



Wastewater Surveillance for COVID19 Virus in NL

Department of Environment and Climate Change

Water Resources Management Division

March, 2022

Outline

The Basics of Wastewater Surveillance for Public Health
Building a Wastewater Surveillance Program from Scratch
Reporting and How Data Has Been Used
Challenges and What We've Learned
Future Uses and Next Steps

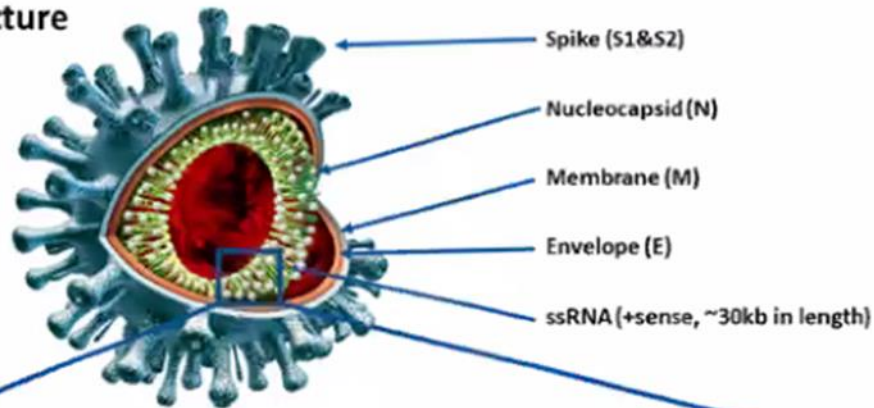
The Basics of Wastewater Surveillance

Wastewater Surveillance Basics

- Wastewater surveillance has been used in the past as a low-cost and non-invasive tool to manage infectious diseases such as norovirus and poliovirus in other jurisdictions
- Supplements clinical surveillance
- During COVID-19 pandemic, SARS-CoV-2 RNA was detected and quantified in wastewater in many locations worldwide

SARS CoV-2 Virus

SARS-CoV-2 Structure



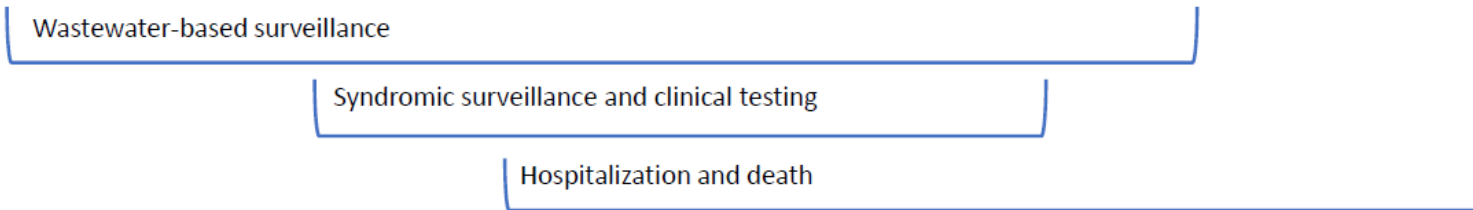
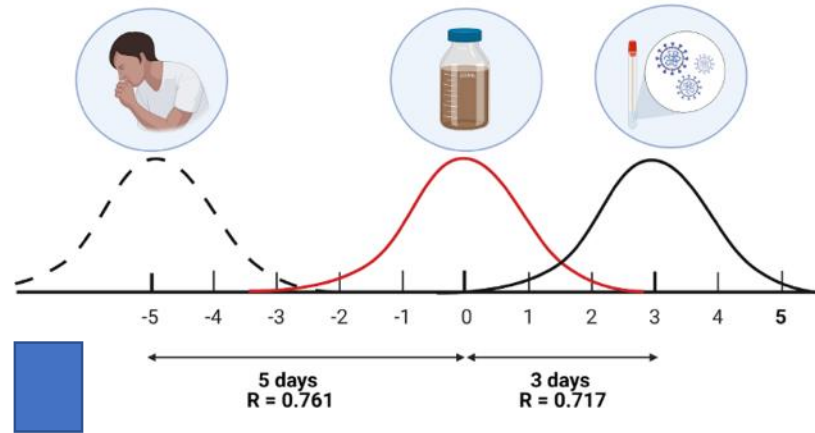
PCR target = CDC N1, N2

<https://www.mdpi.com/2075-4418/10/6/434/htm>

- Virus is encased in an oily envelope
- After it invades our bodies it begins to clone itself
- Copies are shed into our intestines, where the fatty parts of the virus stick to the fats in stool
- When we poop, genetic material from the virus gets flushed down the toilet into the wastewater stream
- Virus can be detected by the same kinds of tests labs use to detect the virus from nasal swabs: RT-PCR

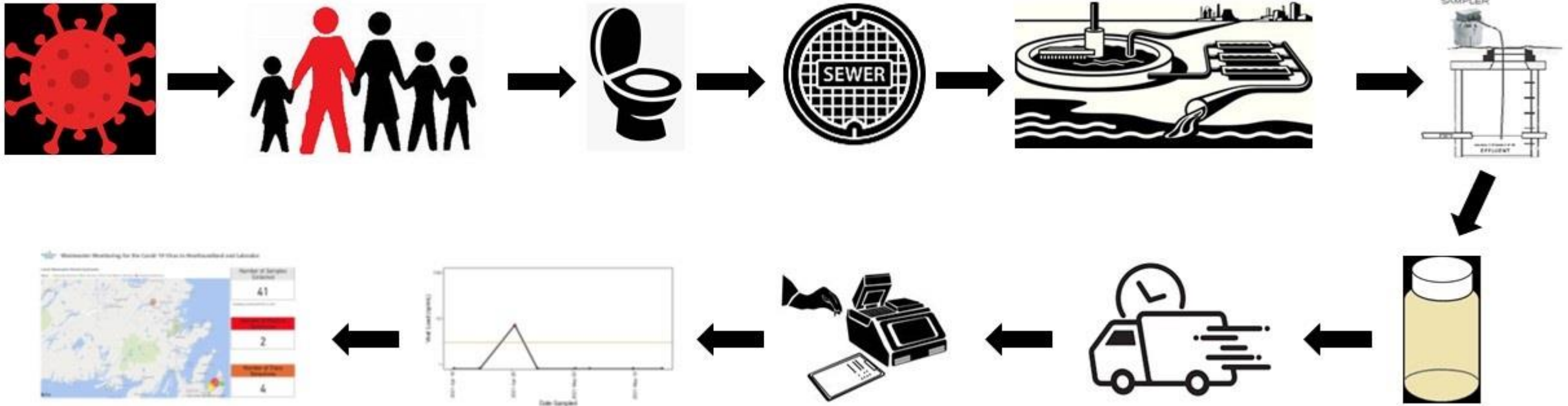
Virus Shedding

Viral shedding (fecal and respirator) increases, levels, and then gradually decreases



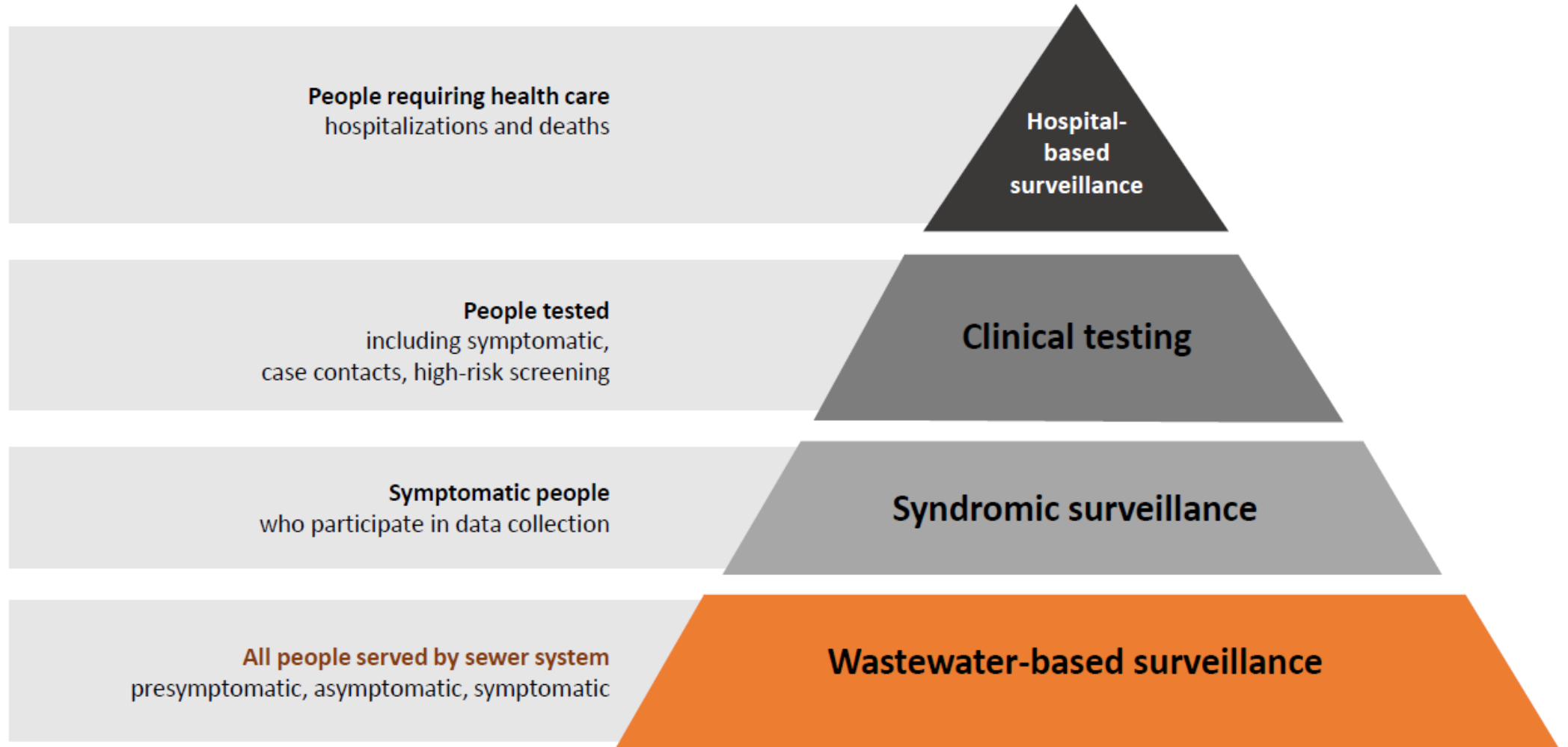
- WW surveillance picks up asymptomatic and symptomatic cases
- WW samples detect Covid19 3-7 days before clinical testing

Premise

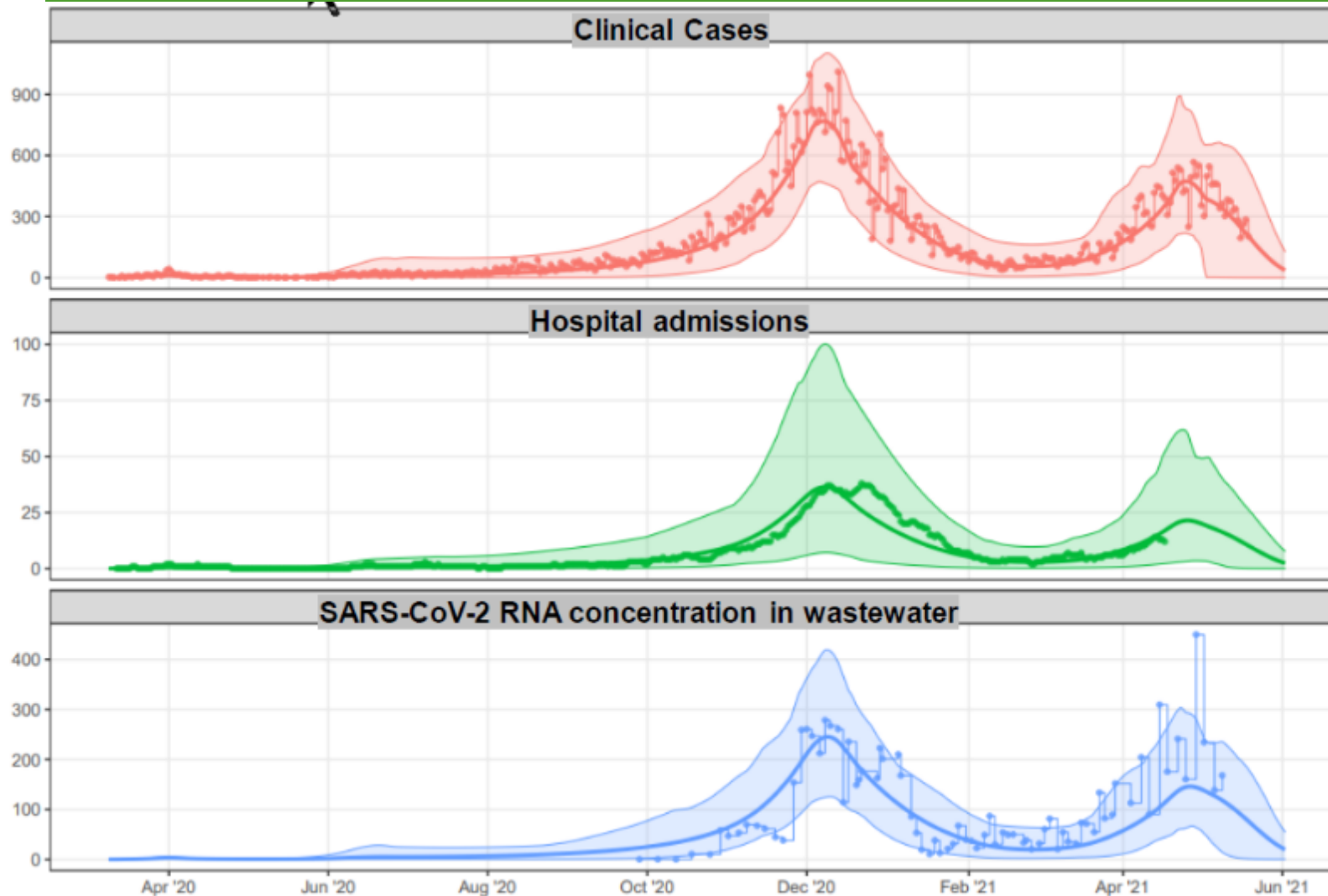


1. Sample is collected from the municipal wastewater system, typically from a wastewater treatment plant before any treatment occurs. Collect either a composite liquid or filter sample.
2. Sample is shipped to a laboratory- National Microbiology Laboratory in Winnipeg does analysis for free.
3. Sample is prepared and virus RNA is quantified using PCR analysis.
4. Results as gene copies/mL are sent to the Department.
5. Special assays or gene sequencing undertaken to identify variants
6. Results are reported via the Results Dashboard on the WRMD website.

Indicators for Covid19



Correlation of WW Data



- Correlation between wastewater data, clinical cases and hospital admissions (data from Edmonton)

Uses During the Pandemic

- Before 2022
 - Early warning of an outbreak
 - Confirmation that there are no cases in a community
 - Basis for Public Health messages
 - Get tested if symptomatic
 - Prevalence of different variants
 - Used to inform predictive models
- 2022 Onward
 - Trend in Covid19 cases
 - 2-6 times more cases than confirmed clinical cases
 - Effects of easing of public health measures
 - Return to school in Jan 2022
 - Lifting of Public Health Emergency in Mar 2022
 - End of pandemic?

Building a Wastewater Surveillance Program from Scratch

History

- Started hearing about other jurisdictions monitoring wastewater for Covid19 back in April 2020
- In Fall of 2020, Eurofins (WRMDs lab for drinking water at the time) informed us they could do analysis of wastewater samples for Covid19
- WRMD and City of St. John's proposed sampling of Riverhead WWTP wastewater to H&CS in Nov 2020
- H&CS greenlit wastewater surveillance for Covid19 in Feb 2021

Partners

Partner	Role
Department of Environment and Climate Change	Sample collection & coordination, community training on sample collection, data interpretation and reporting
Communities	Sample collection, metadata collection
National Microbiology Laboratory	Sample analysis
Department of Health and Community Services	Interpretation, clinical case data, modelling, decision-making and communication

Communities

Community	Population Served
St. John's (x2)	180,000
Paradise	12,387
CBS	18,000
Gander	11,054
HVGB	8100
Clarenville	2400
Corner Brook (x3)	15,490
Deer Lake	5000
GFW	8100
Pasadena	3868
Labrador City	7500
Wabush	1850
Stephenville	6800
Torbay	2100

- Total population of 237,749 included in wastewater surveillance for Covid19
 - Approximately 46% of the population of NL
 - Special sites for MUN and Grenfell campuses

Started in St. John's

- Riverhead WWTP (Southside Rd.) services ~130,000
 - St. John's- 100,000
 - Mount Pearl- 23,000
 - Paradise- 7000
- WWTP has a capacity of 337,000 m³/day, average loading of 134,700 m³/day
- Sampling point after screening, before primary treatment



Auto-sampler

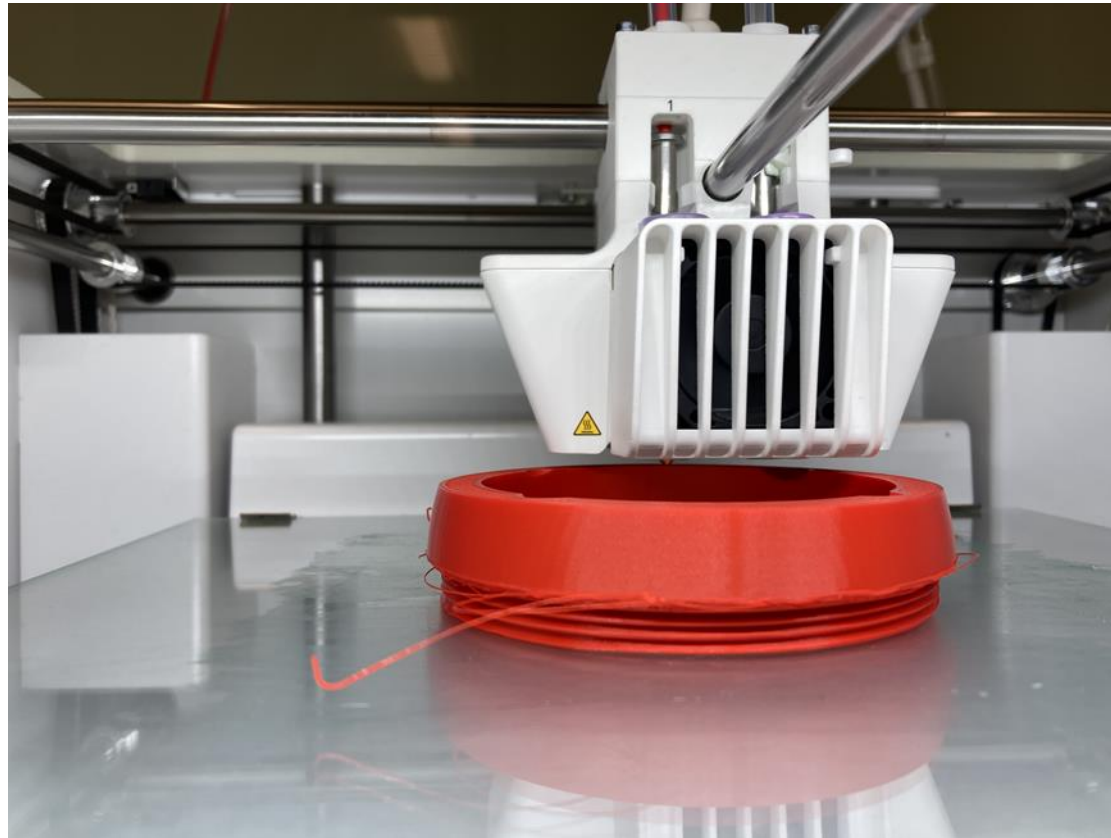
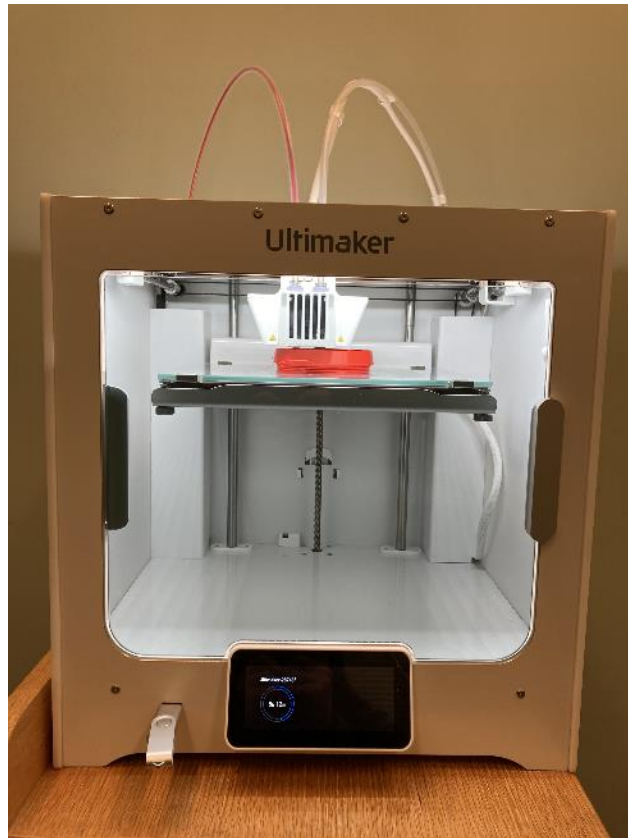


3D printed Cosca ball sampler



Design shared by Dalhousie University

3D Printing



Sampling

- Undertaken by communities mostly
- Use composite auto-sampler (time-proportional) in:
 - St. John's
 - Torbay
 - Gander (during summer)
- Use filters in Cosca balls everywhere else
- 24-72 hour sample
- 25 day sample retention at -2 to 6 °C
- Sampling frequency:
 - St. John's: 2 x per week
 - Torbay: 1 x per month
 - Everywhere else: 1 x per week
- Collect metadata:
 - Flow
 - Weather conditions

NL Covid19 Field Sample Collection Form

1. Date field sample collected: Feb 15/21 Time: 8:00 am

2. Type of sample (check one): Grab Composite
If composite, composite type: Flow Time Composite duration: 24 hrs

3. Collected by: Maurice Clark

4. Location (include street, locality, and/or landmarks, as appropriate):
Riverhead Wastewater Treatment Facility - St. John's, NL

5. Sample ID number/container labeling: 4400-09-001

6. Collection volume (in mL): 6000 Number of aliquots/bottles: 250 mL

7. Wastewater flow rate: 113855 m³

8. Did it rain yesterday? Yes No Did it rain today? Yes No

9. Type of sewer system (check one): Separate Combined

10. Air temperature (in degrees Celsius): -3 °C

11. Sample water characteristics: pH: 7.59 Temperature (in degrees Celsius): 5.2 °C
Total suspended solids: Chlorine residual: N/A

12. Sample transportation/shipping notes:

Other Important Information (If Known)

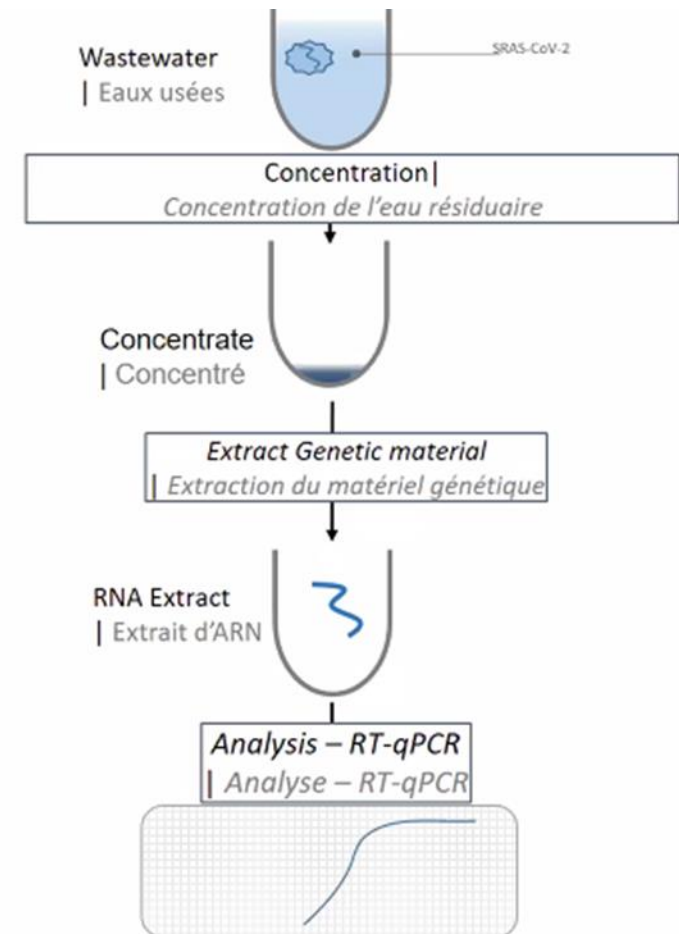
13. Population served: _____

14. Service area notes: _____

15. Public health data: _____

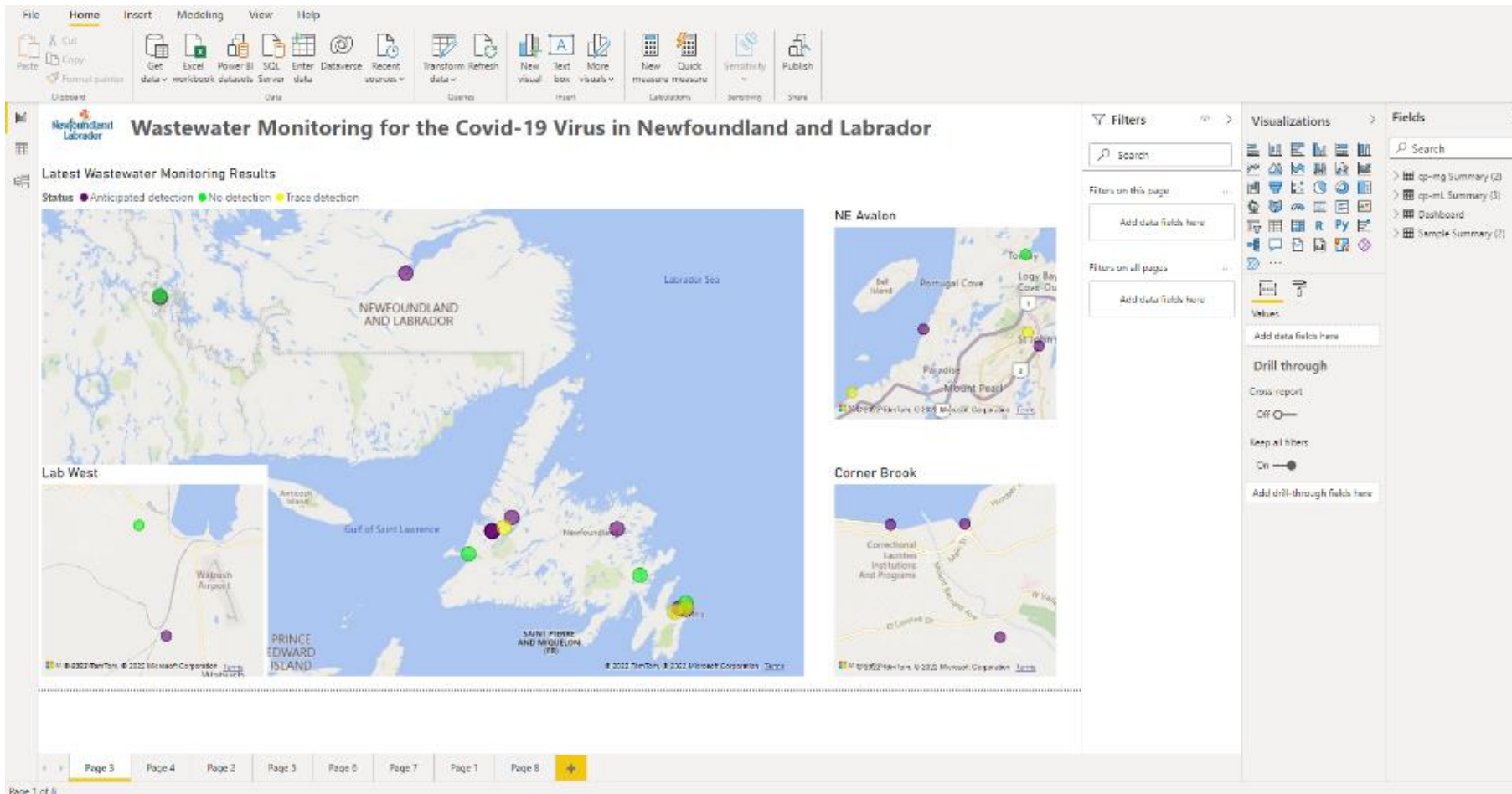
Analysis

- Samples are shipped to the National Microbiology Laboratory in Winnipeg
- RT-PCR analysis
 - The lab tests for 2 target genes (N1/N2) on the SARS-CoV-2 virus genome in accordance with WHO recommendations
 - Low false positivity rates
 - Sensitivity of 1:11,000
 - Gene copies per mL
- Assays to detect variants:
 - alpha, beta, gamma, omicron
- Gene sequencing to detect variant lineages:
 - Omicron BA.1, Omicron BA.2



Reporting and How Data Has Been Used

Dashboard (The Poop Report)

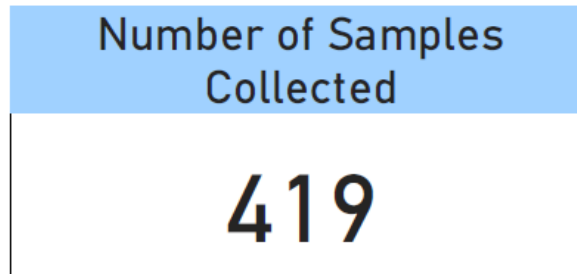


- Dashboard done in PowerBI:
- Useful data visualization tool
 - Input from multiple spreadsheets/databases

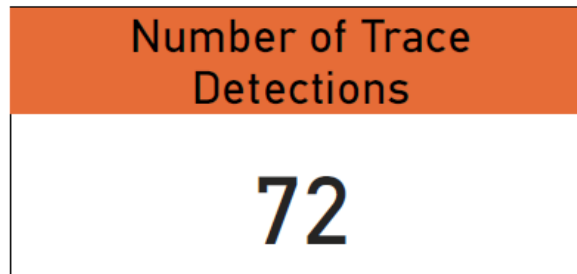
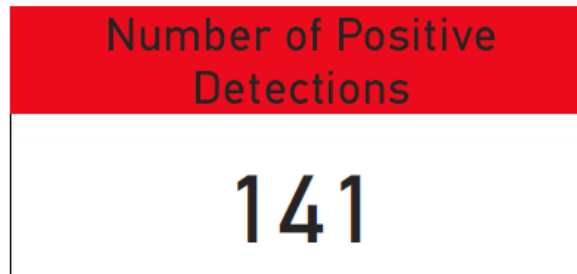
<https://www.gov.nl.ca/ecc/waterres/wastewater-surveillance-for-covid-19-virus/>

17 locations

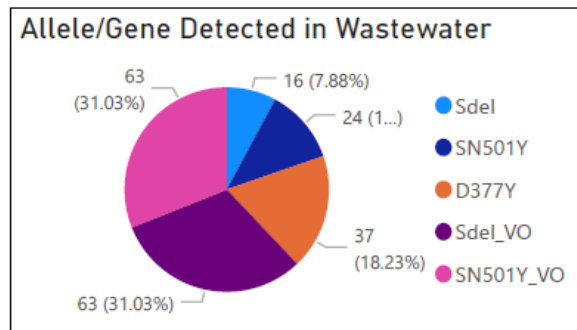
Community	Date of Most Recent Sample	Status	Number of Samples Analyzed	Testing Frequency	Allele/Gene Detected
GFW	07-Mar-22	Anticipated detection	9	1 x week	Sdel_VO, SN501Y_VO
St. John's	07-Mar-22	Anticipated detection	103	2 x week	Sdel_VO, SN501Y_VO
St. John's-Clark Pl-MH	03-Mar-22	Anticipated detection	23	1 x week	Sdel_VO, SN501Y_VO
CBS	02-Mar-22	Anticipated detection	30	1 x week	Sdel_VO, SN501Y_VO
Clarenville	02-Mar-22	Anticipated detection	16	1 x week	Sdel_VO, SN501Y_VO
Gander	02-Mar-22	Anticipated detection	37	1 x week	Sdel_VO, SN501Y_VO
Paradise	02-Mar-22	Anticipated detection	35	1 x week	Sdel_VO, SN501Y_VO
Corner Brook East- Basin G	28-Feb-22	Anticipated detection	20	1 x week	Sdel_VO, SN501Y_VO
Corner Brook West- Basin F	28-Feb-22	Anticipated detection	20	1 x week	Sdel_VO, SN501Y_VO
Corner Brook-University Dr-MH	28-Feb-22	Anticipated detection	18	1 x week	Sdel_VO, SN501Y_VO
Deer Lake	28-Feb-22	Anticipated detection	22	1 x week	Sdel_VO, SN501Y_VO
HVGB	28-Feb-22	Anticipated detection	19	1 x week	Sdel_VO, SN501Y_VO
Labrador City	28-Feb-22	Anticipated detection	16	1 x week	Sdel_VO, SN501Y_VO
Pasadena	28-Feb-22	Anticipated detection	11	1x week	Sdel_VO, SN501Y_VO
Wabush	28-Feb-22	Anticipated detection	17	1 x week	Sdel_VO, SN501Y_VO
Torbay	24-Feb-22	Trace detection	5	1 x month	Sdel_VO, SN501Y_VO
Stephenville	21-Feb-22	Anticipated detection	18	1 x week	Sdel_VO, SN501Y_VO



*Sampling commenced Feb 15, 2021

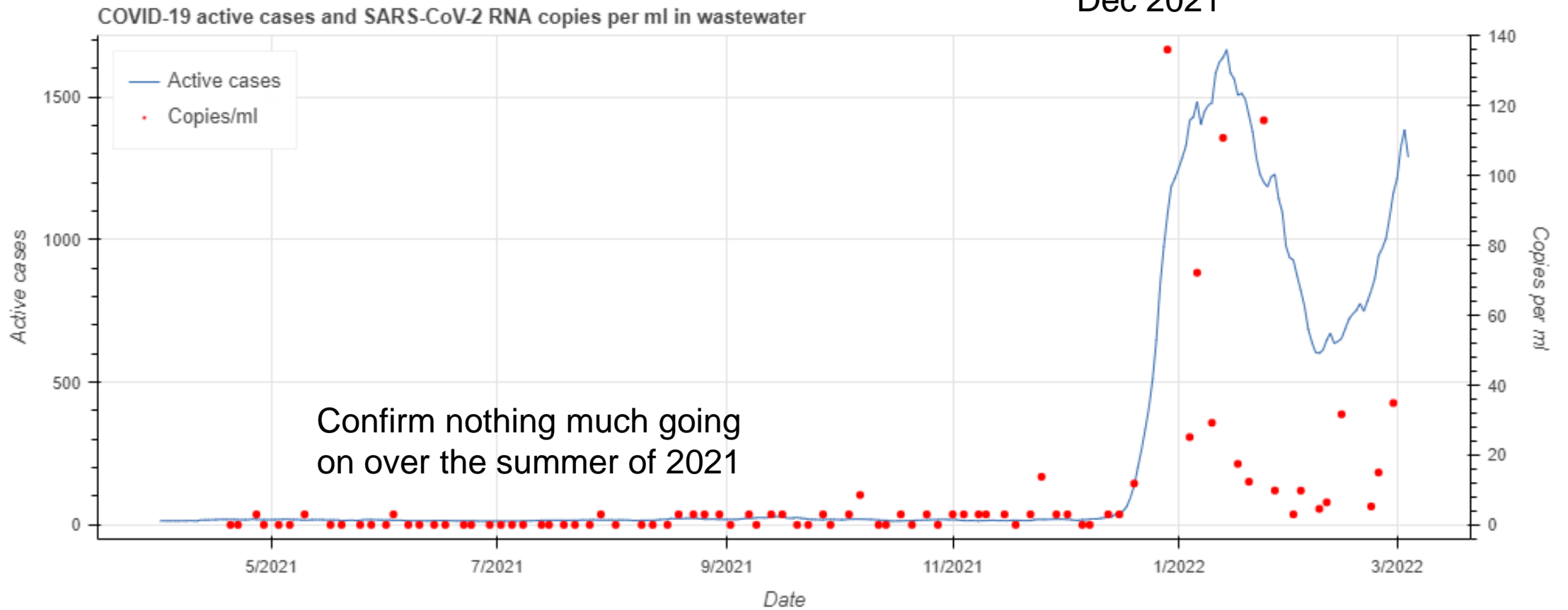


- 1 Change in lab and analysis method after Apr 20, 2021
- 2 St. John's Regional WWTP services most of St. John's, Mount Pearl, and Paradise east of Paradise Rd.
- 3 Variants in the wastewater can be identified through assays to detect specific alleles of the virus gene:
 - Sdel is associated with B.1.1.7 (alpha)
 - SN501Y is associated with B.1.1.7, B.1.351, and P.1. (alpha, beta and gamma)
 - D377Y is associated with the delta variants
 - Sdel_VO is associated with Omicron BA.1
 - SN501Y_VO is associated with the Omicron BA.1 and BA.2
- 4 Change in how lab calculates cp/mL for filter samples after Jan 14, 2022

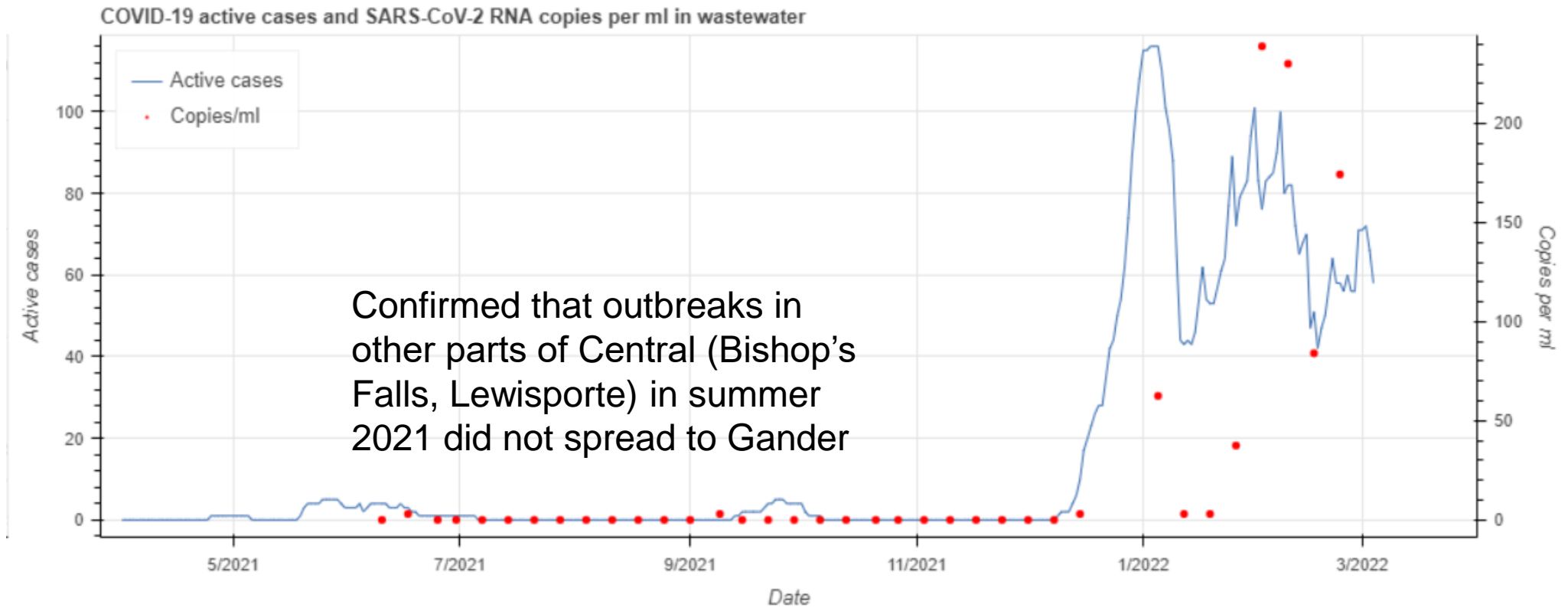


St. John's

Omicron wave
in starts in
Dec 2021



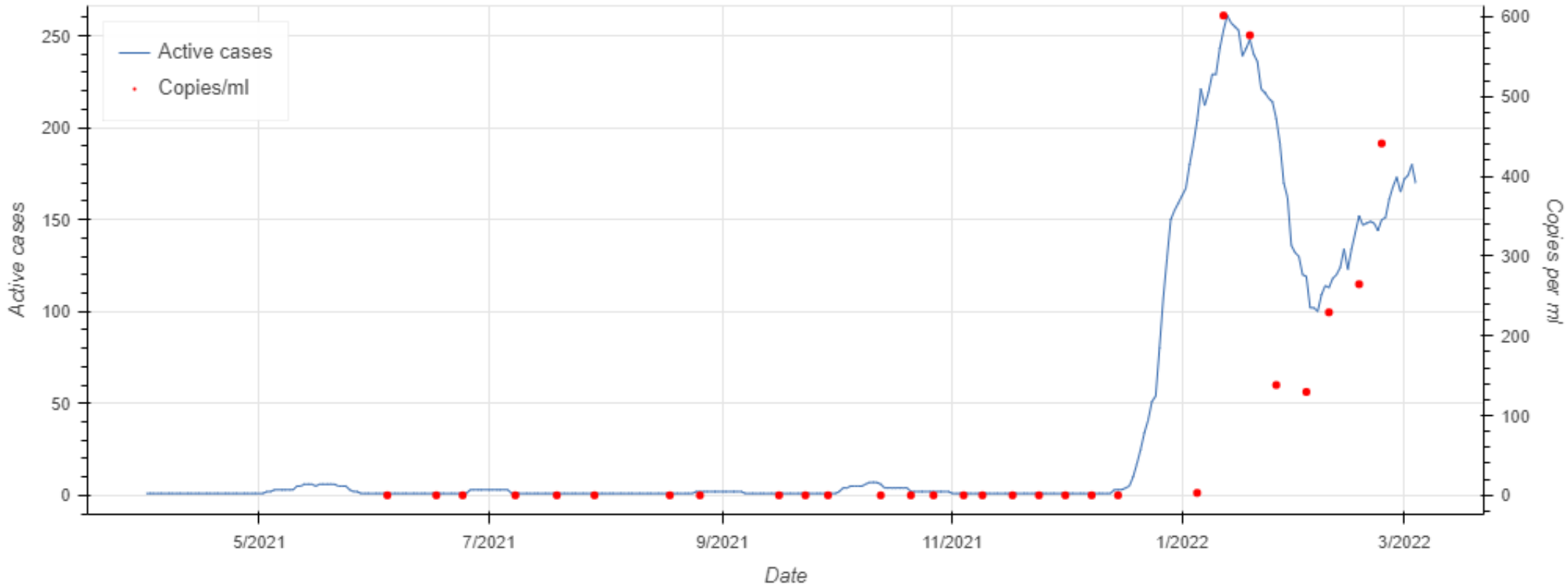
Gander



Confirmed that outbreaks in other parts of Central (Bishop's Falls, Lewisporte) in summer 2021 did not spread to Gander

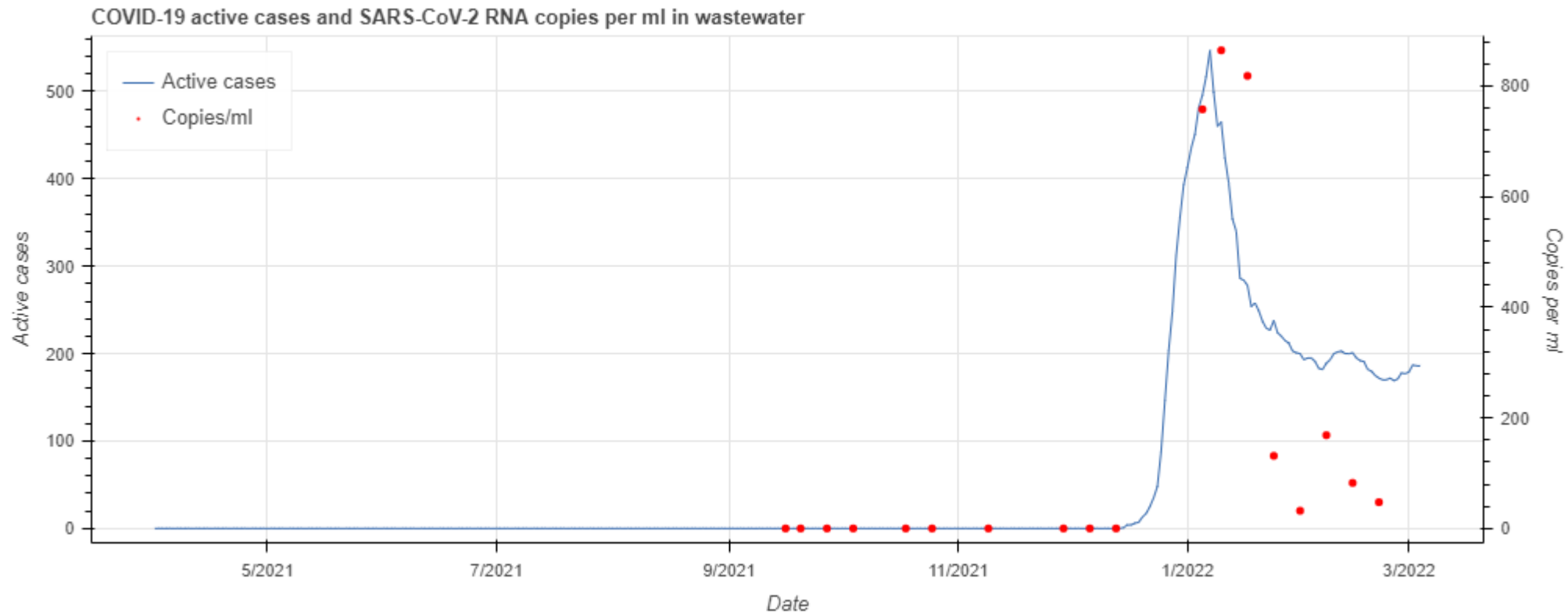
CBS

COVID-19 active cases and SARS-CoV-2 RNA copies per ml in wastewater



- Observe effects of public health decisions:
 - students return to school on Jan 25, 2022
 - Public health emergency lifted on Mar 14, 2022
- Is the trend improving or deteriorating?

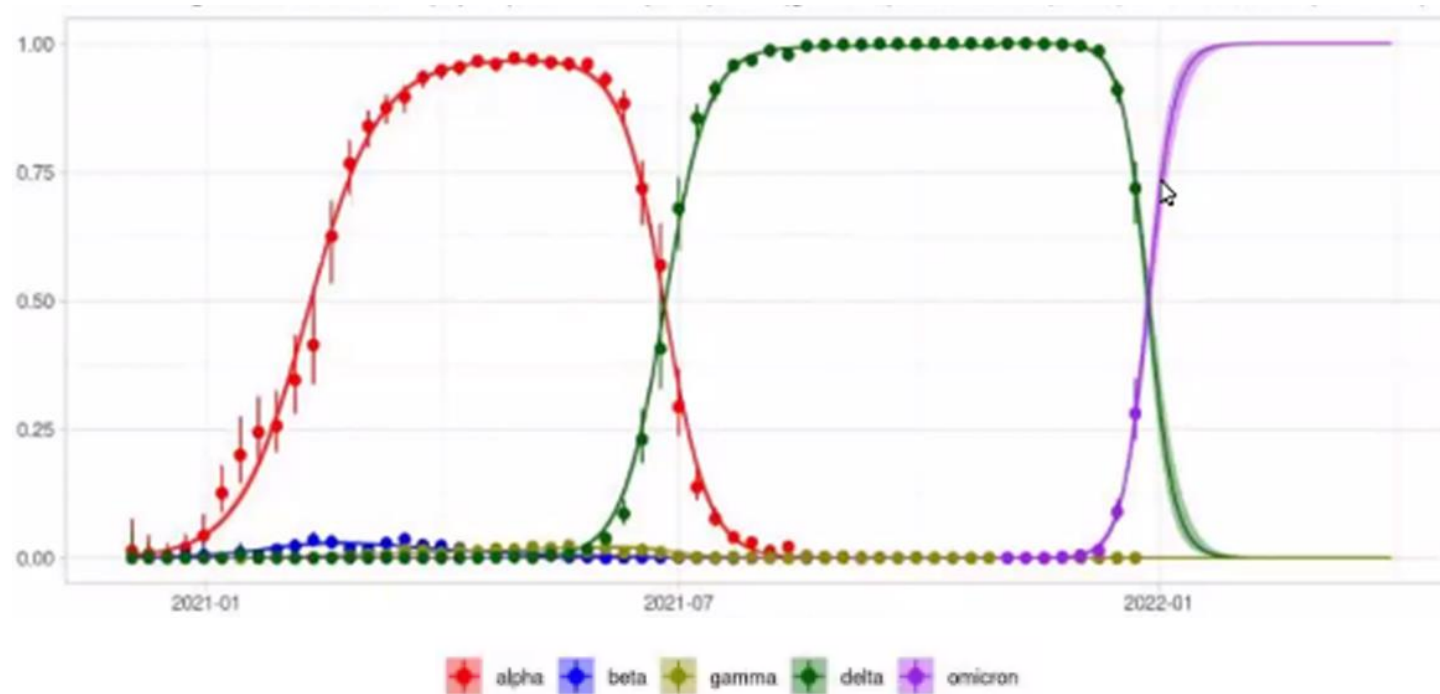
Happy Valley-Goose Bay



Identify the end of the Omicron outbreak and end of the pandemic?

Tracking Variants

General trend in variants observed



- NML was able to provide information on the presence of variants in wastewater

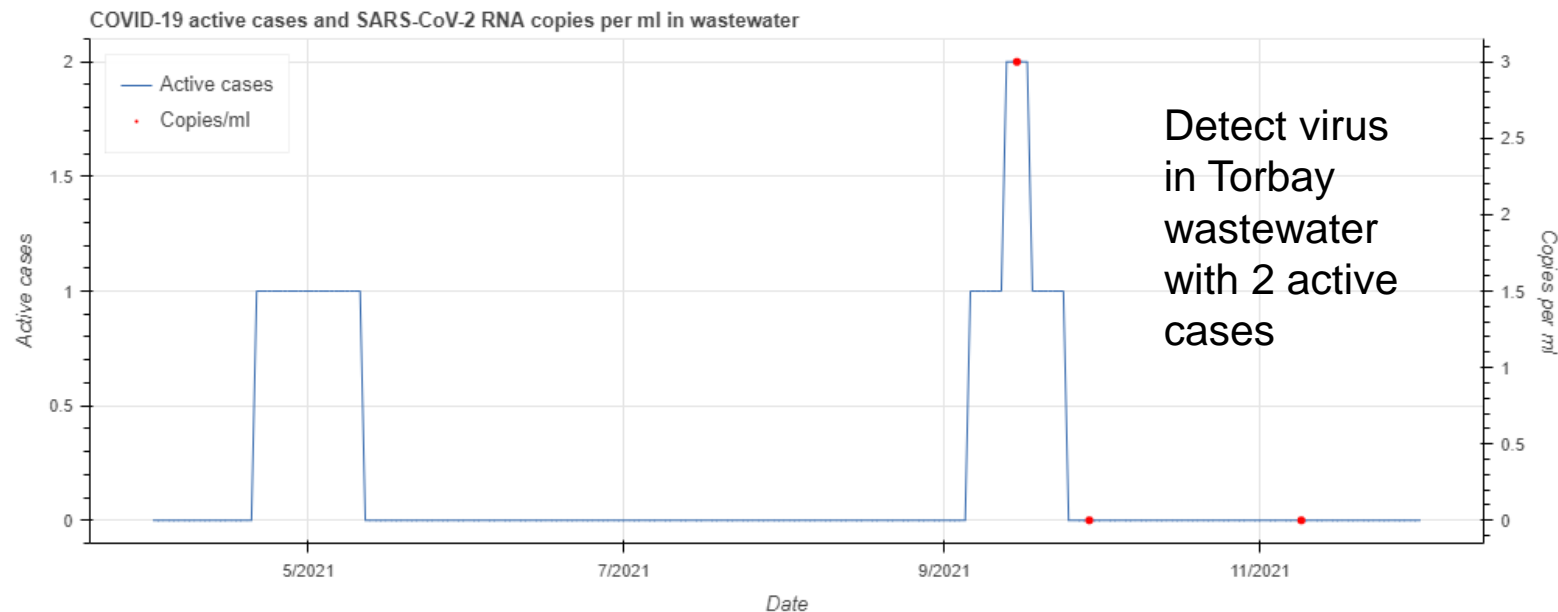
What We've Learned

Main Lessons Learned

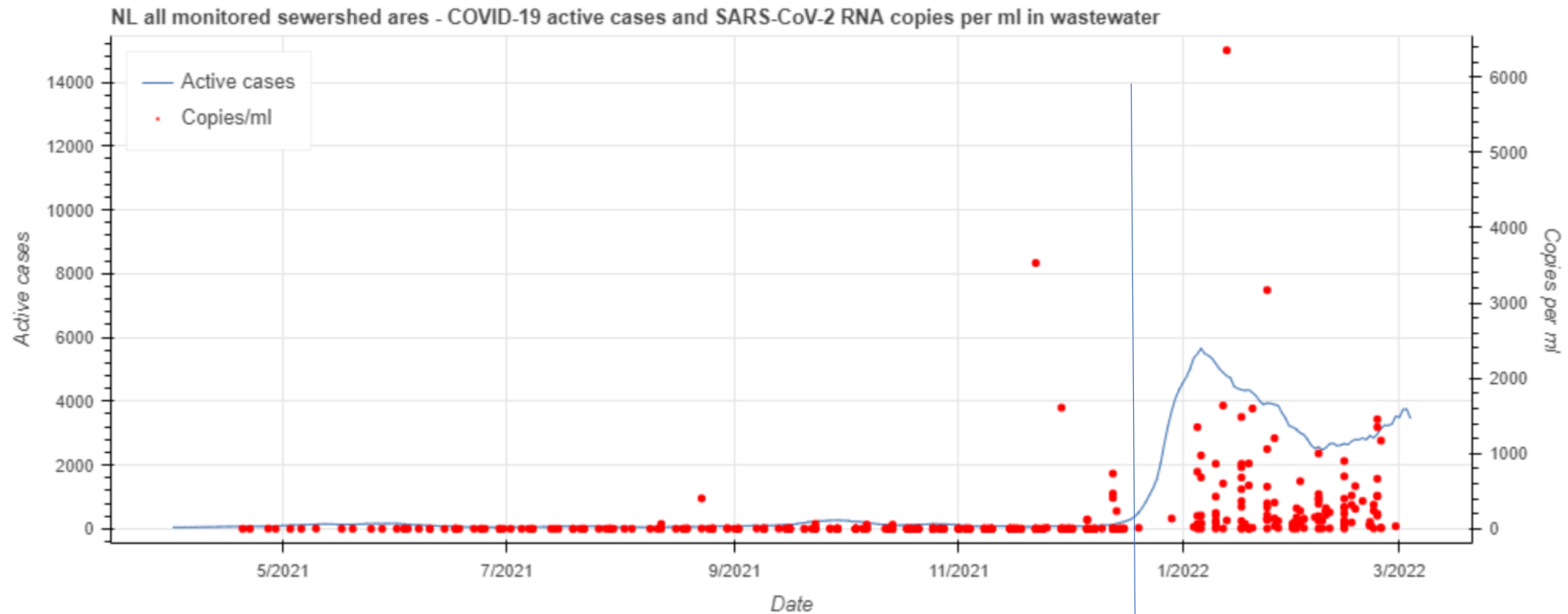
- NL approach saw buy-in from provincial public health, environment and communities
 - In other jurisdictions, wastewater surveillance was led by academia→ data was not incorporated into public health decision making
 - Money eventually ran out where academia was leading the wastewater surveillance efforts
- Establishment of a provincial working group that met every 2 weeks to discuss results, issues, and new advances helped guide development of the pilot program

Accuracy of Results

- Detects a community COVID19 prevalence rate as low as 0.01%
 - 1 virus shedders per 10,000 persons
- Very good sensitivity



A Tale of 2 Pandemics



Before Omicron



After Omicron

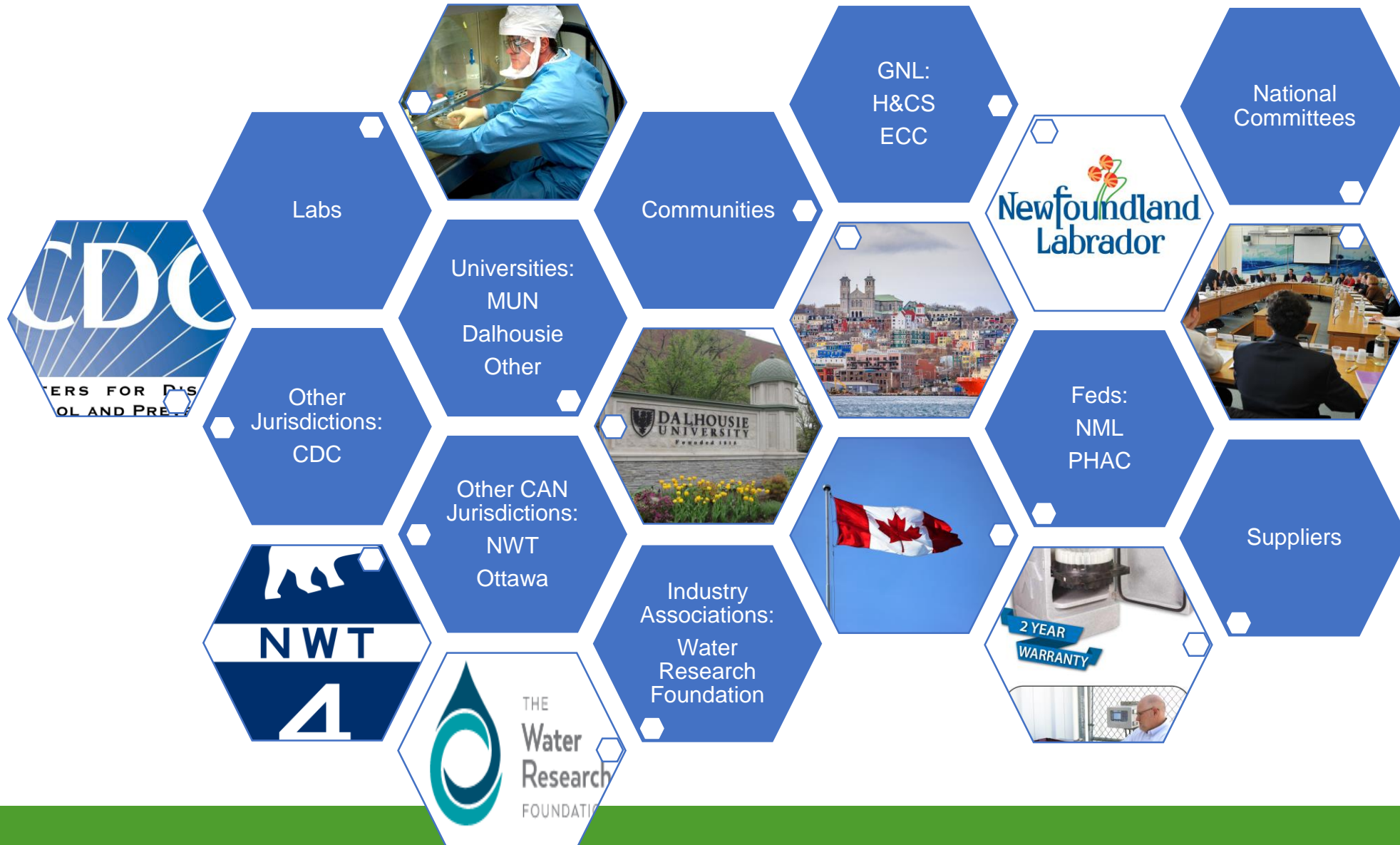
Jan 2022 Onward

- Daily case counts no longer reflect actual case load
 - 2-6 times more cases than being reported
- Wastewater data helped show the spread of Omicron throughout NL and that the containment/suppression approach to the pandemic was no longer valid
- Trends in wastewater have become much more important indicator compared to clinical testing

Challenges

- No laboratory analysis capacity in NL
 - Shipped samples to ON and then MB
- Time to get results ranged from 2-14 days, average ~7 days
 - Negates the use for outbreak detection
- Christmas 2021
 - Staff on holiday
 - Lab and courier closed over holidays
 - People getting sick with Covid19
- Covid19 levels in wastewater affected by:
 - Wastewater flows (high infiltration/inflow in NL)
 - Variation in viral load in those infected: age, variant, vaccination status
 - Collection method
- Lack of comparability between lab analysis methods
- Supply chain issues with supplies (e.g., ran out of filters)

Our Network



Future Uses and Next Steps

Plans in Other Jurisdictions

- Quebec's health department now has a mandate to establish wastewater surveillance in Quebec, with a long term vision including expansion to other pathogens
- SK is "flying blind" with no clinical case reporting- heavy reliance on wastewater data
- NWT are looking into using wastewater surveillance in support of their Syphilis outbreak response
- BC plans to undertake wastewater surveillance for enteric pathogens, respiratory pathogens, and sexually transmitted and blood infections (STBI)
- US CDC has created a National Wastewater Surveillance System
 - Plans to expand the number of pathogens monitored:
 - Influenza, a fungal superbug called Candida auris, E. coli, salmonella

Additional Uses

- Wastewater continues to gain importance in Public Health decision making
 - Understanding what is happening at a community level
- Dr. Theresa Tam referenced wastewater data in her February 18, 2022 presentation on national trends:
 - Wastewater surveillance shows the Omicron wave is ebbing
- Dr. Fitzgerald on Mar 9, 2022 briefing: “We are continuing with wastewater testing and how we will use that as part of our surveillance going forward. One of the silver linings of Covid is that we have learned to use this tool. Hopefully we will see it expanded to look at other types of surveillance for public health.”
- Other parameters for surveillance in wastewater:
 - Illicit drugs (opioids)
 - Anti-microbial resistant superbugs

Next Steps

- Continue Covid19 wastewater surveillance
- Continue to work with NML to see what federal plans are
- Continue to improve data reporting
- Lay groundwork for a permanent program

Questions?

