

THE WATER PROFESSIONAL'S GUIDE TO COVID-19

WEF Disinfection and Public Health Committee's (DPHC) Waterborne Infectious Disease Outbreak Control (WIDOC) Working Group

Editor's Note

The information presented here is a summary of current knowledge about this emerging viral pathogen. The state of knowledge will evolve as additional investigation and research is conducted, continue to monitor reputable sources.

A new coronavirus was identified as the cause of an outbreak of respiratory illness, referred to as COVID-19. It was first detected in Wuhan, China, on Dec. 12, 2019. Because this disease has spread worldwide, it is important that water sector professionals keep informed on the attributions of this virus and any measures needed to protect both workers and public health, in general.

Extent of the COVID-19 Outbreak

Based on the sharp increase in number of COVID-19 infections, on Jan. 30, 2020, the World Health Organization (WHO) declared the current outbreak to be a public health emergency of international concern.

On March 4, 2020, the World Health Organization reported 93,090 cases globally and 3,198 deaths in 66 countries worldwide, with the vast majority (80,422 cases and 2,984 deaths) in China, according to WHO's Situation Report – 44.

The U.S. reported its first confirmed case of person-to-person spread with this virus on Jan. 30, 2020. As of March 5, 2020, there were 163 confirmed cases in the U.S. across 18 states, as well as 11 deaths, according to news reports.

In Canada, 33 cases of COVID-19 had been confirmed in three provinces as of March 5, 2020, according to the Public Health Agency of Canada. Canadian case numbers are being updated daily.

Have We Seen This Virus Before? What Do We Know About Its Origin?

The virus, technically named SARS-CoV-2, is a newly identified virus strain, but it is the seventh coronavirus known to infect humans. The resulting illness is referred to as COVID-19. This virus is in the same coronavirus family as severe acute respiratory syndrome coronavirus (SARS-CoV or SARS) and Middle East respiratory syndrome coronavirus (MERS-CoV or MERS), which caused the two previous outbreaks in 2003 (SARS) and 2012 (MERS).

Since SARS and MERS are from the same family of coronaviruses, they have similar physical and biochemical properties and comparable transmission routes as COVID-19. In the absence of COVID-19 specific data, we rely on SARS, MERS, and coronavirus surrogate data to extrapolate, assess, and manage risk. See a comparison of COVID-19 to SARS and MERS on p. 28.

In addition to the seven coronaviruses known to infect humans, many other coronaviruses are known to infect animals. Viruses that infect animals do not normally infect humans and vice versa, but mutations in the viral genetic material can occur naturally and lead to animal-to-person spread, formally known as zoonotic transmission.

Initially, many of the patients in the outbreak in Wuhan reportedly had some link to a large seafood and animal market suggesting animal-to-person



How COVID-19 Compares to SARS and MERS

COVID-19 seems to display a different pattern of infection than SARS making it more similar to other conventional human coronaviruses that cause common colds in the winter season.

During early stages of infection, COVID-19 patients produce a large quantity of the virus in the upper respiratory tract but also experience a mild onset of symptoms. Thus, patients remain mobile and carry on usual activities contributing to the spread of infection. Transmission of SARS, however, did not occur during early stages of illness when those infected were asymptomatic or mildly ill and infectious particles were mainly concentrated in the lower respiratory tract. Most SARS transmission is thought to have occurred when infected individuals presented with severe illness, possibly explaining why controlling SARS transmission was easier than controlling COVID-19 transmission.

While viable, infectious SARS has been isolated from respiratory, blood, urine, and stool specimens, viable, infectious MERS has only been isolated from respiratory tract specimens, as the CDC reports. To date, only one report by the China CDC suggested the isolation of infectious COVID-19 virus from patient stool. The report contained no quantification making its use in risk assessment difficult. It remains to be seen if other reports support this finding, and if so, how well COVID-19 virus is able to survive in wastewater.

While COVID-19 lab-confirmed case numbers soared from about 50 in China to nearly 89,000 in at least 66 countries from December to early March, the 9-month SARS outbreak only resulted in 8,098 confirmed cases. Similarly, MERS had been circulating since 2012 with only about 2,500 known cases (McNeil, 2020). However, the higher number of COVID-19 confirmed cases could be due to improved virus detection technologies over recent years.

Although most human coronavirus infections are typically mild, mortality rates were 10% for SARS and 37% for MERS (Huang *et al.*, 2020). In comparison, COVID-19 has a much lower estimated mortality rate of 2%, dropping from a high of 4.1% in Wuhan to approximately 0.17% elsewhere in mainland China. The factors that cause some COVID-19 infections to be more severe than others still need to be determined.

How Does Coronavirus Compare to Ebola?

COVID-19 virus is different from the Ebola virus. Ebola virus is a bloodborne, highly infectious, enveloped filovirus. In contrast, SARS and MERS are from the same family of coronaviruses and have similar physical and biochemical properties and comparable transmission routes to COVID-19 virus. In the absence of COVID-19 specific data, we rely on SARS, MERS, and other coronavirus surrogate data to extrapolate, assess, and manage risk.

Despite differences between the COVID-19 and Ebola, we can adopt many lessons learned from our recent experience with the 2013 to 2016 Ebola outbreak as it relates to risk assessment and risk communication. The table compares what is currently known about COVID-19, SARS, and Ebola viruses.

	COVID-19	SARS	Ebola virus
Etiology	RNA virus from <i>Coronaviridae</i> family	RNA virus from <i>Coronaviridae</i> family	RNA virus from <i>Filoviridae</i> family
Source	Zoonotic	Zoonotic	Zoonotic
Transmission	Direct contact with infected person respiratory droplets	Direct contact with infected person respiratory droplets	Direct contact with infected person blood or bodily fluids
Incubation period	2 to 14 days	2 to 14 days	2 to 21 days
Symptoms	Fever, cough, shortness of breath or difficulty breathing, diarrhea	Fever, cough, headache, malaise, shortness of breath, diarrhea	Fever, headache, vomiting, stomach and muscle pain, bleeding, diarrhea
Asymptomatic individuals infective	Yes	No	No
Secondary transmission (fomites)	Unknown	Yes	Yes
Airborne	Unknown	Yes	Yes
Detected in feces	Yes	Yes	Yes
Persistence in wastewater	Likely	Yes	Yes
Effective skin disinfectants	Handwashing with soap and water (min. 20 sec); alcohol-based sanitizer (min. 60%)	Handwashing with soap and water; alcohol based-sanitizer as per manufacturer's instruction	Handwashing with soap and water; 0.05% hypochlorite solution; alcohol-based sanitizer (min. 60%, min. 20 sec)
Effective surface or object disinfectants	Common detergents effective against coronaviruses	Common detergents are effective (e.g., 0.21% hypochlorite, 0.05% triclosan)	0.5% hypochlorite solution

spread. Later on, an increasing number of patients with COVID-19 had no exposure to animals, indicating person-to-person transmission is occurring.

This has occurred with other coronaviruses such as SARS and MERS, which originated from animal reservoirs, spread into the human population, and then continued to spread by person-to-person contact. A recent publication linked COVID-19 to bats (Zhou, 2020) but only found a 96% similarity in DNA between the bat coronavirus and the novel coronavirus identified in humans. This implied the presence of an intermediate host between bats and humans that facilitated transmission. In the case of SARS in 2002, the intermediate hosts were civet cats, which were killed en masse after the outbreak. The U.S. Centers for Disease Control and Prevention (CDC) continues to post updated information on this topic at www.cdc.gov/coronavirus/2019-ncov/index.html.

How Is COVID-19 Transmitted, and How Contagious Is It?

While many questions remain regarding transmission of COVID-19, most often coronaviruses spread from person-to-person during close contact — about 2 m (6 ft). Person-to-person spread is thought to mainly occur via respiratory droplets produced when an infected person coughs or sneezes, similar to how influenza and other

What Utilities Can Do

PEOPLE


- Do not panic
- Stay informed
- Communicate the reasons behind decisions
- Communicate that PPE and good hygiene practices are protective

respiratory pathogens spread. These droplets can land in the mouths or noses of people who are nearby or possibly be inhaled into the lungs. Close contact generally does not include brief interactions, such as walking past a person.

With most respiratory viruses, people are thought to be most contagious when they show symptoms of infection. However, some viruses can be contagious prior to symptoms development, and a correspondence published in the *New England Journal of Medicine* states that COVID-19 has been reported to have spread from an asymptomatic infected patient to a close contact.


The rate at which a person can get COVID-19 by touching a contaminated surface or object (i.e., fomites) and then touching their own mouth, nose, or possibly their eyes is unclear. We also

IMPLEMENTING THE HIERARCHY OF CONTROLS FOR WASTEWATER WORKER PROTECTION




Engineering Controls

- Use physical barriers to prevent worker exposure to splashes or sprays of potentially contaminated waste water.
- Enclose processes that may generate potentially infectious aerosols (e.g., mixing zones, tank discharge points, pressurized lines).
- Use ventilation equipment to remove contaminated air from the work environment.




Administrative Controls and safe work practices TRAINING


- Wash hands with soap and water: immediately after handling waste or sewage, before eating or drinking, and before and after using the toilet.
- Avoid touching face, mouth, eyes, nose, or open sores and cuts while handling sewage.
- Before eating, remove work clothes and eat in designated areas.
- Do not smoke or chew tobacco/gum.
- Keep open sores, cuts, and wounds covered with clean, dry bandages.
- Remove work clothes before leaving worksite.
- Make appropriate vaccines available, such as those for tetanus, polio, typhoid fever, Hepatitis A and B, and influenza.




Personal Protective Equipment TRAINING




Goggles



Rubber boots



Liquid repellent coveralls and gloves



Face mask or face shield

- PPE required changes with task, work site, and potential exposures.
- Train workers on how to properly put on, use/wear, and take off PPE, as well as how to clean/disinfect, maintain, store, and dispose of PPE.
- Other types of PPE may be needed to ensure a fully protective ensemble.

IF WORKERS ARE EXPOSED TO WASTE OR SEWAGE

- Gently flush eyes with clean water if sewage contacts eyes.
- Wash cuts and abrasions with soap and water.
- Consider providing workers with post-exposure evaluation and follow-up care, especially for sharps or puncture injuries.
- Clean contaminated work clothing daily with 0.05% chlorine solution.

virus can survive in wastewater from hours to days (Casanova *et al.*, 2019 and Wang *et al.*, 2005b). In 2003, research on SARS had suggested that wastewater was implicated in the infection of a cluster of cases in the Amoy Gardens apartment block in Hong Kong (Hung, 2003). A report this year from CNN indicated possible COVID-19 transmission through wastewater pipes in a building in Hong Kong, but this remains to be confirmed.

However, previous work also highlights that SARS can readily be disinfected when chlorine dosing produces a free chlorine residual between 0.2 and 0.5 mg/L for municipal wastewater (Wang

et al., 2005a). While Ebola virus is different, it is reassuring that the article, “Persistence of Ebola Virus in Sterilized Wastewater,” (Bibby, 2015) similarly showed that no virus was recovered at doses of 5 and 10 mg/L of chlorine and a 3.5 log reduction was achieved in the presence of free chlorine residual of 0.16 mg/L for 20 seconds.

These results imply that standard municipal wastewater system disinfection and hyper (or shock) chlorination practices may be sufficient to control the virus provided utilities monitor free available chlorine during treatment to ensure it has not been depleted.

Signs and Symptoms of Coronavirus Infection

Three main symptoms are being highlighted by the CDC: cough, fever and shortness of breath.

One distinguishing feature of this Coronavirus infection, named COVID-19, is dyspnoea or shortness of breath, which has been reported in more than half of patients [55%]. It can take anywhere from 2 to 14 days for symptoms to develop, according to the U.S. Centers for Disease Control and Prevention.

A study published by the *Lancet* reported that as of Jan. 2, 2020, included other less common symptoms at onset of illness, such as fever [98%], cough [76%], myalgia, or fatigue [44%], sputum production [28%], headache [8%], haemoptysis (coughing up blood) [5%], and diarrhea [3%] (Huang *et al.*, 2020).

Treatment or Vaccine for the Coronavirus?

At press time, there currently were neither vaccines nor direct treatments against the novel Coronavirus. Upon admission to hospitals patients are provided with supportive therapies to help with symptom relief until the immune system can fight the virus. Development of vaccines may be complicated by COVID-19’s reinfection rate which is as high as 14% in China but has only occurred once outside of China in Osaka, Japan.

How Can I Stay Healthy?

While the CDC reports that the immediate risk of this new virus to the American public is believed to be low at this time, they recommend that everyone do their part to help us respond to this emerging public health threat. Because people of all ages have been infected by COVID-19, the WHO advises everyone to take proper infection control precautions. The best way to prevent infection is to avoid being exposed to this virus. However, as a reminder, CDC always recommends everyday preventive actions to help prevent the spread of respiratory viruses, including:

- Stay informed.
- Wash your hands often with soap and water for at least 20 seconds.
- If soap and water are not available, use an alcohol-based hand sanitizer with at least 60% alcohol content.
- Avoid touching your eyes, nose, and mouth with unwashed hands.
- Avoid close contact with people who are sick.
- Stay home when you are sick.
- Cover your cough or sneeze (ideally with a disposable tissue).
- Clean and disinfect frequently touched objects and surfaces.
- Do not place your personal belongings on the floor or on surfaces that may be contaminated.

What Should You Do If You Think You Are Infected?

If you feel sick with fever, cough, have difficulty breathing, and have traveled to China or were in close contact with someone with COVID-19 in the 14 days before you began to feel sick, seek medical care immediately.

Before you go to a doctor’s office or emergency room, call ahead and tell them about your recent travel and your symptoms.

What Utilities Can Do

PROCESS

- **Business as usual**
 - **Current disinfection practices are expected to be sufficient**
 - **Monitoring plant performance (e.g., free chlorine, fecal indicator bacteria)**
- **Supply chain management is crucial (e.g., parts, equipment, personal protective equipment (PPE), chemicals).**

Wastewater Treatment and COVID-19

Disinfection systems at water resource recovery facilities (WRRFs) and the associated regulatory requirements were developed to be protective of a broad spectrum of potential pathogens. The recent coronavirus serves as another example of the importance of this infrastructure for protecting public health.

On Feb. 5, 2020, the U.S. Occupational Safety and Health Administration (OSHA) released its new wastewater worker guidance stating that current disinfection conditions in WRRFs, such as oxidation with hypochlorite or peracetic acid, and inactivation by ultraviolet irradiation, are expected to be sufficient to protect wastewater workers and public health. The recommendation is based on coronavirus disinfection data from healthcare settings and corresponds with OSHA's position on the susceptibility of coronaviruses to disinfection. It also aligns with what we know about CDC's hierarchy of decreasing levels of resistance of microorganisms to disinfection shown in Figure 1 (p. 30).

These recommendations are likely to be

Current disinfection conditions in WRRFs, such as oxidation with hypochlorite or peracetic acid, and inactivation by ultraviolet irradiation, are expected to be sufficient to protect wastewater workers and public health.

broadly applicable, although more research may be warranted for disinfectants such as peracetic acid (Worley-Morse, 2019) and combined chlorine (chloramines), where coronavirus specific data is lacking or evidence suggests higher bacterial susceptibility to disinfection compared to viruses (Worley-Morse, 2019). Although coronaviruses have not been tested, peracetic acid has been found to have some efficacy against some non-enveloped viruses (e.g., Norovirus) that are known to be more resistant than enveloped viruses based on the CDC hierarchy of microorganisms resistance to disinfection (Figure 1).

Chlorine is extensively used for wastewater disinfection due to its effectiveness, low cost, and ease of application. It typically reacts with ammonia present in wastewater to form combined chlorine (chloramines), which behaves differently than free chlorine during disinfection. Thus, it is important for each facility to understand the chlorine species that are present and their relative abundance within the disinfection process. We would also expect some virus inactivation in primary and secondary treatment. A meta-analysis by Sano *et al.* published in 2016 showed that conventional activated sludge systems can achieve 0.87 and 1.48 log removals for rotavirus and norovirus GI, respectively. We would expect higher removals for enveloped viruses. Additional research is needed to provide reassurance on the effectiveness of wastewater disinfection and treatment processes, specifically against coronaviruses and at lower doses and contact times.

Is This Virus an Occupational Health Concern to Wastewater System Workers?

Wastewater treatment and collection system workers are commonly exposed to untreated wastewater that contains disease-causing organisms that could result in an infection. While the risk of infection may increase during some outbreaks (Haas *et al.*, 2017), thus requiring additional protective measures for workers, this is not the case for COVID-19, based on the current OSHA guidance at press time. Access this guidance at www.osha.gov/SLTC/covid-19/controlprevention.html#solidwaste.

These findings are bolstered by what we know about disinfection and persistence of coronaviruses and their surrogates in the environment (Rabenau *et al.*, 2005).

WRRF operations should ensure workers follow routine practices to prevent exposure to wastewater, including using the engineering and administrative controls, safe work practices, and PPE normally required for work tasks when handling untreated wastewater. It is important to communicate that

proper PPE use and sound hygiene practices are protective against coronaviruses and other waterborne infectious viruses. It is also important for utilities to reexamine their standard operating procedures and hazard assessments to evaluate the protections in place against infectious agents found in wastewater and collection systems. Research on the survival and infectivity of COVID-19 virus in wastewater, and on the efficacy of different wastewater disinfection options, including chlorination, peracetic acid, and UV, are needed to better assess the risk to both public and occupational health.

For information specific to protection of workers during infectious disease outbreaks, OSHA has a page dedicated to COVID-19 occupational health protection that highlights resources for workers and employers on the evolving situation. It also has resources for housekeeping practices — www.osha.gov/SLTC/etools/hospital/housekeeping/housekeeping.html#Disinfectants — that can be helpful and resources for protecting workers during pandemics and apply to office workers, too. Access this guidance at www.osha.gov/Publications/OSHA-FS-3747.pdf.

Should We Disinfect Surfaces That May Have Come in Contact with Untreated Wastewater?

For contaminated surfaces to play a role in transmission, respiratory pathogens must be shed into the environment, survive on the surface, be transferred to hands or other objects at concentrations high enough to cause infection (*i.e.*, at an infectious dose) and be transferred to the mouth, nose, or eyes at an infectious dose. Transmission can be interrupted at any of these steps. Therefore, disinfection of PPE, surfaces, and equipment that comes in contact with untreated wastewater can lower risk of infection.

Studies have shown that SARS virus can be inactivated fairly effectively (greater than or equal to 4 log reductions) using common household sanitizers or hand rubs provided recommended contact time and concentrations are used. Similar results were found when investigating common household disinfectants to reduce coronavirus surrogate concentrations (Dellanno *et al.*, 2009). This is consistent with OSHA's statement on coronaviruses being highly susceptible to inactivation by many commonly used disinfectants. The American Chemistry Council's Center for Biocide Chemistries compiled a list of products that have been pre-approved by the U.S. Environmental Protection Agency (EPA) for use against emerging enveloped viral pathogens and can be used during this outbreak.

COVID-19
CORONAVIRUS DISEASE

SYMPTOMS OF CORONAVIRUS DISEASE 2019

Patients with COVID-19 have experienced mild to severe respiratory illness.

Symptoms* can include

- FEVER**
- COUGH**
- SHORTNESS OF BREATH**

*Symptoms may appear 2-14 days after exposure.

Seek medical advice if you develop symptoms, and have been in close contact with a person known to have COVID-19 or if you live in or have recently been in an area with ongoing spread of COVID-19.

For more information: www.cdc.gov/COVID19-symptoms

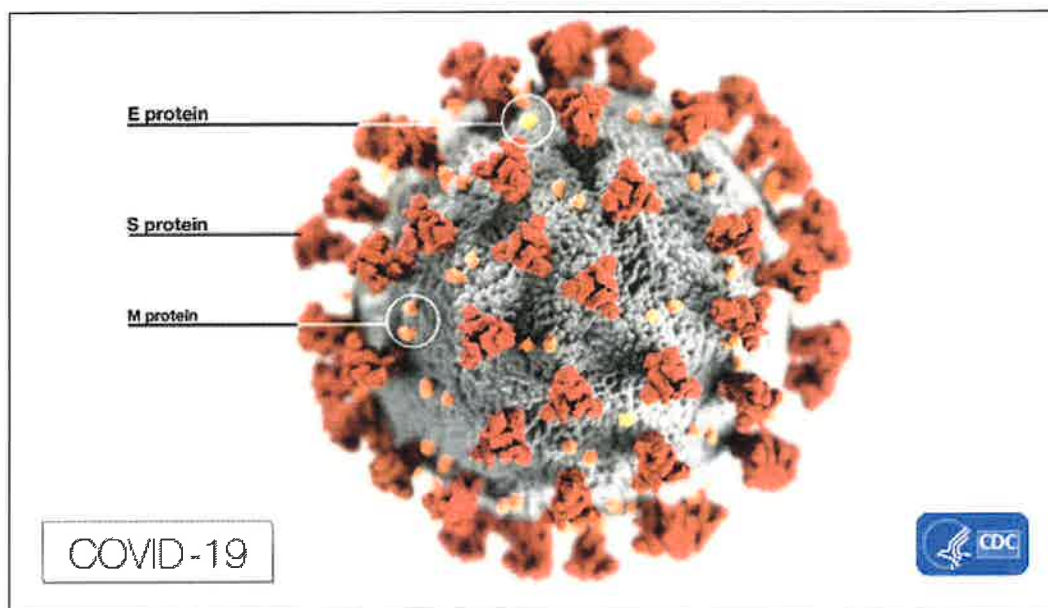
CDC

This product list — available at www.americanchemistry.com/Novel-Coronavirus-Fighting-Products-List.pdf — is not exhaustive but can be used by business owners, health professionals, and the public to identify products suitable for COVID-19 infection control. Before recommending products and disinfectants to wastewater workers, it is important for utilities to ensure supply chains are proactively managed and the products are available for use. The additional research on COVID-19 quantitative occurrence,

What Utilities Can Do

FACILITIES AND COLLECTION SYSTEMS

- Examine administrative controls (*e.g.*, safe work plans, hazard assessments and registries, and risk assessments)
- Identify areas of high concerns - *e.g.*, high splash activities
- Identify critical staff and their backups
- Review engineering controls



survival, inactivation rates, and dose-response could support quantitative microbial risk assessments.

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