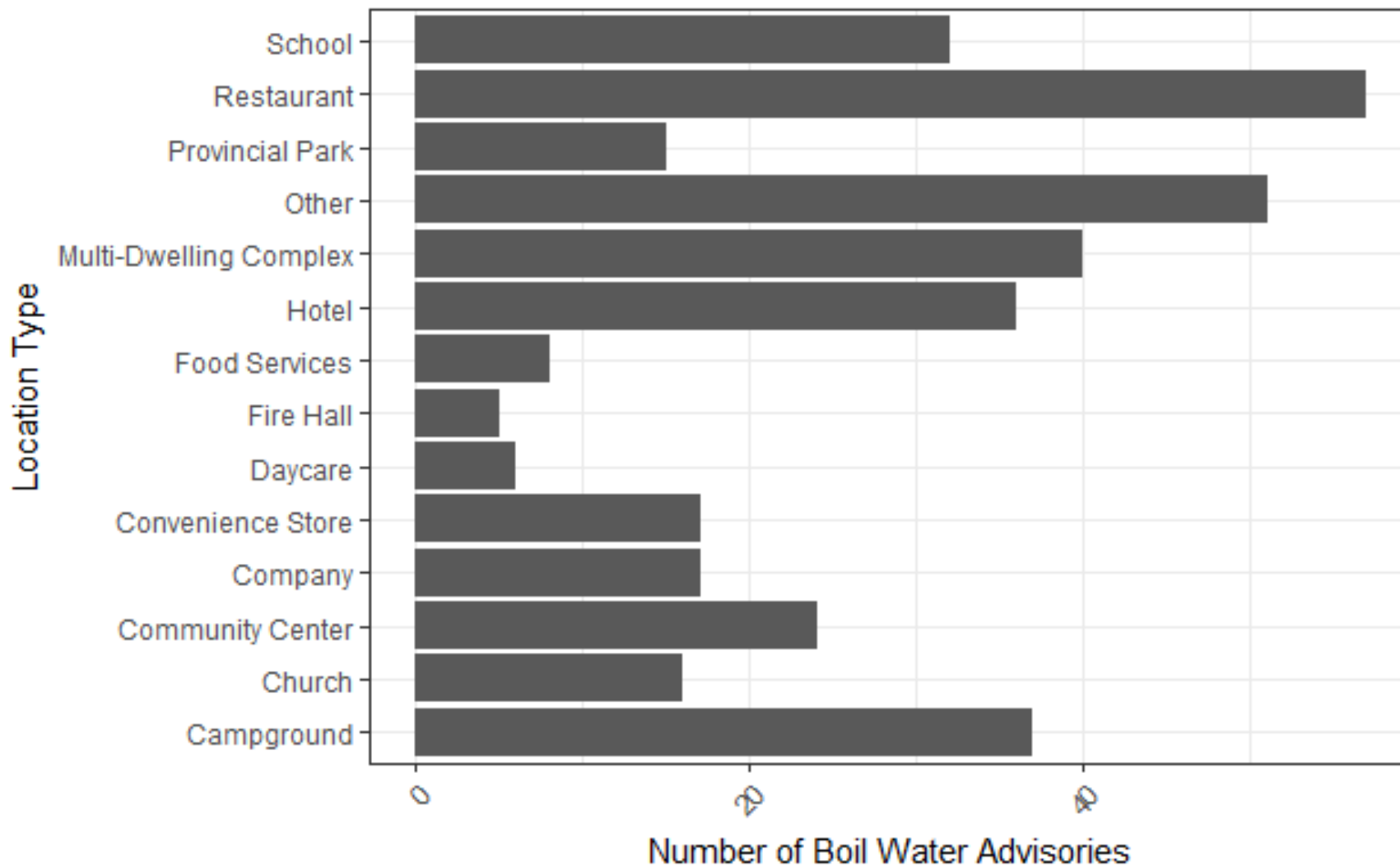
Do you think the public complied with the BWA?



# A.2 Nova Scotia BWAs

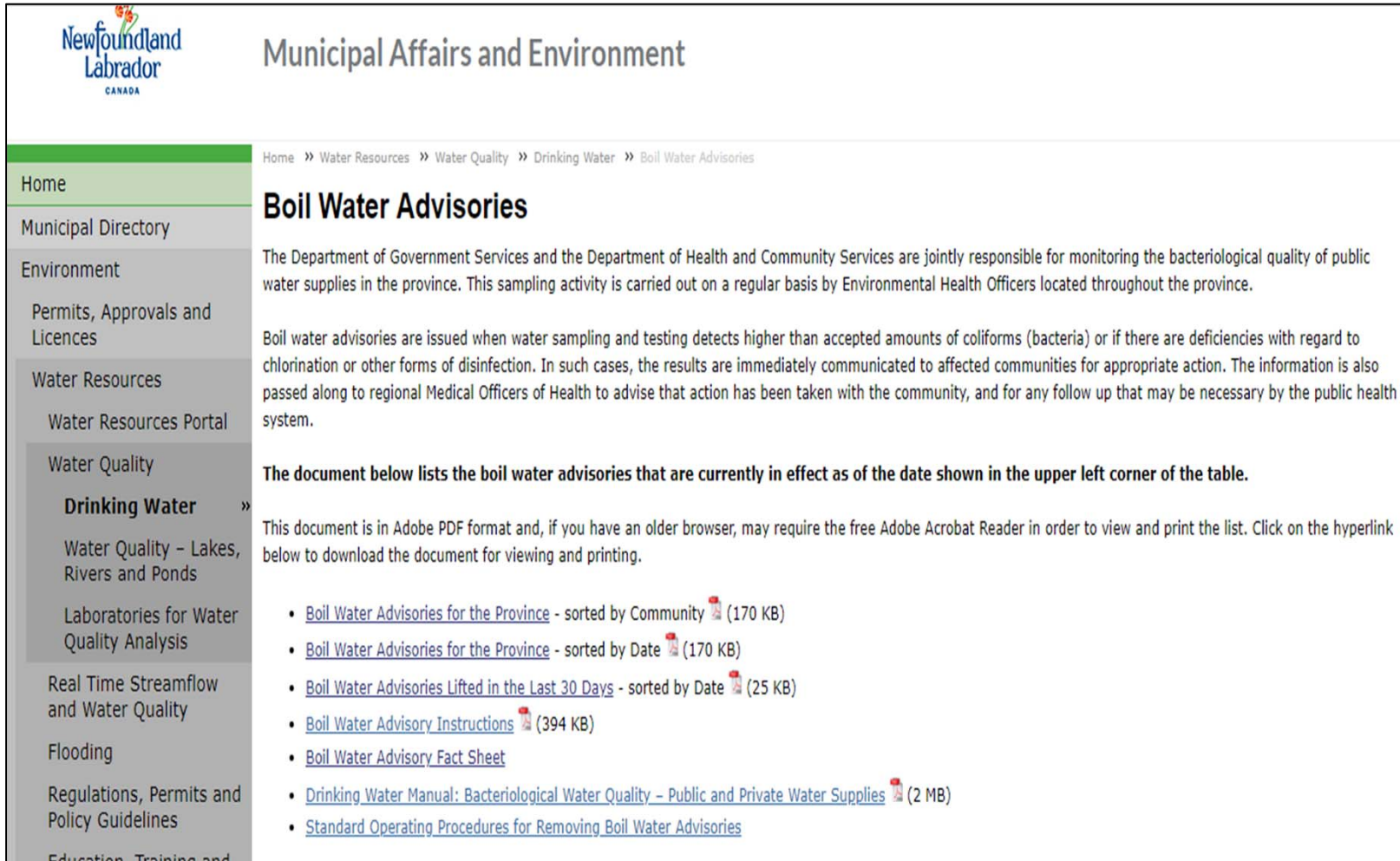


# A.2 Nova Scotia BWAs





# A.2 Newfoundland & Labrador



The screenshot shows the website for Newfoundland and Labrador, specifically the Municipal Affairs and Environment section. The page is titled "Boil Water Advisories" and provides information about water quality monitoring and advisories. A navigation menu on the left includes links for Home, Municipal Directory, Environment, Permits, Approvals and Licences, Water Resources, Water Resources Portal, Water Quality, Drinking Water (selected), Water Quality - Lakes, Rivers and Ponds, Laboratories for Water Quality Analysis, Real Time Streamflow and Water Quality, Flooding, Regulations, Permits and Policy Guidelines, and Education, Training and... The main content area includes a breadcrumb trail: Home » Water Resources » Water Quality » Drinking Water » Boil Water Advisories. The page explains that the Department of Government Services and the Department of Health and Community Services are jointly responsible for monitoring the bacteriological quality of public water supplies. It states that boil water advisories are issued when water sampling and testing detects higher than accepted amounts of coliforms (bacteria) or if there are deficiencies with regard to chlorination or other forms of disinfection. The document below lists the boil water advisories that are currently in effect as of the date shown in the upper left corner of the table. A note indicates that the document is in Adobe PDF format and may require the free Adobe Acrobat Reader in order to view and print the list. A list of links is provided, including "Boil Water Advisories for the Province - sorted by Community" (170 KB), "Boil Water Advisories for the Province - sorted by Date" (170 KB), "Boil Water Advisories Lifted in the Last 30 Days - sorted by Date" (25 KB), "Boil Water Advisory Instructions" (394 KB), "Boil Water Advisory Fact Sheet", "Drinking Water Manual: Bacteriological Water Quality - Public and Private Water Supplies" (2 MB), and "Standard Operating Procedures for Removing Boil Water Advisories".

Newfoundland  
Labrador  
CANADA

## Municipal Affairs and Environment

Home » Water Resources » Water Quality » Drinking Water » Boil Water Advisories

### Boil Water Advisories

The Department of Government Services and the Department of Health and Community Services are jointly responsible for monitoring the bacteriological quality of public water supplies in the province. This sampling activity is carried out on a regular basis by Environmental Health Officers located throughout the province.

Boil water advisories are issued when water sampling and testing detects higher than accepted amounts of coliforms (bacteria) or if there are deficiencies with regard to chlorination or other forms of disinfection. In such cases, the results are immediately communicated to affected communities for appropriate action. The information is also passed along to regional Medical Officers of Health to advise that action has been taken with the community, and for any follow up that may be necessary by the public health system.

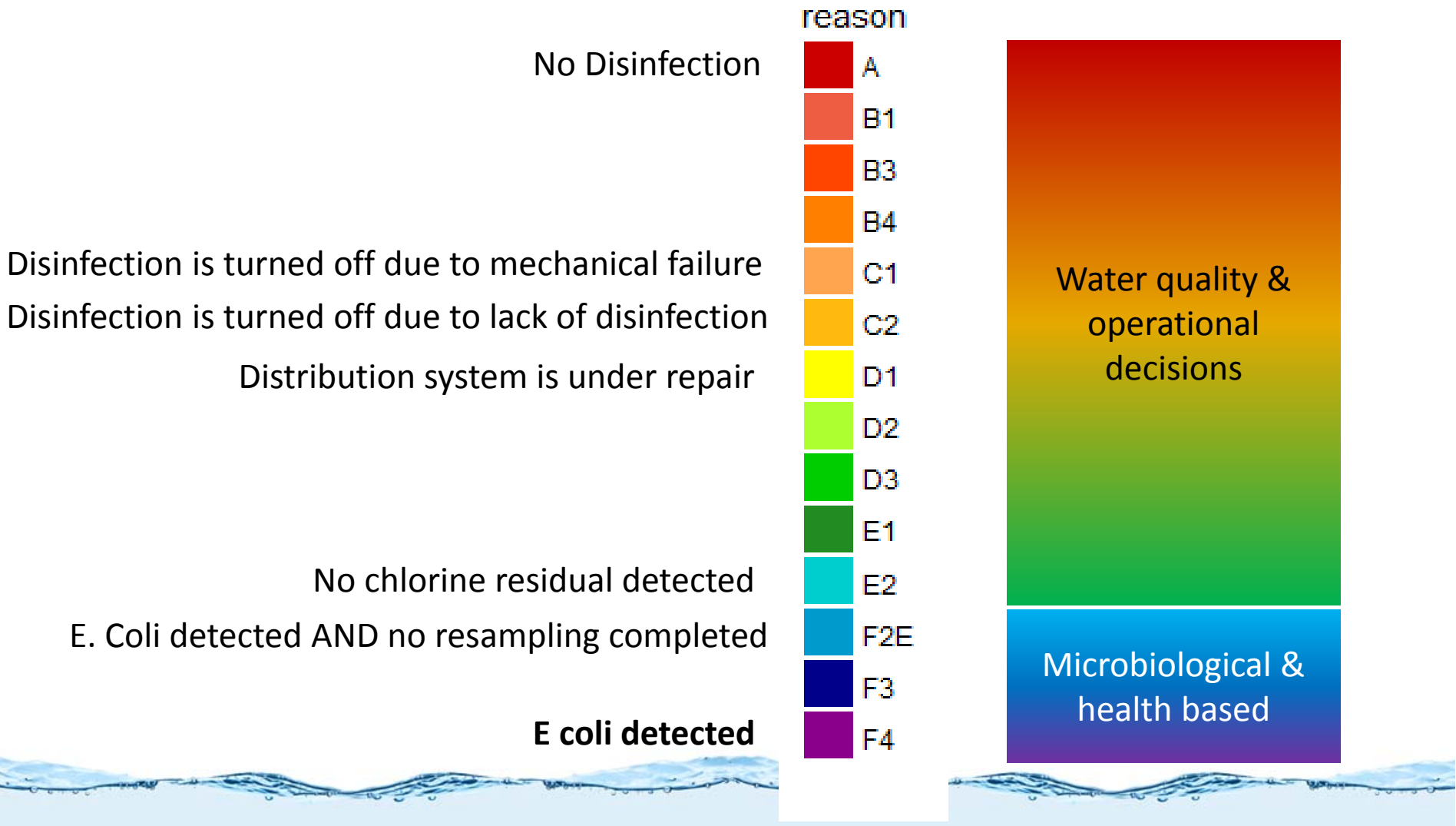
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This document is in Adobe PDF format and, if you have an older browser, may require the free Adobe Acrobat Reader in order to view and print the list. Click on the hyperlink below to download the document for viewing and printing.

- [Boil Water Advisories for the Province](#) - sorted by Community 📄 (170 KB)
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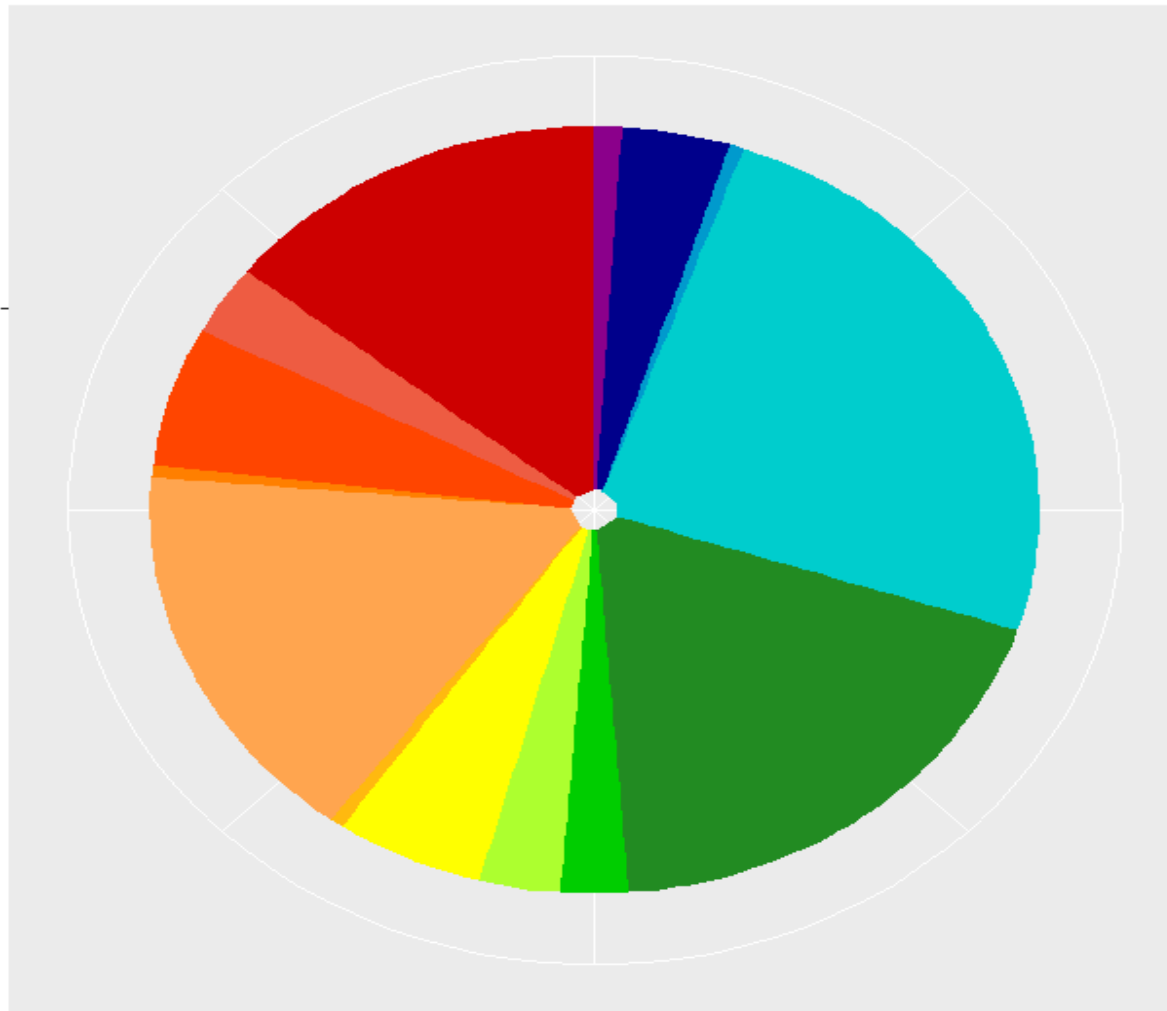


# A.2 Review of NL BWA Data





# A.2 Review of NL BWA Data



Number of BWAs

reason

- A
- B1
- B3
- B4
- C1
- C2
- D1
- D2
- D3
- E1
- E2
- F2E
- F3
- F4



Less than 1/8 of all BWAs still in place in 2019





## A.2 BWA Assessment & Take-aways

Majority of cases relate to operational concerns (NL)

BWAs can sometimes last a very long time (NS)

Not sure if public is adhering to BWA (BC)





# B. Water Safety Plans





## **B.1 Water Safety Plans**

Promoted by the World Health Organization (WHO) since 2001

Currently adopted by 93 countries  
Scalable to situation

Proactive, NOT reactive  
**Risk Based Approach**



# B.1 Prioritized Risk

Daily Activity	Risk from WSP Assessment
Calibrate Chlorine Analyzer	Low
Record Chlorine Dose	Low
Measure Turbidity	Moderate
Measure pH in Contact Chamber	High
Check Chlorine Pumps for Failure	Moderate
Calculate Contact Time (CT)	Low

Address Concerns with pH FIRST

Address these Concerns NEXT





## B.1 Prioritization will result in *“Knowing Your System”*

What are the consequences of **NOT** knowing your system?

- Complacency
  - *“Chemical spills could never happen here”*
- Failure to recognize warning signs
  - *“Water is a little a difficult to treat during storms but we manage”*
- Failure to respond
  - *“Our consultant prepared our emergency response plan”*



## B.1 Knowing your system

### *Requires an Understanding of Risk*

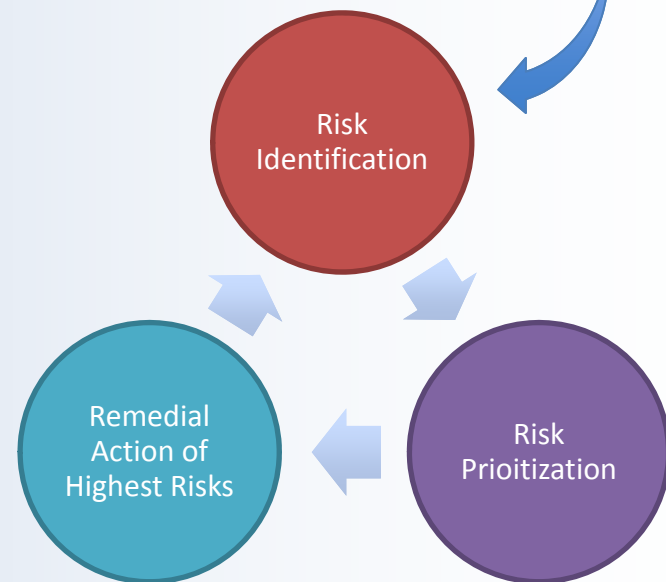
Every parameter has a risk

- Zero tolerance
- Can lead to complacency or delinquency



### Water Safety Plans:

- *Risks are identified*
- *Risks are prioritized*
- *Action based on priorities*

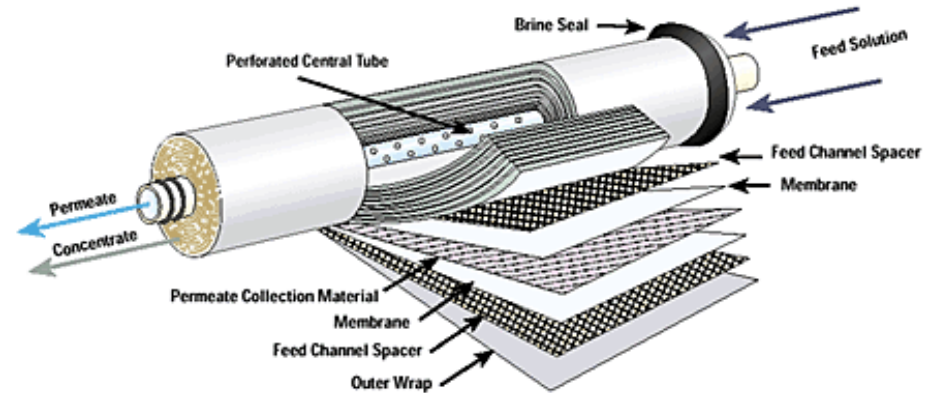


# B.1 “Know Your System”

## Is not Tech-focused

### Technical Dimension

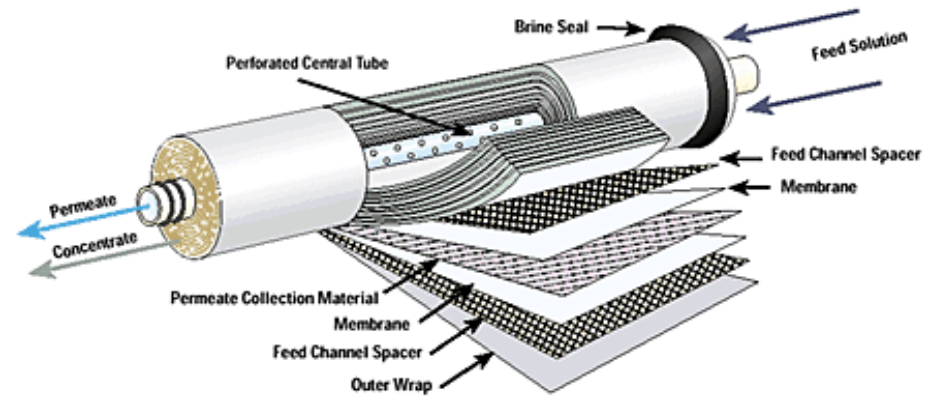
- ✓ On-line continuous measurements
- ✓ Innovative technology
- ✓ Web operations of treatment facility



# B.1 “Know Your System” Is not Tech-focused

## Technical Dimension

- ✓ On-line continuous measurements
- ✓ Innovative technology
- ✓ Web operations of treatment facility



## B.1 “Know Your System”

### Requires Planning & Judgment

#### Technical Dimension

- ✓ On-line continuous measurements
- ✓ Innovative technology
- ✓ Web operations of treatment facility

#### Planning Dimension

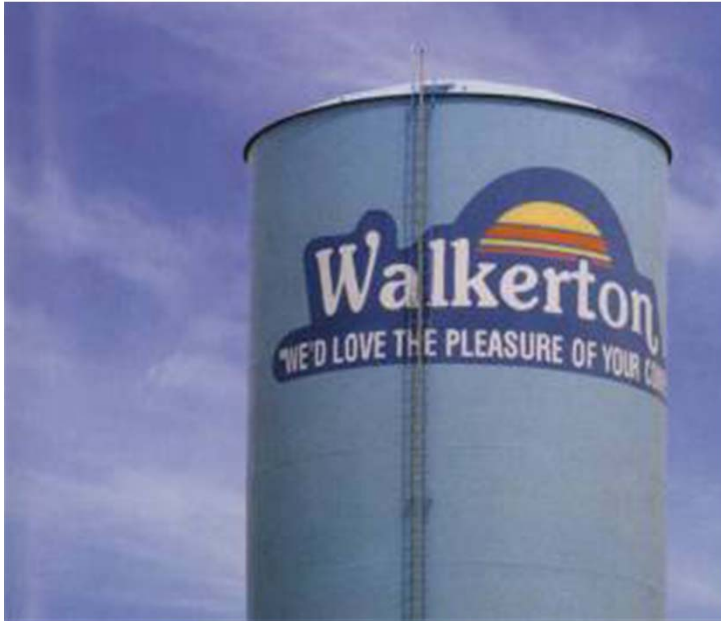
- ✓ Robust record keeping
- ✓ Continuous learning & training
- ✓ Communication to public



## B2. Can Water Safety Plans Improve Water Quality in Small Communities?



## B.2 Planning is Critical for Safe Water



### Huge fine and jail for drinking water violations in township

by DIANNE SAXE on FEBRUARY 4, 2013

The small Municipality of **West Elgin** (pop. 5,157) and three of its water distribution system operators were **fined \$154,500 in St. Thomas Provincial Offences Court** for drinking water violations, including providing false information and failing to report adverse test results. One of the operators was sentenced to 30 days in jail and stripped of his right to work in a water plant. No wonder municipalities are finding it harder to hire and keep good water staff.

2000



2013

*Are there technical barriers to monitoring?*



# B.2 Regulated Water Safety Plans



Microsoft Excel - Alberta DWSP Template - Macro version September LOGO\_2\_Locked version 2011 (unlocked).xls

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2										
3										
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5										
6										
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8		This page contains short cuts around the spreadsheet and will take you either to the start of a section or to another commonly used sheet.								
9		Simply click on the box description that you want and it will transfer you to that sheet								
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14		<b>Main areas</b>								
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19		<b>Other useful links</b>								
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Main areas

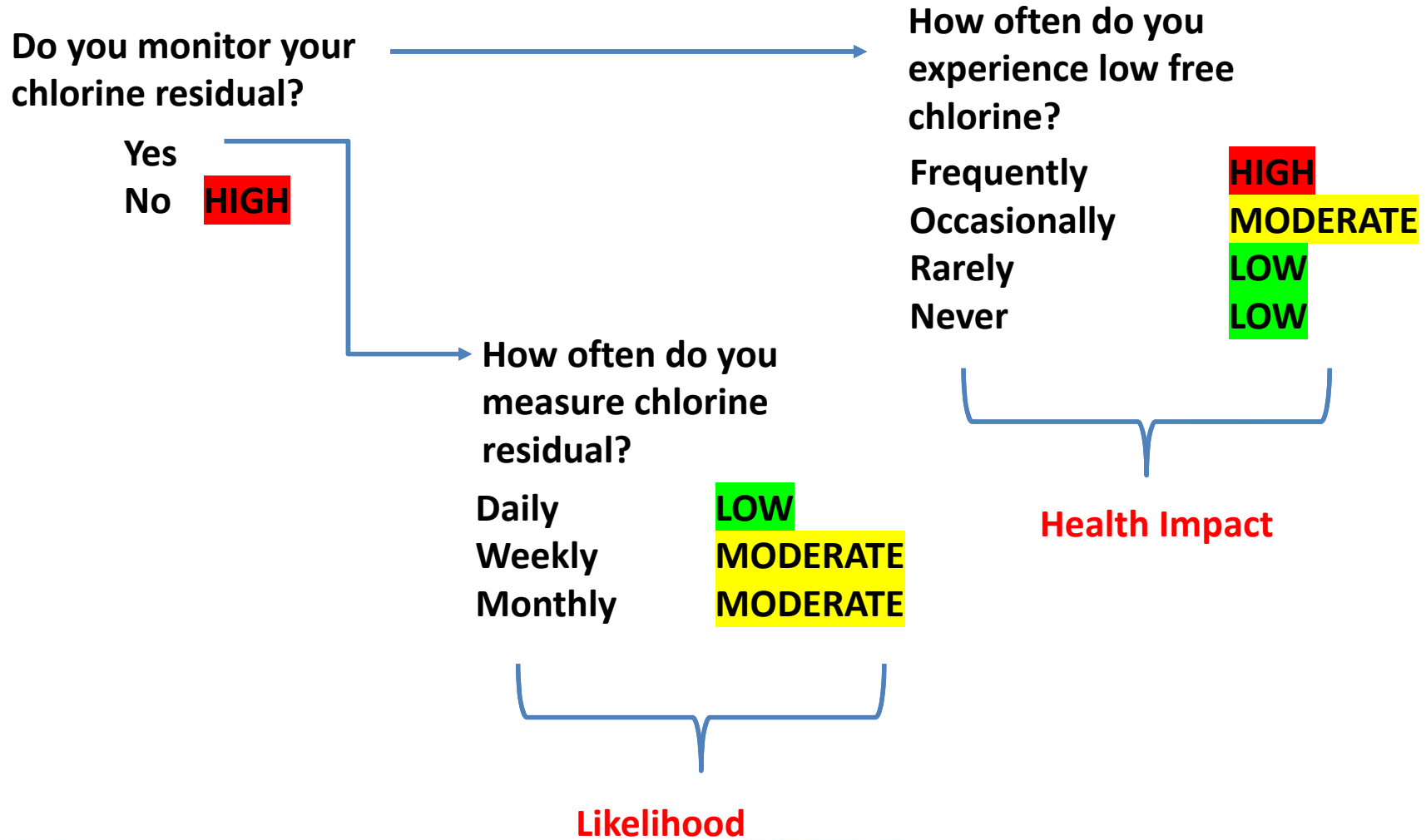
Other useful links





# B.2 Water Safety Plans

## Address Routine but Important Activities

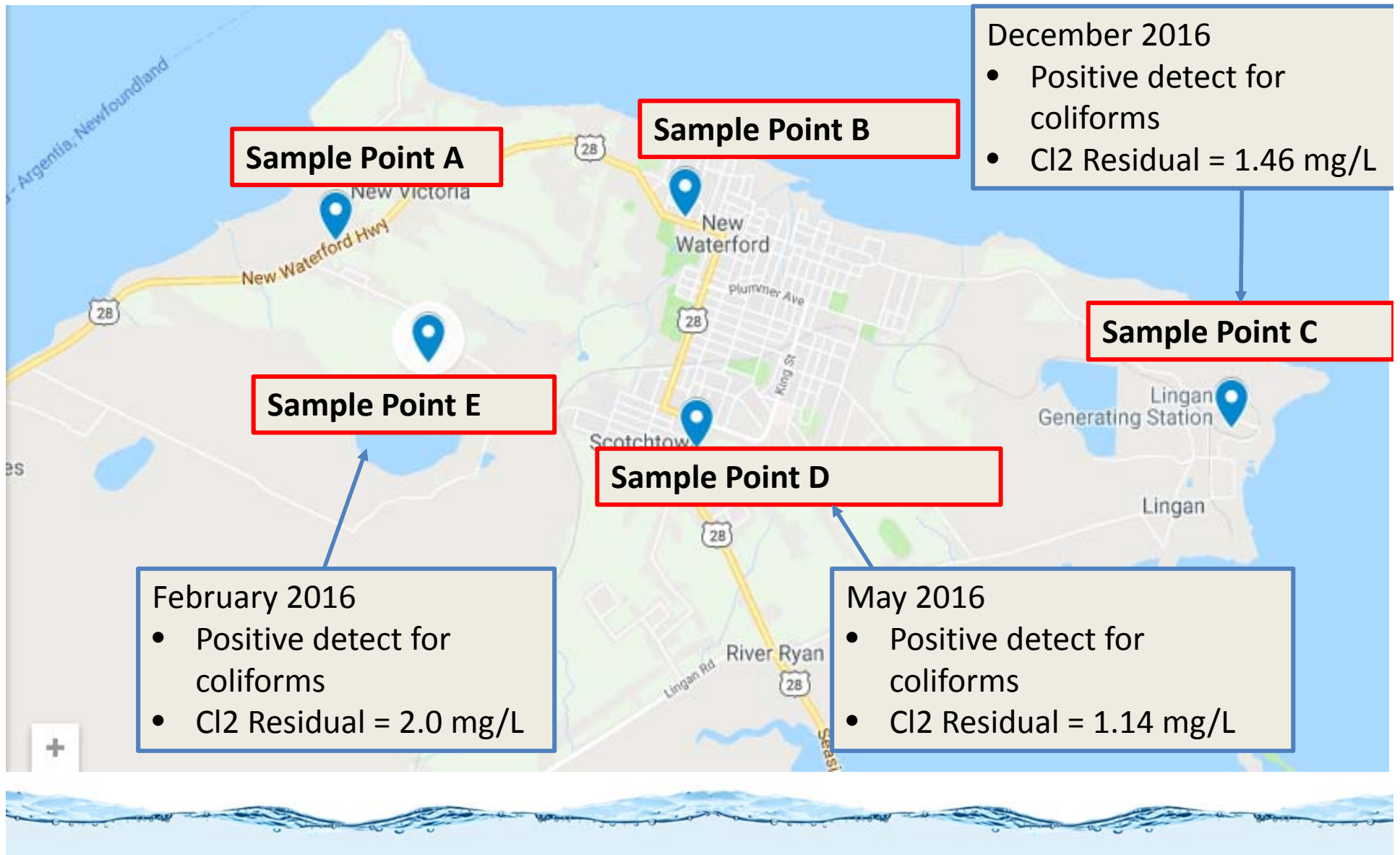




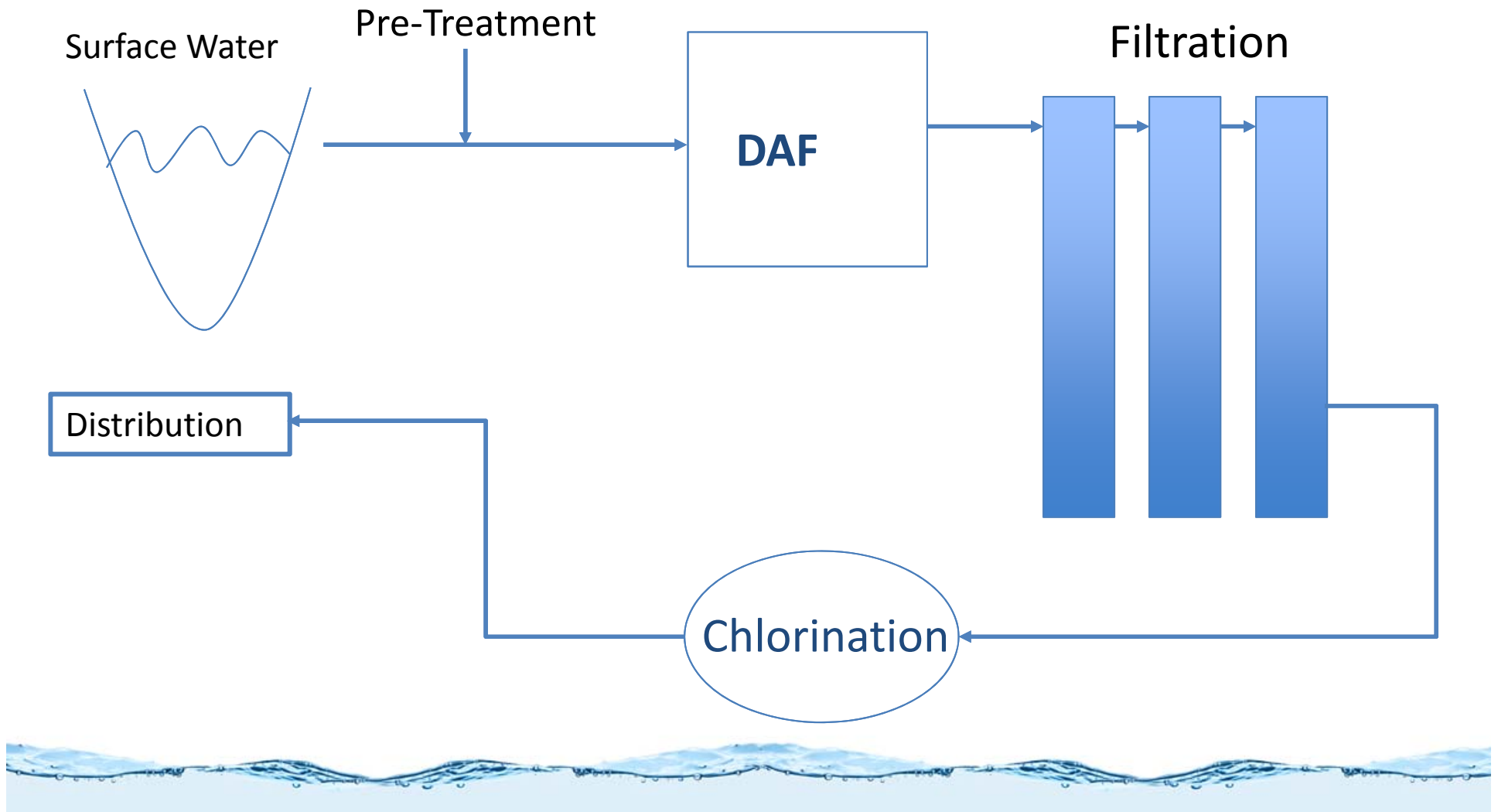
# C. Applying Water Safety Plans



# C.1 Community with Three BWAs



# C.1 Water Treatment Facility



# C.1 BWAs – Feb, May & Dec

	Sampling Location	Time	Chlorine (mg/L)	Turbidity (NTU)	pH	Temperature °C
<b>February BWA</b>						
2/19/2016	New Waterford Treatment Plant	9:35	2.00	0.06	7.40	6.90
2/19/2016	Lingan Power Plant	8:45	1.34	0.08	7.24	6.10
2/19/2016	Home Hardware Store	9:55	1.60	0.10	7.27	6.30
2/19/2016	Horyls Superior Sausage	9:20	1.34	0.08	7.05	6.90
2/19/2016	New Victoria Post Office	9:45	1.63	0.12	7.35	6.70
<b>May BWA</b>						
5/19/2016	New Waterford Treatment Plant	8:45	2.00	0.07	7.61	14.00
5/19/2016	Lingan Power Plant	9:40	1.26	0.08	7.73	10.50
5/19/2016	Home Hardware Store	10:45	1.51	0.09	7.47	11.70
5/19/2016	Horyls Superior Sausage	10:10	1.14	0.09	7.39	12.00
5/19/2016	New Victoria Post Office	10:30	1.45	0.08	7.44	10.70
<b>December BWA</b>						
12/9/2016	New Waterford Treatment Plant	10:10	2.10	0.24	7.31	5.50
12/9/2016	Lingan Power Plant	9:05	1.46	0.26	7.32	10.90
12/9/2016	Home Hardware Store	10:45	1.57	0.25	7.17	8.90
12/9/2016	Horyls Superior Sausage	9:55	1.49	0.24	7.23	10.30
12/9/2016	New Victoria Post Office	10:25	1.54	0.18	7.07	10.40





# C.1 Approach to understand system

## Task One: Data Collection

- **Interviews** with plant staff
- Gathered SCADA and sampling data

## Task Two: Data Analysis

- Basic Statistics: Mean, SD
- Reference Distributions and optimal parameters

## Task Three: Risk Analysis and Recommendations

- Probability density functions (PDFs)





# Task One: Data Collection



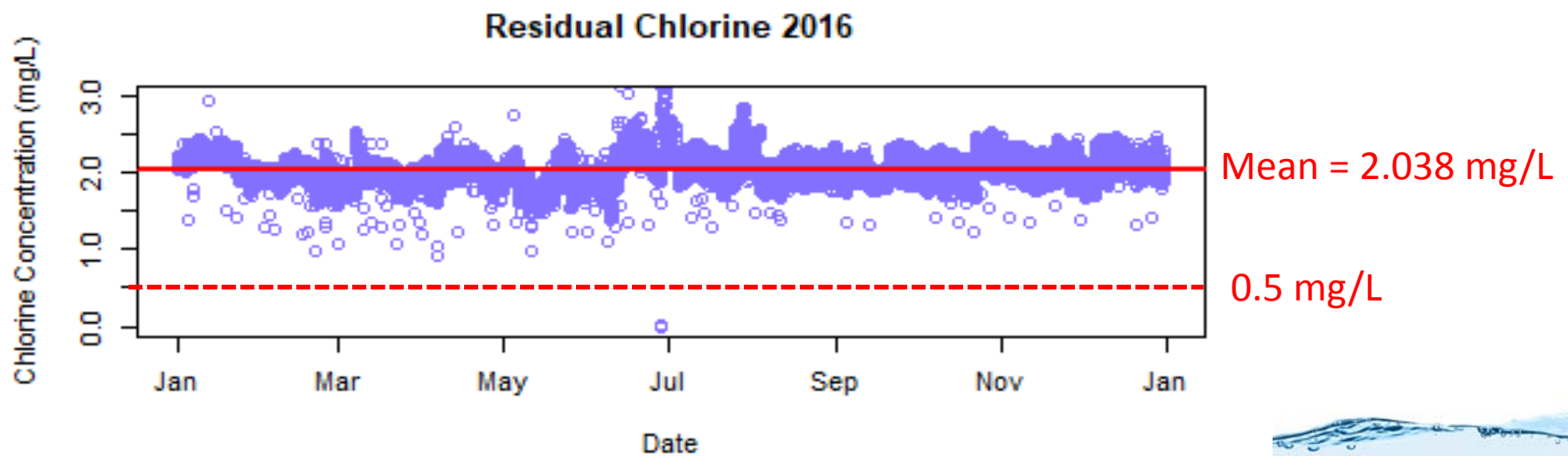
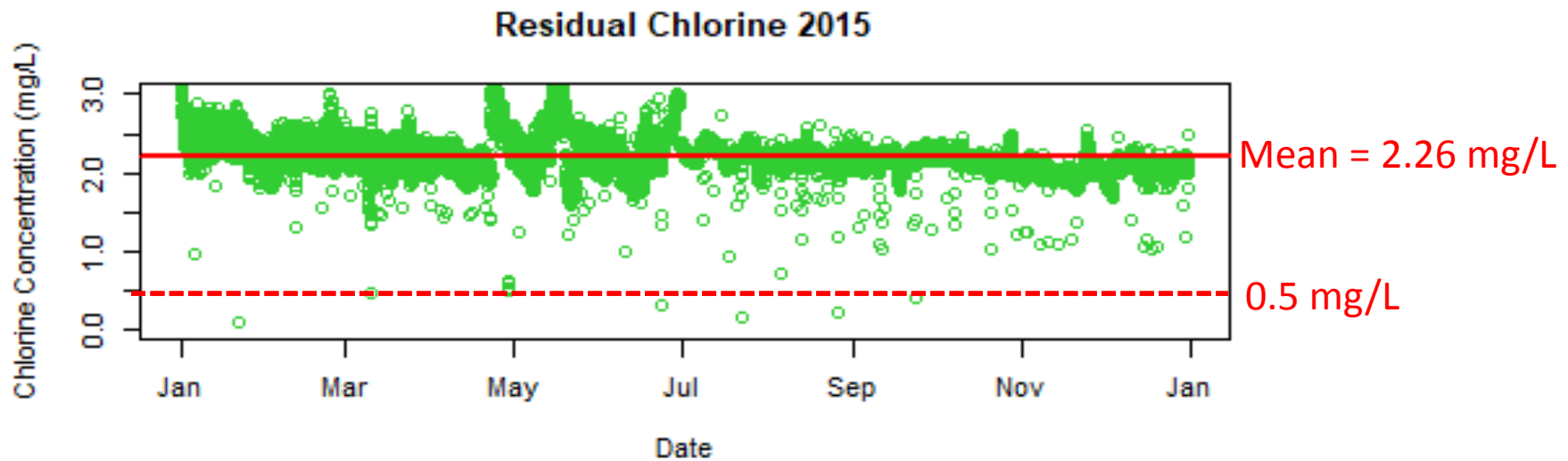
# C.2 SCADA Parameters for Analysis

**8761 Rows**      **24 Parameters**      **6 Years**      **1,261,584 Data Points**

SCADA Parameters	
Raw pH	Filter1 Runtime
Raw Flow	Filter2 Runtime
Raw Turbidity	Filter3 Runtime
Coagulant Level	Filter1 Effluent Turbidity
Stabilization Tank pH	Filter 2 Effluent Turbidity
Oxidation Tank pH	Filter3 Effluent Turbidity
DAF1 Effluent Turbidity	Filter1 Flow Rate
DAF2 Effluent Turbidity	Filter2 Flow Rate
DAF1 Floc pH	Filter3 Flow Rate
DAF2 Floc pH	Chlorine Residual
Treated pH	Clearwell Residual



# C.2 Exploratory Analysis



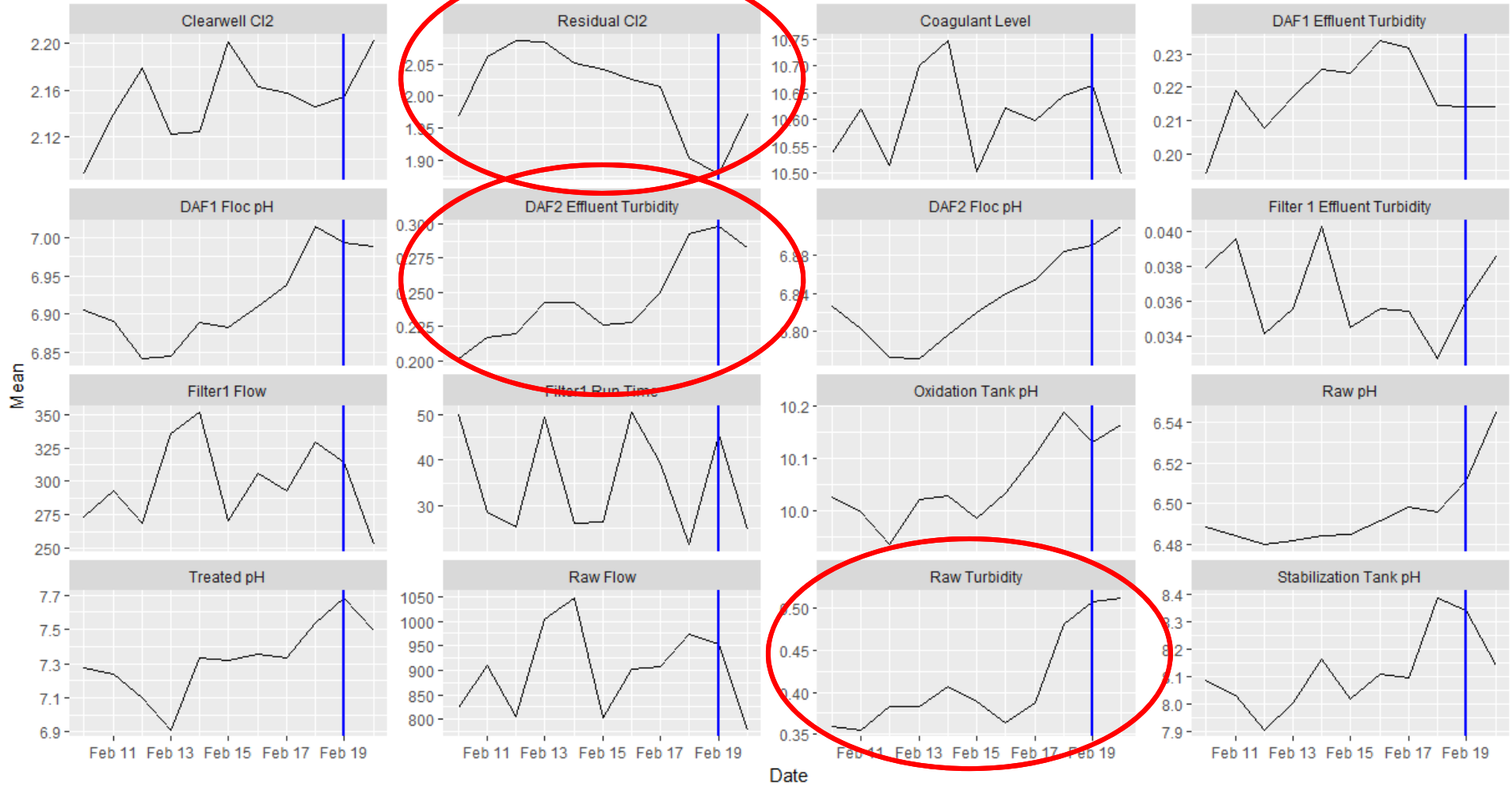


# Task Two: Data Analysis



# C.3 February BWA

February BWA

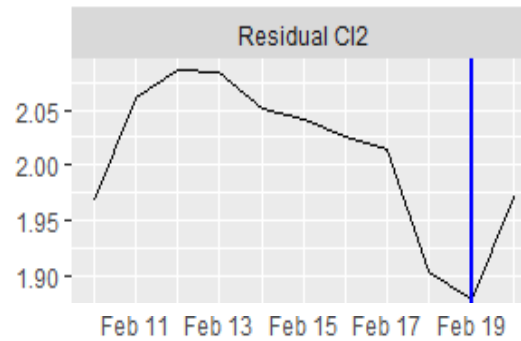
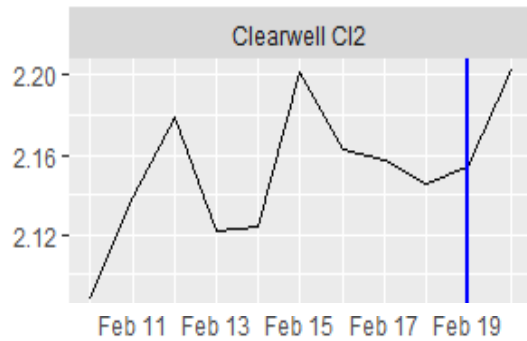


# Isolating Chlorination

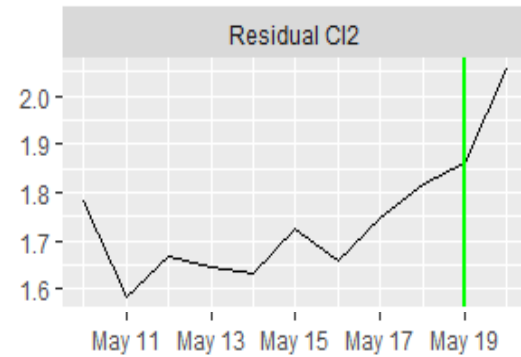
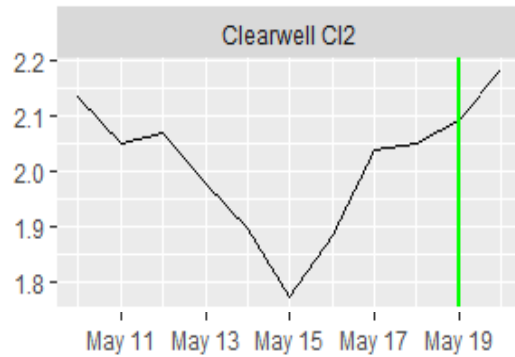
Periods of low chlorine residual before a BWA occurred

Variability in Clearwell Chlorine before events

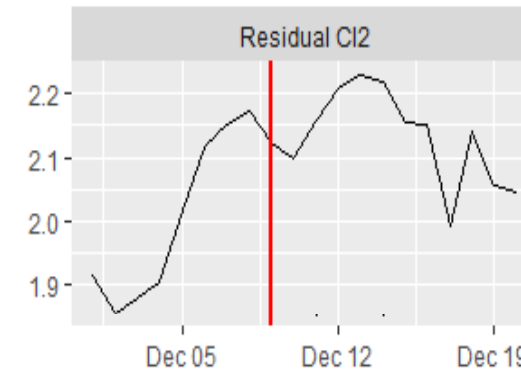
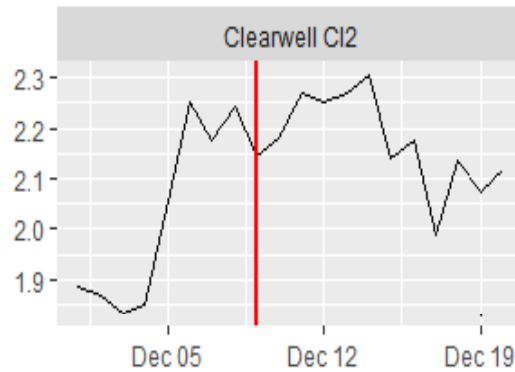
### February BWA



### May BWA



### December BWA



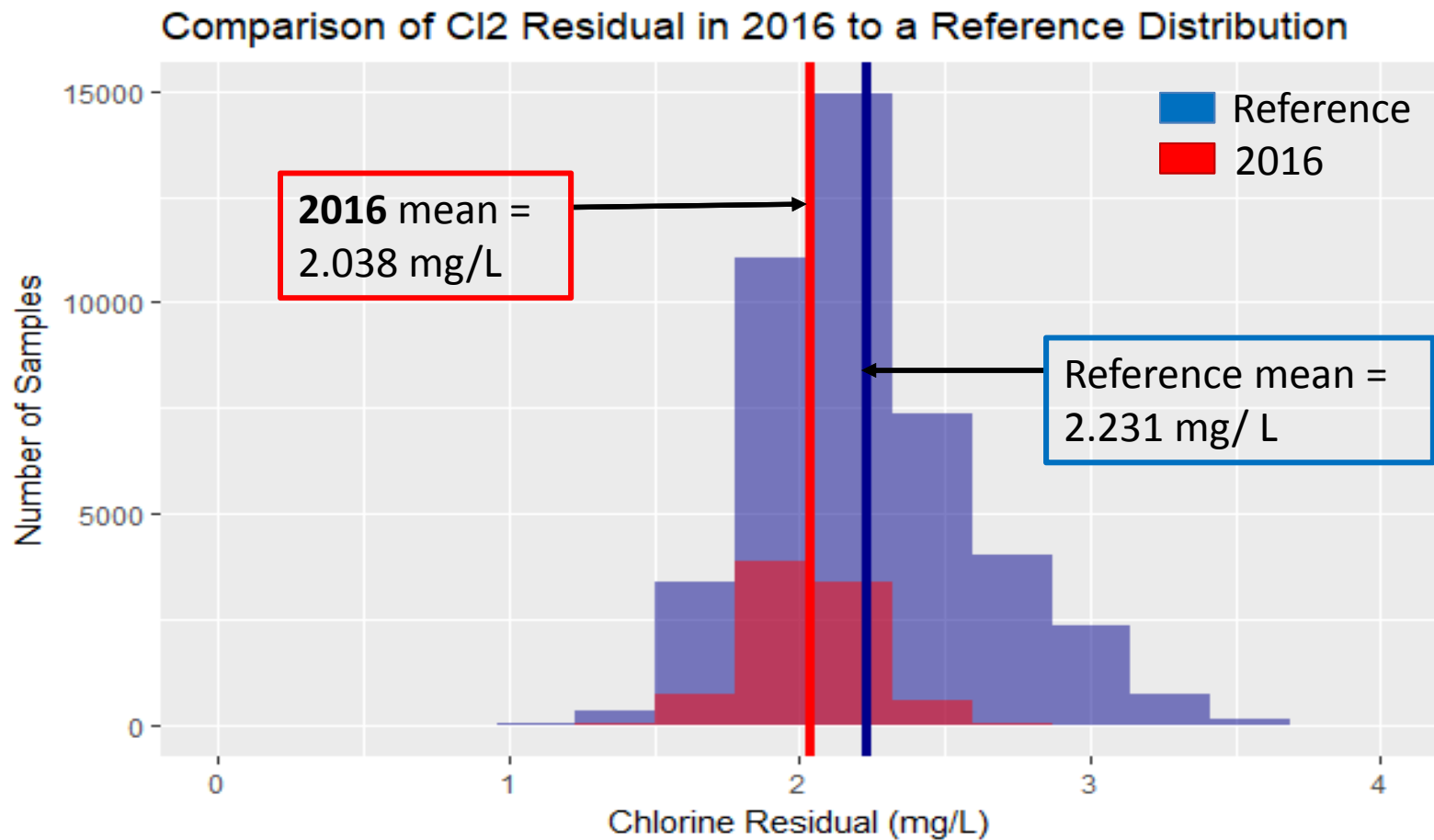


# Task Three: Risk Analysis

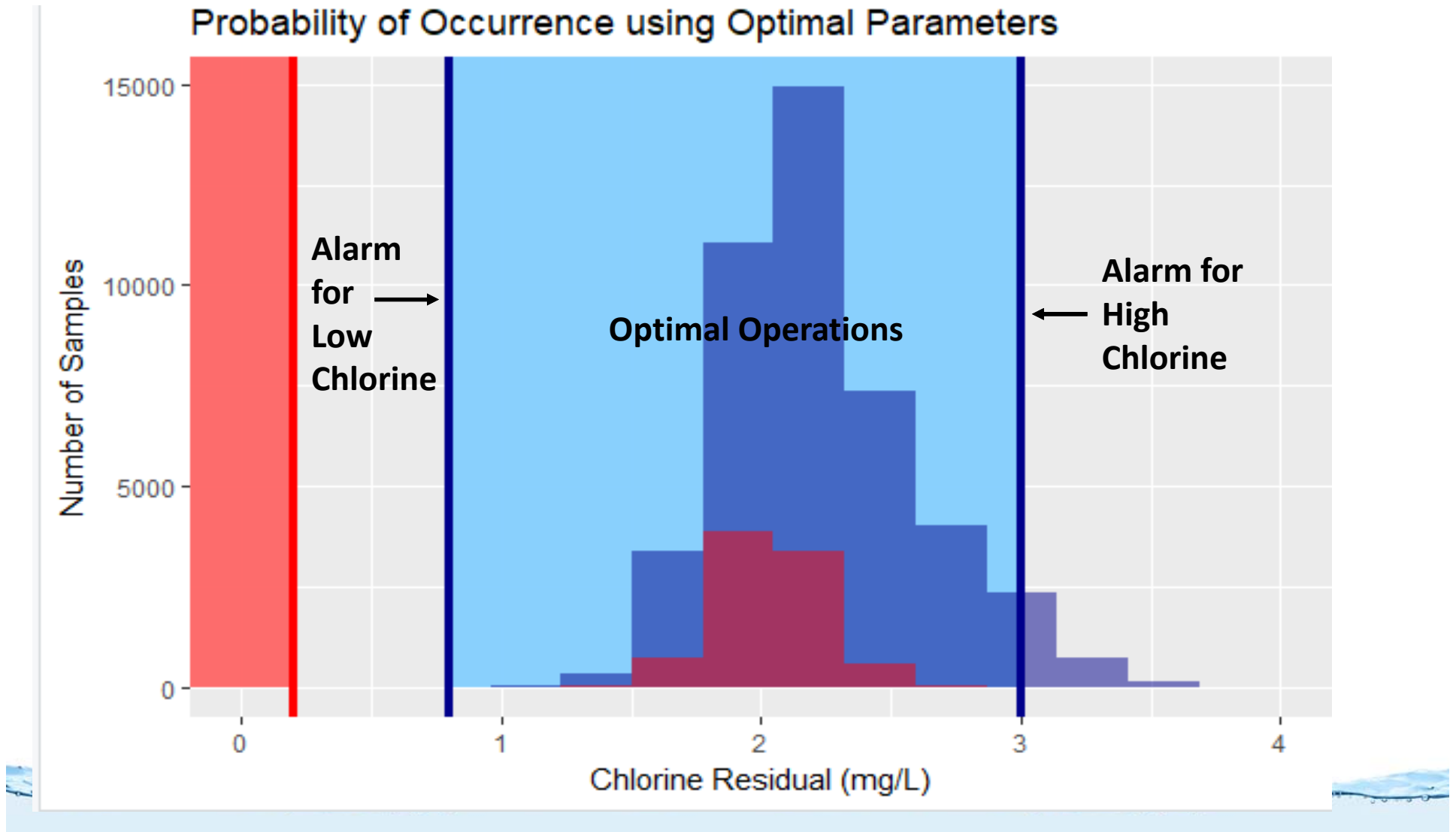


## C.4 Reference Distribution Approach

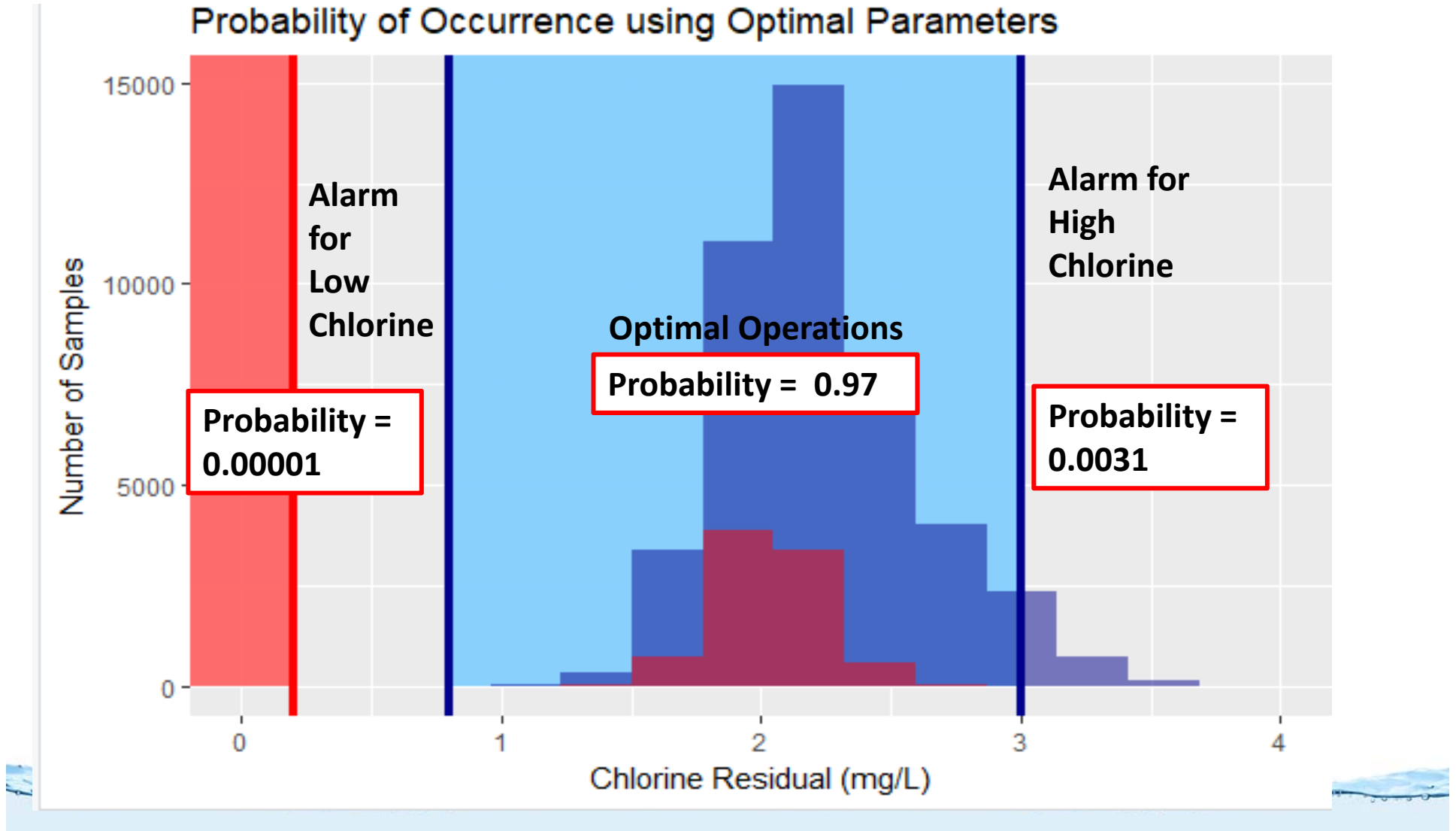
Gather data from 2012-2017 to form a baseline & compare



# C.4 Risk Analysis



# C.4 Risk Analysis







## **C.5 Key Findings**

### **Interviews & Data Analysis revealed that**

- Occurred at peak Filter Run Times
  - Possible floc carry over from DAF
- Rapid decreased chlorine in clearwell

### **Risk Analysis showed that:**

- Normally within optimal operating parameters for chlorine disinfection



## C.5 Key Findings

**Interviews & Data Analysis** revealed that

- Occurred at peak Filter Run Times
  - Possible floc carry over from DAF
- Rapid decreased chlorine in clearwell

Risk An

- Non
- for

**WATER SAFETY PLAN**

Built around understanding  
system behavior

meters



# C.5 Long-term Goal

## CWRS Water Safety Plan

The image shows a screenshot of a web interface divided into two main sections: 'Monitoring' and 'Municipal Treatment Assessments'. In the 'Monitoring' section, a dropdown menu under 'ROUTINE' lists 'Chlorine Monitoring', 'UV Monitoring', 'Filtration Monitoring', and 'UV-LED Monitoring'. The 'UV-LED Monitoring' option is circled in red, with an arrow pointing to a red-bordered box containing the text 'New Methods of Disinfection'. In the 'Municipal Treatment Assessments' section, a dropdown menu under 'SELECT AN ASSESSMENT' lists various treatment processes: 'Chlorine', 'Coagulation', 'Daf', 'Direct filtration', 'Inline coagulation', 'Membrane filtration', 'Mn biofiltration', 'Ph adjustment', 'Plant construction', 'Rapid sand', and 'Sedimentation'. The 'Chlorine' option is circled in red, with an arrow pointing to a red-bordered box containing the text 'Traditional Disinfection'. Both sections also feature 'View Previous Assessments' and 'View Previous Reports' buttons with corresponding icons.

New Methods of Disinfection

Traditional Disinfection



# Summary Thoughts

Water technology is **necessary** for addressing serious public health risk

Proper management and planning is **essential** for long-term success

BWA → Water Safety Planning



# Acknowledgements

The research team acknowledges funding through the NSERC / Halifax Water Industrial Research Chair program and its member partners.

The research team acknowledges the support from participating utilities and research team members that have supported the work to date.



waterstudies.

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# Northumbrian Water Limited



**Private** Water Company in the United Kingdom

Services counties of Northumberland, Tyne and Wear

Revenue: 730.6 million GBP (2012)

Net income: 214.3 million GBP (2012)



# UK – Northumbrian Water

**Generate Assessments**

**Group Assessment Overview**

Asset Type	Water Treatment Works	Hazardous Event Event Stage
Hazard(s)	A4	Number of Assessments
Other Filters		

**Group Assessment Detail**

**Assessment Information**

Assessment Date \*  Assessor   
 Pre-control Likelihood? \*  Pre-control Severity? \*

**Control Measures**

**Assets by Section of WSP**

- Autishutdown
- Reactive maintenance
- Reactive maintenance (holding colour)
- Regular product assessment and review
- Run to waste**
- Standby (personnel)
- Suitable product selection - Chemicals
- Training and procedures
- Visual inspection
- Works shutdown (manual)

**Control Measure Details**

**Control Measure Group**

## Source Asset

- Honey Hill Raw Water- Hyschope Reservoir
- Honey Hill Raw Water - Smiddy Shaw Reservoir
- Honey Hill Raw Water- Waskerley Reservoir (Combined Mains)
- Fontburn Raw Water
- Tosson Raw Water - Tosson Spring
- Broken Scar Raw - Borehole 10
- Broken Scar Raw - Borehole 12
- Broken Scar Raw - River Tees
- Larlington Raw Water - Balderhead Reservoir
- Larlington Raw Water - Blackton Reservoir
- Larlington Raw Water - Grassholme Reservoir
- Larlington Raw Water - Hury Reservoir
- Larlington Raw Water - Hury & Grasshole Mixed
- Larlington Raw Water - Selsot Reservoir
- Bleakridge Raw Water for Murton WTW with disinfection at Bleakric
- Felkington Raw Water for Murton WTW with disinfection at Bleakrid
- Fowberry Raw Water - Fowberry Mains A
- Fowberry Raw Water - Fowberry Mains B
- Wear Valley Raw Water
- Allenheads Raw Water
- Birchtrees Raw Water
- Byrness Raw Water
- Carrshields Raw Water
- Dalton Raw Water
- Fowberry Raw Water - Fowberry Raw Number 1

## Downstream Asset

- Honey Hill WTW
- Honey Hill WTW
- Fontburn WTW
- Tosson WTW
- Broken Scar WTW
- Broken Scar WTW
- Broken Scar WTW
- Larlington WTW
- Larlington WTW
- Larlington WTW
- Larlington WTW
- Larlington WTW
- Larlington WTW
- Murton WTW
- Murton WTW
- Fowberry WTW
- Fowberry WTW
- Wear Valley WTW
- Allenheads WTW
- Birchtrees WTW
- Byrness WTW
- Carrshields WTW
- Dalton WTW
- Fowberry WTW
- Fowberry WTW