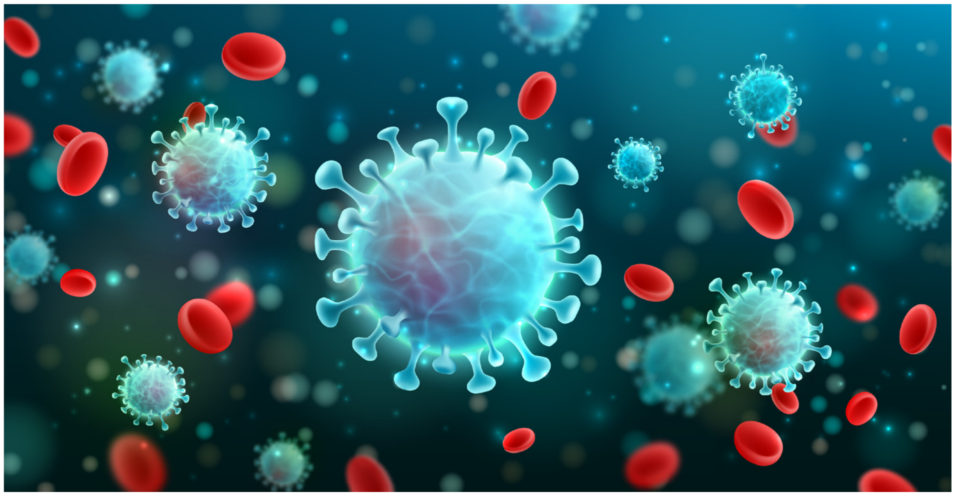
Smart Note

Wastewater surveillance of COVID-19

Why is wastewater surveillance of COVID-19 necessary?

Wastewater (i.e., sewage) testing for SARS-CoV-2 (the virus that causes COVID-19) can be helpful to public health agencies and government officials as a novel complement to existing COVID-19 surveillance systems. Monitoring wastewater for SARS-CoV-2 is used for early detection of COVID-19 spread within a community. By testing the amount of the virus in sewage water and continuous trend monitoring can serve as an early warning of COVID-19 in communities. The detection of SARS-CoV-2 viral RNA in wastewater has rapidly become a significant tool to address the ongoing pandemic. Wastewater detection of SARS-CoV-2 is particularly useful where significant numbers of asymptomatic infections occur. The fluctuation of virus levels in sewage water can help communities see how well preventive measures are working. Wastewater-based epidemiology (WBE) programs can be an invaluable additional predictive tool for addressing the COVID-19 pandemic.



The data generated by National Wastewater Surveillance System (NWSS) will help public health officials to better understand the extent of COVID-19 infections in communities.[1] Multiple testing methods and laboratory workflows are used to quantify SARS-CoV-2 in wastewater.[2] A balanced nutrient ratio is essential if the microorganisms are to function at maximum efficiency. The most important of these nutrients are nitrogen and phosphorus. It is helpful to know how many people are contributing to the wastewater so that detected amounts of RNA can be compared or 'normalized' to faecal load. Several options exist that may allow estimation of relative human faecal load including biomarkers such as ammoniacal nitrogen, urea and creatinine. Analysis of chemical and physiochemical reference parameters such as pH and conductivity, ammonia, nitrate, nitrite, total organic nitrogen, ortho-phosphate, and other ions such as chloride and sulfate are important. Total nitrogen, phosphorus, biological oxygen demand, ammonium, and urea have also been proposed as population biomarkers.[3] The survival period of coronavirus in water environments strongly depends on temperature, property of water, concentration of suspended solids and organic matter, pH, salinity, ammonia, organic matter, microbial activity, biofilms, and dose of disinfectant used.[4]

How does population biomarker analysis help in identifying communal spread?

Quantitative reverse-transcription polymerase chain reaction (RT-qPCR) is commonly used for the SARS-CoV-2 quantification in wastewater. Fluctuations in ammonium (NH_4^+), measured as NH_4-N loads in sewage treatment plants showed a distinctive pattern which was associated to weekly (i.e., commuters) and seasonal (i.e., holidays) fluctuations of the population.[5] Creatinine and urea are endogenous population size markers. The measured concentrations of nutrients and physico-chemical parameters helps to monitor the seasonal trend. Bioindicators measurements, urea, ammonia, and creatinine serve to find correlation with the nominal number of connected residents. Virus quantification by RT-PCR, together with other biomarkers like phosphorus, total nitrogen and pH play an important role in sewage water analysis in WBE programs, and sewage water treatment.

How are chemical reference parameters and population size markers measured in sewage water and wastewater?

Traditional water testing involves multiple wet chemical analyses for multiple parameters such as ammonia, total nitrogen, pH, conductivity, phosphorous and other nutrients. Each test requires a separate sample and often multiple sequential steps which extends the testing process. With slow processes and the need for specialist staff to run and monitor equipment, water quality testing is labor-intensive, time-consuming and inefficient. Routine sewage water testing can be costly and time consuming for a laboratory that performs sewage water testing and sewage water treatment.

Consolidated multiparameter discrete analysis now offers a solution to these difficulties and offers high throughput wet chemical analysis workflow. Discrete analyzers consolidate and simultaneously test for up to 20 parameters using a single instrument with a single operator. The high-throughput discrete analyzer platforms, together with ready-to-use system reagents, simplifies the wet chemical analysis and offers the highest flexibility with walkaway efficiency. Automated discrete analysis is a technique that utilizes colorimetric and enzymatic measurements of several analytes simultaneously from a single sample through photometric analysis. Optional modules for some discrete analyzers can also conduct electrochemical analysis for pH and conductivity in sewage water samples. The option to perform simultaneous and parallel measurements of pH conductivity considerably improves the lab's throughput.

What are the standard methods followed for testing chemical, physiochemical, and population size markers?

Collected samples are tested immediately for chemical and population size markers following the internationally approved standard methods from DIN, ISO, and United States Environmental Protection Agency (U.S. EPA). Ammonia in sewage water is determined by EPA 325.1. The applicable range is 0.01 to 2.0 mg/L NH_3 as N.[6] Higher concentrations can be determined by sample dilution and approximately 60 samples per hour can be analyzed. pH and conductivity in sewage water is determined as per U.S. EPA methods 150.2, and EPA 120.1 respectively.[7] Ortho phosphate and total phosphorus are determined by as per U.S. EPA 365.1 and EPA 365.4 respectively. Total oxidizable nitrogen is determined by highly selective enzymatic nitrate reductase method as per NECi Method N07-003. Beyond the analytes discussed, Thermo Scientific™ Gallery™ Discrete Analyzers can test other parameters, such as creatinine,[8] alkalinity, calcium, chromium (VI), fluoride, ferrous iron, magnesium, total hardness, and urea in various water samples.

How does the Gallery Plus discrete analyzer with ECM modules help with WBE workflows?

The integrated Gallery discrete analyzers provide two measurement techniques for photometric (colorimetric and enzymatic) and electrochemical (pH and conductivity) analysis, which can be run simultaneously. pH is a critical parameter for sewage water and wastewater analysis and directly influences the virus stability. Electrochemistry unit (ECM) is capable of measuring up to 67 samples per hour for pH and conductivity, parallelly, and simultaneously with other photometric measurements. The Thermo Scientific™ Gallery™ Plus Discrete Analyzer can accommodate 108 samples and 42 reagents in separate sample and reagent disks, with the capability to run up to 350 tests per hour.

The Gallery and Gallery Plus discrete analyzers are easy to use, automated systems that allow laboratories to simplify the sewage water and wastewater surveillance for essential chemical, physiochemical, and endogenous population size markers testing with dual benefits—time and cost savings. All necessary analysis steps are automated, providing true walkaway time for the operator. Parallel determination of multiple analytes from a single sample as well as the presence of several automated features ensures analytical efficiency. Ready-to-use Thermo Scientific™ Gallery™ reagent kits for water analysis offer:

- Accurate and reproducible results
- Less reagent usage
- Reduction of preparation errors
- Minimal hands-on time
- Ease of use

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We are happy to help your wastewater and sewage water surveillance program for COVID-19 testing. **Contact our specialists** to discuss your application needs.

References:

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5. Been F., Rossi L., Ort C., Rudaz S., Delémont O., Essevia P. Population normalization with ammonium in wastewater-based epidemiology: application to illicit drug monitoring. Environmental Science and Technology. 2014;48:8162–8169. doi: 10.1021/es5008388.
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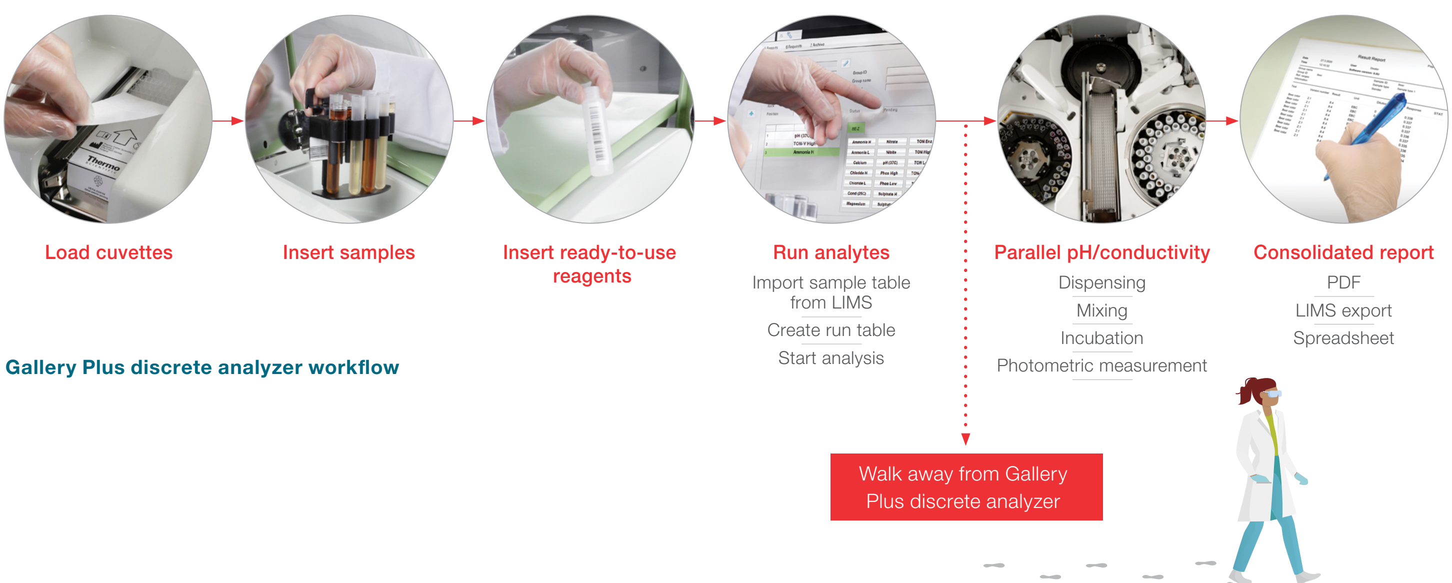

Gallery Plus discrete analyzer workflow

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