COVID-19: Development of a portable detection device for SARS-CoV-2 in wastewater

Sponsor

The Public Health Agency of Canada (PHAC) in collaboration with the National Research Council of Canada (NRC)

Program

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Description

SARS-CoV-2, the causative agent of COVID-19, can be detected in wastewater either by detection of the virus, its breakdown products, antibodies produced in response to the virus or other compounds produced in response to the virus. Wastewater based detection of SARS-CoV-2 provides early warning to the emergence of outbreaks and can monitor community infection trends. Wastewater signals can inform more efficient public health action and help mitigate the social and economic impact of the COVID-19 pandemic. For wastewater monitoring of SARS-CoV-2 to be successful in providing actionable public health intelligence these signals must be detected quickly, and directly at the point of sampling. Ideally, a portable detection device would be compatible with multiple types of wastewater, including raw wastewater, primary influent, mixed liquor, and secondary effluent (before disinfection).

Current wastewater surveillance is hampered by delays along the axis of sample collection, sample transportation, laboratory processing and data reporting. Sampling upstream in the sewershed requires laborious and costly sampling to be useful. There is a need for a portable end-to-end SARS-CoV-2 wastewater detection device that can expedite this process. Such a device will provide rapid public health intelligence at both the city and neighbourhood scale.

Essential (mandatory) outcomes

Phase 1

Proposed solutions must:

1. Operate in the field without laboratory support.
2. Be simple to operate with minimal training.
3. Operate in a simple and straight-forward manner. The operator's role should only be to

insert a wastewater sample for analysis and then request analysis, or the device should have the capability to autonomously sample wastewater (see additional outcomes).
4. Specifically detect and report SARS-CoV-2 concentration in wastewater. The concentration must be reported as a numeric value (viral copies/mL or another acceptable method of reporting concentration) or within defined concentration ranges.
5. Specifically detect and report the concentration of at least one fecal indicator (e.g. Pepper Mild Mottle Virus, crAsshpage, etc.). The concentration must be reported as a numeric value (viral copies/mL or another acceptable method of reporting concentration) or within defined concentration ranges.
6. Ensure any hazardous and non-hazardous waste produced during sampling or analysis is stored safely for later disposal and firm must arrange for disposal.

The firm must ensure that:

7. It has access to wastewater for sampling/analysis in one or more locations that are highly likely to have detectable concentrations of SARS-CoV-2 and locations that are highly likely to not have detectable concentrations of SARS-CoV-2.

Phase 2

Proposed solutions must:

1. Be capable of analyzing multiple forms of wastewater, i.e. raw wastewater, primary influent, mixed liquor, and secondary effluent (before disinfection).
2. Operate in multiple types of field situations, e.g.:
    - At a sewage treatment plant sampling from the influent main or the primary clarifier or an installed sampling port.
    - At a sewer main with person access either by sampling with an extendable sampling device or by sampling personnel entering the access hole to descend to the flowing wastewater.
    - At a sewer line with an access port at ground level.
    - Inside a building at a sewer line/pipe with an access port.
    - At a lagoon or septic tank.
3. Utilize an internal process control to monitor assay performance.
4. Have a lower limit of detection of 30 viral copies / mL in wastewater, with a sensitivity of 95% (As compared to laboratory developed RT-qPCR tests).
5. Have analytical processes that are robust against interference from wastewater constituents, and any incompatibility with wastewater constituents must be well defined to the user.
6. Be resilient to clogging from particulates and debris within the wastewater during the operation of device, with minimal pretreatment in the field required.
7. Store data on-board. The device should be able to store at least 7 days worth of data assuming that up to 30 samples per day could be analyzed. Alternatively relay data in real-time or in near real-time batches to a related field device and contain a system for relaying data to a central repository via internet or cell network.
8. Have security measures in place to reasonably protect any stored or transmitted data.
9. Have the option to password protect both the operation of the machine and retrieval of

the data.
10. Be able to operate in all weather conditions expected to be encountered in Canada.
11. Operate on internal or external battery power, and be able to operate for 24 hours in the field without the need to recharge power supply.
12. Possess a unique identifier (e.g. serial code, QR or bar code) for each unit.
13. Be intrinsically safe for all situations including confined spaces if it is intended to be used in confined spaces or sites with fire/explosion hazards.
14. By the end of Phase two, must have a set of Standard Operating Procedures to accompany it.
15. Field demonstrate, in the last 4-6 weeks of Phase 2, a performance comparable to the current PHAC test, which minimally consists of molecular detection by a qPCR test using two gene targets (e.g. N1 and N2 genes) from a minimum processed volume of 30 ml. Gold standard testing can be performed by the National Microbiology Laboratory or an accredited lab provided the samples are submitted in a blinded and anonymized fashion. Multiple municipalities, facilities or locations may be required in Phase 2 demonstration. PHAC and/or NRC staff may accompany the firm in the field and may assist in arranging for sampling sites.

Additional Outcomes

Proposed solutions should:

1. Run continuously for a period of three days on battery power, and without the need to resupply reagents.
2. In addition to operating on battery power, operate on electricity provided by the electrical grid or a generator or a portable stand-alone battery.
3. Have a built-in error indicator for all scenarios including sampling process, equipment/battery failure, and internal quality control failure. Ability to remotely transmit errors over cellular or local wireless data networks.
4. Have built-in memory and analytical functions to record and perform basic analysis to notify the operator any alarming trend or anomaly.
5. Store and transmit its GPS coordinates over a remote data network.
6. Provide physiochemical analysis of the wastewater, including turbidity/total suspended solids, temperature of incoming wastewater.
7. Have the ability to be easily modified or configured to add or change to detect other known or unknown pathogens found in either the soluble or insoluble wastewater factions.
8. Have compatibility with sludge as an alternate sample input.
9. Have capabilities of autonomous wastewater sampling with the following parameters:
    - A variable integration time for the analytic pipeline as selected by the users (e.g. 2 hours to 24 hours).
    - Capability to draw subsamples of wastewater with at a time resolution of 5 minutes or less.
    - Concurrently sample wastewater while simultaneously analyzing a previously collected sample.
    - Store multiple (120) refrigerated aliquots of sample for later retrieval of at least 100 mL each, or a single large aliquot of at least 18 L.
    - Have the ability for operational parameters (e.g. sampling rate) to be controlled

remotely over cellular data or local wireless networks.

10. Accommodate a large process volume (e.g. >100 mL) to minimize sampling biases.
11. Monitor and record flow parameters in the wastewater.
12. Lift wastewater from a height of at least 28 ft.
13. Accommodate both low (e.g. institutional) and high flow (e.g. wastewater treatment plant) wastewater streams.
14. Have positive and negative control materials available that can be used to monitor device performance.

Background

Currently, COVID-19 wastewater testing is being performed by molecular detection using RT-PCR technology. This is occurring in public health, industrial and academic laboratories and introduces several challenges, including sample routing (from sampling point to lab) that result in delays in reporting. Mobile testing at the point of sampling would mitigate these delays and improve the usability of wastewater surveillance of SARS-CoV-2 and allow for real time data collection.

PHAC will:

- Assist in arranging for split samples to be analyzed at a NML site.
- Cover costs related to NML sample analysis.

Eligibility

Solution proposals can only be submitted by a **small business** that meets all of the following criteria:

- for profit.
- incorporated in Canada (federally or provincially).
- 499 or fewer full-time equivalent (FTE) employees.*
- research and development activities that take place in Canada.
- 50% or more of its annual wages, salaries and fees are currently paid to employees and contractors who spend the majority of their time working in Canada.*
- 50% or more of its FTE employees have Canada as their ordinary place of work.*
- 50% or more of its senior executives (Vice President and above) have Canada as their principal residence.*

*Calculations must take into account and include affiliated businesses, such as parent companies and subsidiaries, that are either in or outside of Canada.

Only applicants/bidders that are eligible businesses can respond to a challenge. However, applicants/bidders are allowed to use sub-contractors to perform the anticipated work in Phases 1 and 2. Sub-contractor(s) may be academic, industrial or not-for-profit. Applicants/Bidders must perform at least two-thirds (2/3) of the research and development (R&D) work in Phase 1 and a half (1/2) of the work for Phase 2. The remaining R&D can be sub-contracted to other organizations or individuals.

Funding Availability

Multiple grants could result from this Challenge.

Phase 1:

- The maximum funding available for any Phase 1 Grant resulting from this Challenge is: $150,000.00 CAD.
- The maximum duration for any Phase 1 Grant resulting from this Challenge is: 4 months.
- Estimated number of Phase 1 grants: 2.

Phase 2:

- The maximum funding available for any Phase 2 Grant resulting from this Challenge is: $350,000.00 CAD.
- The maximum duration for any Phase 2 Grant resulting from this Challenge is: 6 months.
    - Note: Only eligible businesses that have completed Phase 1 could be considered for Phase 2.
- Estimated number of Phase 2 grants: 1.

Maximum Project Value

Please see 'Funding Availability' for details.

Indirect Costs

15%

Project Duration

- Phase 1 projects have a maximum duration of four months.
- Phase 2 projects have a maximum duration of six months

Special Notes

Travel

The firm will have to travel to the sampling sites in both phases and perhaps to one of the National Microbiology Laboratory sites in Phase 2 (Lethbridge, Winnipeg, Guelph, St. Hyacinthe).

Kick-off meeting

Via videoconference or teleconference.

Progress review meeting(s)

Any progress review meetings will be conducted by videoconference or teleconference.

Final review meeting

All communication can take place by telephone, videoconference, and WebEx.

Please note that research activities carried out in the context of COVID-19 need to adhere to the University of Guelph COVID-19 research principles, policies, guidelines and processes as they may be updated from time to time and communicated on the Office of Research web-page [1].

Deadlines

If College-level review is required, your College will communicate its earlier internal deadlines.

Type	Date	Notes
Internal Deadline	Monday, May 31, 2021 - 4:30pm	Researchers participating in a project where University of Guelph would be a sub-contractor submit all application documents, along with an OR-5 Form, to research.services@uoguelph.ca [2].
External Deadline	Thursday, June 10, 2021 - 2:00pm	Once approval is received from University of Guelph for participation as a sub-contractor, eligible Companies submit their application through the COVID-19 Challenge Website [3].

How to Apply

Researchers participating in a project where University of Guelph would be a sub-contractor submit all application documents, along with an OR-5 Form, to research.services@uoguelph.ca [2] before 4:30 p.m. on May 31, 2021.

Once approval is received from University of Guelph for participation as a sub-contractor, eligible Companies submit their application through the COVID-19 Challenge Website [3].
For Questions, please contact
All incoming questions regarding this specific challenge should be addressed to solutions@canada.ca [4].

All enquiries must be submitted in writing no later than ten calendar days before the Challenge Notice closing date. Enquiries received after that time may not be answered.

You can also consult the Frequently asked questions [5] about the Innovative Solutions Canada Program.

A glossary [6] for the Innovative Solutions Canada Program is also available.

Office of Research

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