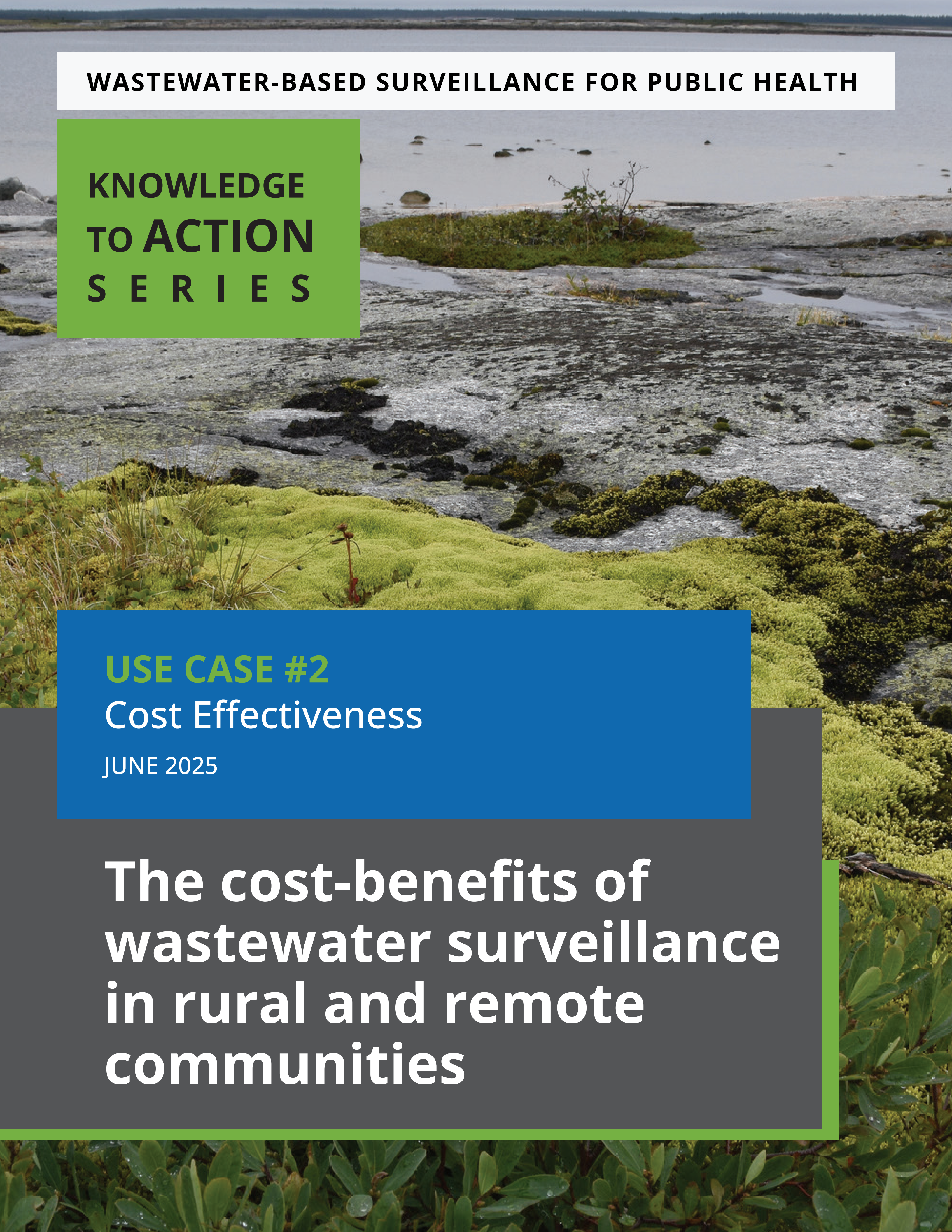


WASTEWATER-BASED SURVEILLANCE FOR PUBLIC HEALTH

KNOWLEDGE TO ACTION SERIES

USE CASE #2

Cost Effectiveness

JUNE 2025

The cost-benefits of wastewater surveillance in rural and remote communities

Overview

This report looks at cost and benefit elements associated with wastewater-based surveillance (WBS) in remote and rural communities in Canada.

Methods

We reviewed the literature on the cost-effectiveness of WBS programs in rural and remote communities and interviewed Dr. Catherine Dickson, Public Health Physician, Cree Board of Health and Social Services of James Bay and Laurence Truong, Water Quality Coordinator of Cree Nation Government. They described an example of WBS launched in James Bay Cree Nation in 2022.

It is important to note that the conclusions below are based on the limited information in the literature and a single use case example of WBS in rural and remote communities, and therefore may not be generalizable to other rural and remote WBS programs.

Resources for Decision-makers

Is your rural or remote community considering wastewater-based surveillance? Here's a tool that can help you undertake a cost-benefit analysis of combined WBS + clinical testing:

Cost-Benefit Analysis of Wastewater-Based Surveillance and Clinical Testing in a Rural/Remote Community (**Excel spreadsheet**)

xls

Use Case of WBS in Rural and Remote Communities

Rural and remote communities in Canada may be more vulnerable to outbreaks of infectious diseases and more severe health outcomes due to factors such as multi-generational and overcrowded housing, limitations of traditional testing methods (e.g., delays in testing samples), populations that are more interconnected (i.e., closer connections between everyone in the community) and difficulties with timely access to healthcare.[1] To help address these concerns, a number of remote communities in Canada have implemented community-led WBS programs to monitor the spread of SARS-CoV-2 and other respiratory illnesses.[2]

As part of our interview, we discussed one potential use case for WBS in rural and remote communities that we will use to describe the cost and benefit elements of WBS. The use case is the early detection of infectious diseases during a pandemic or as part of regular public health surveillance, including respiratory viruses such as SARS-CoV-2, influenza A and B, and respiratory syncytial virus (RSV) to quickly implement public health measures and limit the spread of infection. The description below represents one way a WBS system for rural and remote communities may be implemented, based on the James Bay Cree Nation example and the costs and benefits associated with the implementation.

The development of WBS programs in James Bay Cree Nation communities were based on existing WBS programs for northern and remote communities. During the COVID-19 pandemic, the Public Health Agency of Canada's National Microbiology Laboratory (NML) played an important role in implementing WBS in remote communities, providing necessary testing supplies such as test tubes and bottles, lending a GeneXpert, training personnel and ensuring ongoing quality assurance on-site.[1] WBS was initially launched in the James Bay Cree Nation's largest community, Chisasibi, in June 2022. The program was expanded in four other communities during the pandemic. Currently, the system is in place in two communities: one on the coast and one inland. Following First Nations principles of ownership, control, access and possession (OCAP), the communities are the owners of the information from the WBS programs and decide how to use it.

The aim of the James Bay Cree WBS program was initially to track the spread of COVID-19 in areas with limited access to lab testing to ensure public health measures could be taken in the event of viral detection to limit the size of a potential outbreak. More recently, WBS has been used to notify clinics about the spread of viruses within the community so they can initiate preventative measures and manage limited healthcare resources (e.g., lab equipment, clinical tests) and staff in these communities. There are plans to explore the potential of WBS to support surveillance efforts for other high-impact diseases like avian influenza because goose hunting is a major activity.

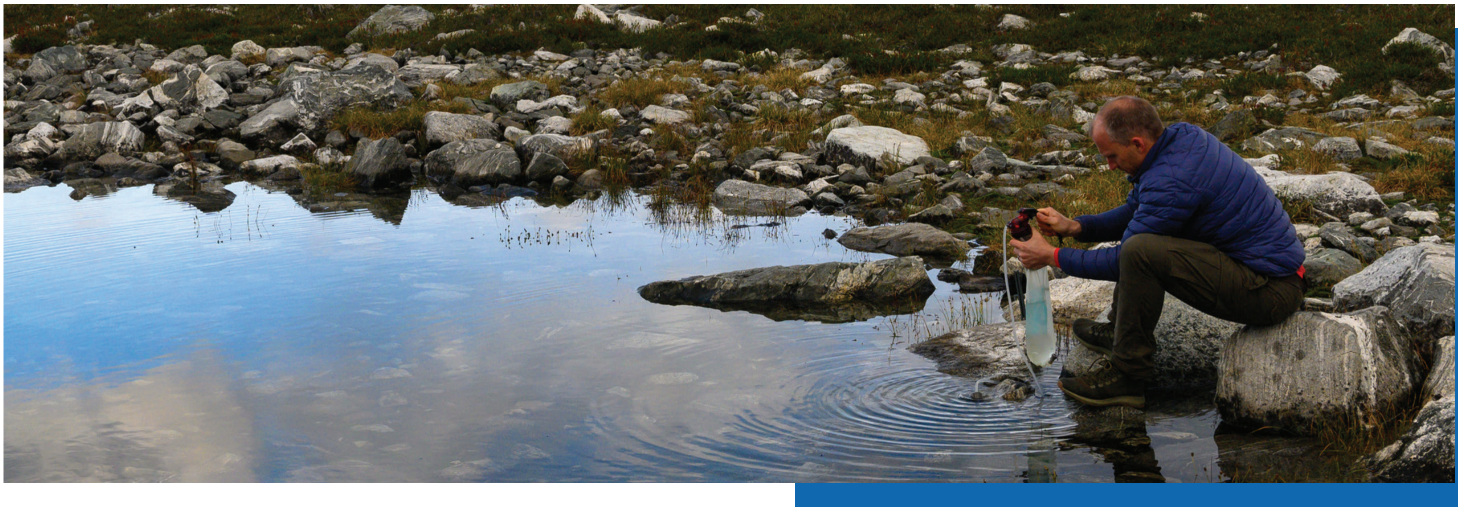
The WBS program in James Bay Cree Nation runs in concert with the clinical lab-based surveillance system. However, it may also be used as an alternative to population-based testing during an outbreak to identify when an infection is present in a community. The Chisasibi and Mistassini communities both have labs that test clinical samples from all nine communities that are part of the James Bay Cree Nation. All laboratory samples need to be sent to these labs or to labs in larger cities, such as Montreal.

Moreover, the communities also have syndromic surveillance, where clinics provide weekly reports on the number of patients visiting and the proportion showing respiratory symptoms. Syndromic surveillance may be seen as an alternative to WBS. However, it should be noted that there are concerns that syndromic surveillance does not provide consistent and timely reporting of infectious diseases in the community.

Benefits and Costs of WBS in Rural and Remote Communities

To conduct a cost-effectiveness analysis for rural and remote communities, researchers need to compare the costs and outcomes of having a WBS program to an appropriate alternative. Two potential alternatives to WBS in remote and rural communities could be status quo or enhanced clinical surveillance during a pandemic. The status quo is defined as how case identification currently happens in these communities when there is no information from WBS; for instance, clinical testing when symptoms arise. Enhanced clinical surveillance during a pandemic could include symptomatic testing, testing of close contacts or population-based testing. The cost-effectiveness of a WBS program is determined by comparing benefits such as quality of life, deaths averted and hospitalization and healthcare costs saved, with the costs of WBS in rural and remote communities. By combining benefits and costs for both WBS and status quo, we can estimate a cost per health outcomes saved (e.g., cost per life saved, cost per QALY saved). There are two options to make this comparison: 1) real-world data analysis, where health outcomes and costs are compared between communities — with and without WBS — after controlling for other factors that can impact these outcomes or 2) a modelling study of the impact of early detection of respiratory viruses on health and healthcare outcomes and costs using available data.

Which benefits and costs are included depends on whose perspective you are using for the analysis. For this overview, we focused on a healthcare perspective, which looks at the health outcomes and costs but not broader impacts such as productivity loss from work time lost.



Benefits

The key benefit of WBS identified by the experts we interviewed in comparison to the status quo is the information it provides on infectious disease activity in the community to inform decision-making. This information can be helpful during a pandemic or outbreak or as part of regular disease surveillance in the community. WBS can provide early warnings of potential outbreaks, allowing for the implementation of public health measures[1] such as increased clinical testing, community-level education on infectious disease spread, coordinated vaccine information and clinics, and increasing contact tracing — all of which can help limit the spread of the disease. Additionally, with this information, people in the community can adopt more precautionary measures, such as staying home when sick, practicing sanitization and other preventative actions. These public and individual-level measures could ultimately result in a reduction in the number of infections, leading to decreased healthcare and associated costs, including fewer doctor visits, emergency room visits, hospitalizations, medical travel, reductions in medication and decreasing deaths. Moreover, by reducing these negative health and healthcare outcomes, WBS may also lead to improvements in community quality of life.

It is often possible to get results from WBS faster than clinical testing, because less testing is required to obtain information about infectious disease activity across the entire population. During a pandemic, this information could be invaluable in reducing the need for isolation (e.g., if no pathogen is detected in the community, then fewer isolation requirements may be necessary) and helping to manage health resources that may be very limited (e.g., clinical tests available, staff time to swab community members). In the absence of a WBS program during a pandemic, healthcare systems in these communities may have no alternative but to expand healthcare and testing capacities. This may lead to isolating more individuals while they wait for their results, which is both costly and time-consuming. Prolonged isolation, especially during a pandemic, could lead to substantial quality of life impacts.

Costs

The key costs of the initiation and implementation of WBS in rural and remote communities in comparison to status quo include: the costs of purchasing, installing and maintaining equipment (e.g., autosampler and GeneXpert for each community), the cost of materials (e.g., gloves, bottles, reagent, absorbent materials, coolers, ice packs, laptop, centrifuge filters, gene expert cartridge), shipping costs (e.g., packing boxes, community charter flight, etc.), travel costs for WBS experts to help train staff, cost of labour (e.g., training cost, wages of technicians, trainers and samplers) and data management and reporting costs.

It is worth noting that implementing WBS in rural and remote communities may not require extensive infrastructure, as it may be possible to use existing equipment and personnel already engaged in environmental or clinical testing programs. For example, the cost of autosamplers and the time to sample the wastewater may be covered by the environmental testing programs in these communities. Therefore, WBS could be used as a potentially low-cost surveillance method[3] that can complement clinical testing. A study by Ngwira et al. (2022) showed that the cost per sample for WBS in rural and low-income communities is low and is associated with economies of scale.[4]

Moreover, if WBS provides an alternative to individual clinical testing (e.g., population-based testing during a pandemic), then that should be compared with the costs associated with those methods, including healthcare provider time — which can be very limited in rural and remote communities, as well as transportation of all individual samples (versus transportation of WBS samples) and testing costs for all the individual samples either in an internal or external lab. In both WBS and clinical lab testing methods, equipment, lab and transportation costs are the major cost components, especially as the samples often need to be sent by charter flight for testing. However, these costs are considerably larger for clinical testing, where there are typically more samples to be shipped and tested.

Limitations and Considerations

Rural and remote communities may encounter significant challenges for initiating and implementing a WBS program, which may impact the costs and benefits. For instance, the considerable distance to research and government facilities capable of conducting lab testing for WBS may increase costs, and the limited public health staff in communities may make it difficult to review the results and act on them.[2] Additionally, a lack of personnel, equipment or specialized expertise for wastewater sampling could limit the ability of authorities in these areas to initiate and effectively implement a WBS program.[2] WBS in communities would also not comprehensively capture all community members, especially individuals who spend a substantial amount of time outside the community (e.g., camping or hunting), meaning their samples may not be integrated in the WBS testing. Finally, if communities do not already have an accessible wastewater system, the costs of setting up a WBS system would be very high. At the same time, WBS in rural and remote communities may find economies of scale by piggybacking off other surveillance taking place in the community (e.g., environmental testing, transportation of staff and patients) which reduces the costs of running a WBS program and helping to improve its cost-effectiveness.

Additional challenges in conducting a cost-effectiveness analysis in rural and remote settings include the difficulties of estimating what would have happened without a WBS system in place, and to appropriately measure the incremental benefits and costs associated with WBS in these communities. Moreover, a societal perspective may be more important to use in community-based WBS, as the benefits of reducing infections may be broader than just health. These broader benefits (e.g., the impact of travel, isolation and sickness on paid and unpaid labour) would require additional data gathering.

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Wastewater-Based Surveillance for Public Health:
A Knowledge-to-Action Series. Part 4. Cost-Effectiveness Use Cases.
The Cost-Benefits of Wastewater Surveillance in Rural and Remote Communities

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