Technical Support Document for the Final Fifth Contaminant Candidate List (CCL 5) - Microbial Contaminants

Office of Water (4607M)
EPA 815-R-22-004
October 2022
www.epa.gov/safewater

Table of Contents

Acronyms

AGI	Acute gastrointestinal illness
CCL	Contaminant Candidate List
CCL 1	EPA's First Contaminant Candidate List
CCL 2	EPA's Second Contaminant Candidate List
CCL 3	EPA's Third Contaminant Candidate List
CCL 4	EPA's Fourth Contaminant Candidate List
CCL 5	EPA's Fifth Contaminant Candidate List
CDC	Centers for Disease Control and Prevention
CIS	Contaminant Information Sheet
CNS	Central Nervous System
EPA	Environmental Protection Agency
GWR	Ground Water Rule
HUS	Hemolytic Uremic Syndrome
MAC	*Mycobacterium avium* complex
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MCM	Manual of Clinical Microbiology
MMWR	Morbidity and Mortality Weekly Reports
NDWAC	National Drinking Water Advisory Council
NIH	National Institute of Health
NORS	National Outbreak Reporting System
NPDWR	National Primary Drinking Water Regulation
NRC	National Research Council
NTM	Nontuberculous mycobacteria
OGWDW	Office of Groundwater and Drinking Water
PCCL	Preliminary Contaminant Candidate List
PWS	Public Water System
SAB	Science Advisory Board
SDWA	Safe Drinking Water Act
SWTR	Surface Water Treatment Rule
UCMR	Unregulated Contaminant Monitoring Rule

WBDO	Waterborne Disease Outbreak
WHO	World Health Organization

Chapter 1 Introduction

Section 1.1 Background

The 1996 Safe Drinking Water Act (SDWA) Amendments (section 1412(b)(1)) require the United States Environmental Protection Agency (EPA) to publish every five years a list of drinking water contaminants that are known or anticipated to occur in public water systems (PWSs) and that may cause adverse health effects. SDWA specifies that the list (referred to as the Contaminant Candidate List, or CCL) must include contaminants that:

- are not subject to any proposed or promulgated National Primary Drinking Water Regulation;
- are known or anticipated to occur in PWSs; and
- may require regulation under the SDWA

EPA uses this list of unregulated contaminants to help identify priority contaminants for regulatory decision making and to prioritize research and data collection efforts. SDWA also requires the Agency to consult with the scientific community, including the Science Advisory Board (SAB), and to provide notice and opportunity for public comment prior to the publication of the Final CCL. In addition, SDWA directs the agency to consider the health effects and occurrence information for unregulated contaminants to identify those chemicals and microbial pathogens that present the greatest public health concern related to exposure from drinking water.

In a regulatory action separate from the CCL, SDWA Section 1412(b)(1)(B)(ii) directs EPA to make regulatory determinations on at least five of the contaminants from the CCL every five years. The CCL itself does not pose a burden or place requirements on the states or PWSs. Rather, the CCL identifies contaminants that serve as a list to be considered for research and data collection efforts, such as for the Unregulated Contaminant Monitoring Rule (UCMR). Only after additional data and information are collected are contaminants considered for regulatory determination and rulemaking under the SDWA.

EPA has completed four cycles of CCLs since 1996. The previous CCLs are briefly described below:

- EPA published the first CCL (CCL 1) on March 2, 1998 (63 FR 10274, USEPA, 1998a). The CCL 1 was developed based on recommendations by the National Drinking Water Advisory Council (NDWAC) and reviewed by technical experts. CCL 1 contained 50 chemicals and 10 microbial contaminants/groups.

- EPA published the second CCL (CCL 2) on February 24, 2005 (70 FR 9071, USEPA, 2005). EPA carried forward the 51 remaining chemical and microbial contaminants from CCL 1 (those that did not have regulatory determinations).

- EPA published the third CCL (CCL 3) on October 8, 2009 (74 FR 51850, USEPA, 2009a). In developing the CCL 3, EPA implemented an improved, stepwise process that built on evaluation of the previous CCL processes and was based on expert input and

recommendations from the National Academy of Sciences' National Research Council (NRC), NDWAC, and SAB. CCL 3 contained 104 chemicals/chemical groups and 12 microbial contaminants/groups.

- EPA published the fourth Contaminant Candidate List (CCL 4) on November 17, 2016 (81 FR 81099, USEPA, 2016a). The Final CCL 4 contained 97 chemicals/chemical groups and 12 microbial contaminants/groups. All contaminants listed on the Final CCL 4 were carried forward from the CCL 3, except for two contaminants, perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA), that received positive regulatory determinations.

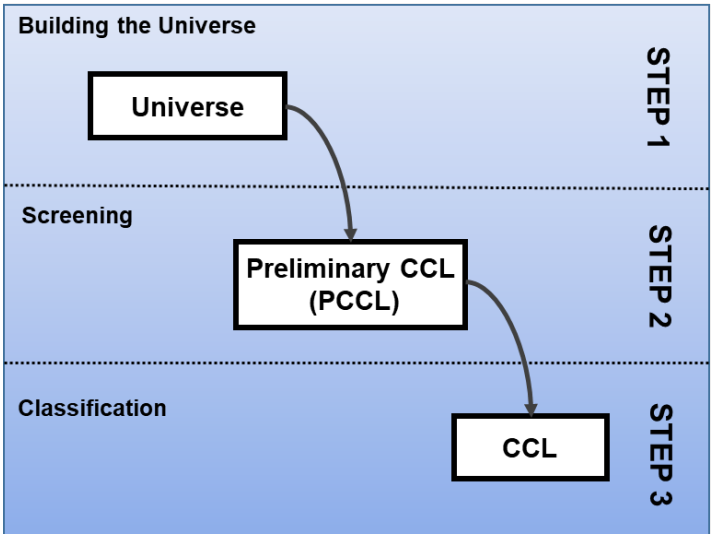
Section 1.2 Overview of the CCL 5 Development Process

During the development of the CCL 3, EPA requested assistance from the NRC in developing a more robust approach to identifying and prioritizing potential drinking water contaminants. NRC formed the Committee on Drinking Water Contaminants, and the committee published their recommendations in 1999 and 2001 (NRC, 1999a; NRC, 1999b; NRC, 2001). EPA used these recommendations to develop the CCL classification process and implemented the process for the CCL 3. In CCL 3, EPA established and implemented a multi-step process to select contaminants. The CCL framework is comprised of three steps:

1. Building the Universe
2. Screening the Universe
3. Classifying contaminants to select the CCL

A simplified illustration of the CCL development framework for contaminants is shown in Figure 1.

Figure 1: CCL Development Framework



The remainder of this technical support document describes in detail the process used for CCL 5 microbial contaminants and the updates made in response to expert input and recommendations provided by the previous and current SABs and public comments. The CCL 5 process for the chemical contaminants can be found in a separate document *Technical Support Document for the Final Fifth Contaminant Candidate List (CCL 5) - Chemical Contaminants* (USEPA, 2022). This document is accessible on EPA's webpage for CCL 5 at https://www.epa.gov/ccl/contaminant-candidate-list-5-ccl-5 or via the EPA docket (Docket ID No. EPA-HQ-OW-2018-0594) at https://www.regulations.gov.

Section 1.3 Overview of CCL 5 Process for Microbes

For the CCL 5 microbial contaminants, EPA used the same methodology that was developed for microbial contaminants in CCL 3. For CCL 5, EPA followed the following steps for microbes:

- Step 1. Build a broad universe of all microbes that may cause human disease;
- Step 2. Screen the universe of microbial contaminants to produce a Preliminary CCL (PCCL); and
- Step 3. Select the CCL microbial list by ranking the PCCL contaminants based on occurrence in drinking water (including waterborne disease outbreaks and human health risks.

These three steps are described in more detail in Chapters 3, 4, and 5 respectively of this technical support document.

Chapter 2 Public Nominations

Section 2.1 Overview

EPA sought public nominations in a Federal Register notice on October 5, 2018, for unregulated chemical and microbial contaminants to be considered for possible inclusion in the CCL 5 (83 FR 50364, USEPA, 2018). In accordance with the SDWA, which directs EPA to consider health effects and occurrence information when deciding whether to place contaminants on the CCL, EPA asked that nominations include responses to the following questions:

1. What is the contaminant's name, CAS registry number, and/or common synonym (if applicable)? Please do not nominate a contaminant that is already subject to a national primary drinking water regulation.
2. What are the data that you believe support the conclusion that the contaminant is known or anticipated to occur in public water systems? For example, provide information that shows measured occurrence of the contaminant in drinking water or measured occurrence in sources of drinking water or provide information that shows the contaminant is released in the environment or is manufactured in large quantities and has a potential for contaminating sources of drinking water. Please provide the source of this information with complete citations for published information (i.e., author(s), title, journal, and date) or contact information for the primary investigator.

3. What are the data that you believe support the conclusion that the contaminant may require regulation? For example, provide information that shows the contaminant may have an adverse health effect on the general population or that the contaminant is potentially harmful to subgroups that comprise a meaningful portion of the population (such as children, pregnant women, the elderly, individuals with a history of serious illness, or others). Please provide the source of this information with complete citations for published information (i.e., author(s), title, journal, and date) or contact information for the primary investigator.

Nominations were received via the EPA docket (Docket ID No. EPA-HQ-OW-2018-0594) on the Federal eRulemaking Portal and were also accepted by mail or hand delivery. EPA compiled and reviewed the information from the nominations process to identify the contaminants nominated and any sources of supporting data submitted that could be used to supplement the data gathered by EPA to inform selection of the Final CCL 5.

Section 2.2 Summary of Microbial Nominations for CCL 5

EPA received public nominations for 16 unique microbial contaminants for consideration for CCL 5. Eight of the same microbes were nominated by more than one organization or individual. *Legionella pneumophila* received the most nominations, nominated by 18 organizations or individuals. One public commenter proposed that all CCL 4 contaminants be retained on the CCL 5. Appendix A shows the microbial organisms or group of microbial organisms that were nominated, along with the number of nominators and any supporting information provided.

All public nominations, both chemical and microbial contaminants, for CCL 5 can be viewed in the EPA docket (Docket ID No. EPA-HQ-OW-2018-0594) at https://www.regulations.gov.

Section 2.3 Analysis of Nominated Microbial Contaminants

EPA reviewed the nominated microbial contaminants and any supporting information provided by nominators to determine if any data provided had not been previously evaluated. Furthermore, the Agency collected additional data for the nominated microbial contaminants by updating both the CCL 3 and the CCL 4 data sources and conducting literature searches covering the time between the CCL 4 and the CCL 5.

Chapter 3 Building the Universe

Section 3.1 Overview of the Microbial Universe

The CCL Microbial Universe is comprised of all pathogens that cause human disease. The CCL 5 Microbial Universe was developed by building upon previous CCL Microbial Universes, in particular, the CCL 3 and the CCL 4 Microbial Universes. During the development of the CCL 3, EPA followed the NDWAC's recommendation to specifically use Taylor et al. (2001) list and literature reviews as the starting point for the microbial CCL 3 Universe (NDWAC, 2004). For the CCL 3, the Agency added organisms to the Taylor et al. (2001) list, with input from subject matter experts and data collected through a literature search. For example, EPA reviewed fungi in drinking water literature and identified six fungal species reported to occur in drinking water

distribution systems that did not appear on the Taylor et al. 2001 list. EPA also added reovirus to the CCL 3 Universe based on additional health effects information (Tyler et al., 2004). Additional microbes, *Methylobacterium* (with two species) and mimivirus, were added to the universe during CCL 3. Adding these two bacterial species, two viral groups (e.g., reovirus and mimivirus) and six fungal species brought the CCL 3 Microbial Universe list to 1,425 microbes. These microbes remained in the CCL 4 Microbial Universe.

For CCL 5, EPA conducted a literature search, sought input from subject matter experts, and reviewed nominations for potential microbial contaminants to add to the CCL 5 Universe. As a result of the literature search, 14 organisms were added to the CCL 5 Universe (Table 1). Changes to nomenclature were made as necessary (in most cases combining two species into one organism group), which brought the total to 1,435 microbes. EPA recognizes that given the dynamic nature of ongoing microbial research, the listing of all human pathogens on the CCL universe needs to be periodically updated to keep up with the latest science. The full microbial CCL 5 Universe is presented in Appendix B.

Table 1. Microbial Organisms Added to the Microbial CCL 5 Universe

Organism	Reference
Alloscardovia omnicolens (bacteria)	Brown et al., 2016
Elizabethkingia anophelis (bacteria)	Figueroa Castro et al., 2017
Neoehrlichia mikurensis (bacteria)	Portillo et al., 2018
Parachlamydia acanthamoebae (bacteria)	Greub, 2009
Waddlia chondrophila (bacteria)	Baud et al., 2014
Human bocavirus (virus)	Allander, 2008
Human coronavirus SARS-CoV-2 (virus)	Ciotti et al., 2019
KI polyomavirus (virus)	Bofill-Maset al., 2010
Kobuvirus (virus)	Ramírez-Castillo et al., 2015
Lujo virus (virus)	https://www.cdc.gov/vhf/lujo/transmission/index.html
Parvovirus 4 (virus)	Sharp et al., 2010
WU polyomavirus (virus)	Bofill-Mas et al., 2010
Botrytsis cinerea (fungi)	Hashimoto et al., 2017
Epiccocum purpurascens (fungi)	https://www.inspq.qc.ca/en/moulds/fact-sheets/epicoccum-purpurascens

Chapter 4 Screening the Microbial Universe to Select the PCCL

Section 4.1 Screening Criteria

The development of the microbial preliminary CCL 5 (PCCL 5) adhered to the process developed for the CCL 3 with additional updates described below. The CCL 3 process followed NRC recommendations by using a hierarchical framework to evaluate the potential occurrence of microbial contaminants in drinking water (NRC, 2001). For CCL 3, EPA also followed recommendations provided by NDWAC (2004) to select microbial contaminants for a PCCL based upon an assessment of occurrence and potential health effects. This assessment related the plausibility of pathogen presence, survival, and transport through drinking water to disease manifestations from drinking water exposure. The CCL 3 screening criteria were developed based upon epidemiology, geographical distribution, and biological properties in the host and in the environment. The screening criteria were developed to be exclusionary, in that, if a pathogen met one of the criteria, it would then be excluded from moving to the PCCL. The screening criteria were recommended by NDWAC and amended by EPA following an external peer review resulting in 12 screening criteria used for initial screening of pathogens in the microbial CCL 3 Universe for placement on the PCCL 3 (NDWAC, 2004). Additional information on recommendations provided by NRC and NDWAC are described in EPA's Final CCL 3 Microbes: Screening to the PCCL (USEPA, 2009b) and NRC (NRC, 2001) and NDWAC reports (NDWAC, 2004).

The 12 exclusionary screening criteria were used to evaluate the five microbial groups (bacteria, viruses, fungi, helminths, and protozoa) that make up the microbial universe, but each criterion did not necessarily apply to every group. Some evaluation criteria would never be used to exclude microbes in a group because of fundamental characteristics of the microbes in that group. For example, Criterion 5: Microflora indigenous to the gastrointestinal tract, skin, and mucous membranes was not used to evaluate viruses and helminths. This was because viruses and helminths do not have a commensal relationship with a human host and are not considered a part of normal human microflora (Davis, 1996). Criteria that were not used are greyed out in their respective columns in the screening table presented in Appendix B.

EPA restricted the PCCL to pathogens associated with source water and recreational water (e.g., swimming pools, hot tubs) only if the source water was also utilized for drinking water. The screening criteria excluded those pathogens whose biological properties are incompatible with water transmission by ingestion, inhalation, or dermal contact, and those pathogens that are typically introduced from sources other than drinking water.

For the CCL 5, EPA re-evaluated the 12 screening criteria utilized in the CCL 3 and the CCL 4 for applicability to microbes and reviewed certain criteria in depth per recommendations received from the SAB (USEPA, 2016c) for CCL 4. In particular, Criterion 1 (anaerobes), Criterion 9 (natural habitat is in the environment without epidemiological evidence of drinking water-related disease) and Criterion 10 (not endemic to North America) were closely re-evaluated based on previous comments from CCL 4's SAB. Upon further evaluation, EPA did not find supporting evidence to modify Criterion 1 and Criterion 10. EPA's evaluation included literature searches for new information, internal EPA expert review, as well as feedback from subject matter experts at the Centers for Disease Control and Prevention (CDC).

To determine if Criterion 1, anaerobes, should be modified, EPA conducted a literature search on the 124 anaerobic microbes excluded from the PCCL for meeting Criterion 1. With the exception of some anaerobes being spore-forming, EPA found insufficient evidence supporting waterborne illnesses attributed to anaerobic microbes. Therefore, Criterion 1 remains unchanged.

In response to the CCL 4 SAB's comment that Criterion 9 was too restrictive, EPA evaluated and expanded Criterion 9 to include nosocomial infections where drinking water is implicated. This expansion also recognized a growing concern for microbial contaminants within distribution systems, building water systems, and biofilms. For past CCLs, microorganisms that had outbreaks but no evidence of a contaminated PWS distribution system as their cause were screened out. Thus, outbreaks, which were attributable to recreational water or were occurring due to nosocomial exposure of drinking water contaminated post-delivery, were not sufficient to place a microorganism on the PCCL unless the drinking water was shown to be contaminated. A literature search was conducted for citations from 2009-2019 (post CCL 3 data collection) to look for evidence of waterborne diseases for microbes that were excluded using Criterion 9, and an additional search was performed to identify any new microbes causing water-related diseases or outbreaks found in the United States since 2009. The peer-reviewed literature was evaluated for evidence of disease caused by exposure to water, whether through a PWS or through nosocomial (hospital-based) exposure where the water system was epidemiologically-linked. The CDC's Morbidity and Mortality Weekly Report (MMWR), National Outbreak Reporting System (NORS), and CDC's page on health care associated infections (https://www.cdc.gov/hai/organisms/organisms.html) were also evaluated for evidence of disease caused by exposure to water. As a result, five microbes that had not been listed previously on a PCCL were listed on the PCCL 5 and further evaluated through the microbial CCL process.

Between the publication of the draft and final CCL 5, EPA reviewed the changes to Criterion 9 and determined that the changes were appropriate. Organisms that had been placed on the PCCL remained on the PCCL.

EPA also evaluated Criterion 10 to determine if additional microbes not previously considered endemic to North America should be passed through to the PCCL. The evaluation supported that Criterion 10 should remain unchanged.

Upon completion of the re-evaluation of the 12 criteria, EPA screened all the microbes in the CCL 5 Universe with the updated Criterion 9 along with the other criteria through the exclusionary screening criteria listed and described below.

Criterion 1:

Anaerobes (microorganisms that cannot survive in oxygenated environments)

Anaerobes are microorganisms that cannot survive in the presence of oxygen (Murray et al., 2007). Due to oxygen toxicity, anaerobes are unable to survive in the ambient water environment, and they pose a negligible threat to human health from drinking water exposure. Examples of anaerobes that were screened out based on this screening criterion included members of the bacterial genera *Actinomyces, Bacteroides, Clostridium, Eubacterium, Fusobacterium*, and *Prevotella*, among others (Murray et al., 2007).

Criterion 2:

Fastidious or obligate intracellular pathogens (environmental survival in water implausible)

Fastidious or obligate intracellular pathogens rely upon their host to provide essential nutrients and growth factors that are not present in the environment, hence these pathogens cannot survive outside their hosts. Many fastidious or obligate intracellular pathogens have a narrow temperature and pH range as a result of host adaptation, and they cannot survive the wide range of temperatures and pH common in the ambient environment. Examples of fastidious or obligate intracellular pathogens that were screened out included members of the genera *Chlamydophila, Mycoplasma,* and *Orientia* (Murray et al., 2007). This criterion was applied only to bacteria, since all viruses are obligate intracellular pathogens (Knipe and Howley, 2007).

Criterion 3:

Pathogens exclusively transmitted by direct or indirect contact with blood or body fluids (including sexually transmitted diseases)

Some pathogens are transmitted by direct or indirect contact with blood or body fluids, where fecal-oral transmission or transmission by aerosolized water is not observed (Mandell et al. 2005). Pathogens causing bloodborne diseases and sexually transmitted diseases are highly host adapted, fastidious, and are usually not present in feces. These pathogens do not survive under environmental conditions, and they are not transmitted by the fecal-oral route, either by direct contact with feces or indirect contact with contaminated drinking water. Examples of pathogens transmitted by blood or body fluids include the etiologic agents of gonorrhea and syphilis, *Chlamydia*, herpes virus, human immunodeficiency virus, and hepatitis virus B, C, D and G (Murray et al., 2007).

Criterion 4:

Pathogens transmitted by vectors

Pathogens transmitted by vectors (which include arthropods and rodents (Acha and Szyfres, 2001) depend upon either insect or other bites, or close contact with rodents, and these pathogens are not transmitted by contact with drinking water. Mosquitoes, ticks, and fleas are the most common vectors of arthropod-borne diseases (Krause, 2003). The genera *Babesia, Borrelia, Brugia, Dirofilaria, Ehrlichia, Leishmania, Plasmodium, Trypanosoma, Rickettsia*, and all arthropod-borne viruses were not moved to the PCCL (Murray et al., 2007).

Criterion 5:

Microflora indigenous to the gastrointestinal tract, skin, and mucous membranes

The human body is colonized with a rich and commensal microflora (Finegold et al., 1983; Drasar and Barrow, 1985; Isenberg and D'Amato, 1995). Some microbes that colonize the human body are transitory, while others are part of the continuing normal flora of the body. Microbes comprising normal flora have a characteristic ecological niche, but sometimes conditions permit their access to areas of the body where they may exhibit pathogenic potential resulting in infection and disease. Infections with normally innocuous microbes are called opportunistic infections, because of their ability to exploit host conditions that may periodically predispose them to disease. Exposure to normal flora microbes is continuous throughout life, and because the populations of normal flora microbes exceed the number of these microbes present in drinking water by many orders of magnitude, drinking water represents an improbable source of infection and disease. Examples of normal flora include members of the genera

Capnocytophaga, Corynebacterium, Staphylococcus, Streptococcus, and several yeasts (Murray et al., 2007).

Criterion 6:

Pathogens transmitted solely by respiratory secretions

Pathogens causing respiratory disease are typically transmitted by direct contact with respiratory secretions, either by inhalation of aerosols, by direct person-to-person contact, or by contact with fomites. Drinking water is an unlikely mode of transmission because the number of pathogens in respiratory secretions and the continuity of exposure to respiratory secretions far exceed exposure through drinking water (Bennett and Brachman, 2007). Examples of pathogens transmitted by respiratory secretions include the etiologic agents of tuberculosis, diphtheria, whooping cough, measles, rubella, and influenza (Knipe and Howley, 2007; Murray et al., 2007; Mandell et al., 2005).

Criterion 7:

Pathogens whose life cycle is incompatible with drinking water transmission

Some pathogens, such as helminths, require intermediate hosts to complete their life cycles. Incidental infection of humans interrupts their life cycle causing subsequent death of the pathogen (Acha and Szyfres, 2001). Some pathogens are adapted to a single route of transmission such as rabies virus, which is transmitted by animal bites. Some pathogens are specifically adapted to survive in a unique ecological niche, and they cannot withstand any alteration of conditions to which they are adapted. For example, rabies virus, *Dientamoeba fragilis*, *Enterobius vermicularis*, and many helminths remain in the microbial CCL 5 Universe and were not considered for the PCCL based on this criterion (Murray et al., 2007; Ashford and Crewe, 2003).

Criterion 8:

Pathogens where drinking water-related transmission is not implicated

Some pathogens cause such rare occurrences of disease that only a few cases have been reported in medical literature, and these rare occurrences of disease present limited opportunity to protect public health from drinking water exposure (Acha and Szyfres, 2001; Knipe and Howley, 2007; Murray et al., 2007; Mandell et al., 2005). Some pathogens are associated with direct transmission from animals to humans, or other transmission routes that do not involve drinking water (Acha and Szyfres, 2001; Krauss et al., 2003; Howard, 2003). Examples of pathogens that remained in the microbial CCL 5 Universe after application of this criterion are *Leptospira*, *Listeria*, *Nosema*, and the etiologic agents of several zoonotic virus infections (Knipe and Howley, 2007; Murray et al., 2007).

Criterion 9:

Natural habitat is in the environment without epidemiological evidence of drinking water-related disease **and without evidence of drinking water-related nosocomial infection**[1].

The environment is teeming with microorganisms, at varying concentrations, and humans are in constant contact with these microorganisms throughout their lives (Bennett and Brachman, 2007; Isenberg and D'Amato, 1995). Microorganisms naturally present in the environment are not considered a threat to public health as a result of drinking water exposure unless epidemiological evidence demonstrates a potential for water-related disease. Thus, outbreaks occurring must be attributable to a contaminated drinking water system (Wenzel, 2003). *Gordonia, Nocardia*, and most fungi were excluded from the PCCL based on this criterion (Murray et al., 2007; Howard, 2003).

Criterion 10:

Pathogens not endemic to North America

Some pathogens have an exclusive geographical distribution, and they are not naturally present in North America (Ashford and Crewe, 2003; Murray et al., 2007; Palmer et al., 1998). Only pathogens endemic to North America have the potential to contaminate drinking water in the U.S. Several helminths such as most *Diphyllobothrium,* and *Paragonimus* species and several viruses such as the hemorrhagic fever viruses and poxviruses would remain in the microbial CCL universe after application of this criterion.

Criterion 11:

A genus and species or serotype may be chosen to represent a group of closely related organisms

EPA has chosen a few pathogens to represent a group based on all serotypes within a group sharing essential biological properties in common with the group. Designation of a representative group provides adequate protection of public health under the PCCL (Murray et al., 2007). Pathogens that represent other pathogens in their group are the following: *Arcobacter butzleri, Campylobacter jejuni, Helicobacter pylori, Legionella pneumophila, Salmonella enterica, Shigella sonnei,* Adenovirus, Astrovirus, Enterovirus, Microsporidia, and *Entamoeba histolytica.* For example, human adenovirus A, human adenovirus B, human adenovirus C, human adenovirus D, human adenovirus E, and human adenovirus F could be consolidated to human adenovirus.

Criterion 12:

Current taxonomy does not support the classification listed by Taylor et al. (2001)

Microbial taxonomy and nomenclature are a dynamic science, and taxonomic classifications are constantly changing. Original taxonomic classifications were based upon the phenotypic characteristics of microorganisms, but these classifications are being revised as genotypic

[1] Bolded language indicates CCL 5 update to previous CCL 3 and CCL 4 Criterion 9

information becomes available. New genera are formed, sometimes prematurely, based upon partial genomic data, and taxonomists do not always agree with proposed changes. Under this criterion, the genera *Fluoribacter* and *Tatlockia* were combined with the genus *Legionella* for screening purposes (Murray et al., 2007).

Section 4.2 Application of Screening Criteria to the Microbial CCL Universe

As the pathogens in the microbial universe are screened through the 12 criteria, a pathogen needs to only to meet one criterion to be excluded from moving on to the PCCL. Some pathogens may meet multiple criteria, however, because the pathogens are evaluated through the exclusionary screening criteria sequentially, the criteria that the pathogen meets first will exclude the pathogen from moving on to the PCCL, and the pathogen will not be further evaluated through the rest of the criteria. For example, if a pathogen could be excluded based on meeting Criteria 3 and 7, the pathogen will be screened out based on meeting Criterion 3 and will not be further evaluated to see if any other criterion is met. The pathogen will be documented as meeting just that one criterion.

All pathogens that pass through all screening criteria are moved to the PCCL. Bacteria, viruses, protozoa, helminths, and fungi in the CCL 5 Universe are shown screened individually through the CCL exclusionary screening criteria in Appendix B. Each table identifies the pathogens in each category and indicates which screening criteria were applied to remove pathogens from further consideration in the CCL process. Those pathogens not excluded by at least 1 of the 10 screening criteria, or consolidated under Criteria 11 or 12, pass on to the PCCL. Table 2 summarized the number of microbes in the CCL 5 Universe, the number of microbes screened out by each criterion, and the resulting number of microbes passed on to the PCCL.

Table 2. Summary of Screening the Microbial CCL 5 Universe

Pathogen Class	Total	Number of Microbes Excluded by Each Screening Criterion												Pathogens Screened Out	On PCCL
		1	2	3	4	5	6	7	8	9	10	11	12		
Bacteria[1]	**545**	121	16	10	38	121	7	0	29	150	2	28	5	527	18
Viruses	**225**	0	0	29	104	0	20	1	20	0	36	8	0	218	7
Protozoa[2]	**66**	0	0	1	29	3	0	4	7	7	0	6	0	59	7
Helminths	**286**	0	0	0	25	0	0	105	0	0	156	0	0	286	0
Fungi	**313**	0	0	0	0	12	3	0	0	295	0	0	0	310	3
Total	**1,435**	**121**	**16**	**40**	**196**	**136**	**30**	**110**	**56**	**452**	**194**	**42**	**5**	**1,400**	**35**

[1] NTM were included on the PCCL as a group as well as individual *Mycobacterium* species.
[2] *Cryptosporidium* and *Giardia* (protozoa) are considered to be regulated by the Long-Term Surface Water Treatment Rule (LT2); even though counted in the microbial universe, they were not evaluated for screening

Based upon this screening exercise conducted on 1,435 pathogens in the CCL 5 Microbial Universe, 1,400 pathogens were excluded from consideration while 35 pathogens passed on to the PCCL. Appendix A details which nominated microbes were included on the PCCL 5.

The modification made to Criterion 9 expanded the PCCL to include nosocomial infections where drinking water was implicated. This resulted in the addition of five bacteria (*Acinetobacter baumannii, Comamonas testosteroni, Pantoea agglomerans, Pseudomonas aerugionosa,* and *Mycobacterium abscessus*) to the PCCL 5 for further evaluation by the CCL process. The specific screening decisions and references are presented in Appendix B.

Chapter 5 Evaluating Microbial Contaminants for CCL 5

EPA used scoring protocols to rank pathogens on the PCCL to produce a CCL. This section briefly describes the process developed under CCL 3 and explains the elements included in the microbial Contaminant Information Sheets (CISs). EPA derived the CCL 3 scoring process in part from recommendations of the NRC and an expert workgroup established by the NDWAC, and two external workshops (USEPA, 2009c). For the CCL 5, EPA made two minor modifications to the CCL 3 microbial scoring process regarding data sources that were used to select microbial contaminants from the PCCL, as described below. For a more detailed discussion on the CCL 3 scoring process and rationale used to develop the scoring process, see Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process (USEPA, 2009c).

Microbes were evaluated for their occurrence in water and their ability to cause adverse health effects in humans. Pathogens on the PCCL were scored for placement on the CCL using a scoring system to assign a numerical value to each pathogen and rank the pathogens based upon both occurrence (waterborne disease outbreaks (WBDOs) and occurrence in water) and potential health risks. WBDO information and occurrence in water information is combined to allow consideration for 1) pathogens that are tracked by public health surveillance programs (i.e., NORS (CDC, 2020); and 2) pathogens that are not yet tracked by public health surveillance programs but for which occurrence information is available (i.e., emerging pathogens). Those microbes receiving high scores were considered for placement on the CCL.

Each microbe was scored using scoring protocols for WBDOs, occurrence in water, and potential health effects (both for general and sensitive populations). Data collected during CCL 3 and CCL 4 were not removed from consideration and remain on the CISs presented in Appendix F. If found, new data were added, and scores were adjusted as necessary. EPA compiled data sources identified from the CCL 3 and the CCL 4, along with data sources recommended by the CCL 5 EPA workgroup and subject matter experts. EPA accessed each potential data source and evaluated them using the following assessment factors: relevance, completeness, redundancy, and retrievability.

Section 5.1 Waterborne Disease Outbreak Data

To determine the WBDO score for CCL 3 and CCL 4, EPA utilized outbreak information from CDC's MMWRs (CDC, 2017). For the CCL 5, EPA also included the CDC's NORS data for outbreak information (Note: NORS was launched in 2009). CCL 3 and CCL 4 examined outbreaks that occurred between 1990 and 2004. For CCL 5, EPA determined outbreaks that occurred in and after 2009 to capture the microbes of concern.

WBDOs are defined by CDC as:

- Two or more people linked epidemiologically by time, location of exposure to water, and type of illness,
- Epidemiologic evidence implicates water as the probable source of illness, and
- Environmental evidence implicates water as the source of infection.

WBDOs were scored on a five-level hierarchy ranging from never caused a WBDO (score of 1) to two or more documented WBDOs in the U.S. (score of 5) in the timeframe specified (Table 3).

Table 3. Waterborne Disease Outbreak Scoring Protocol

Category	Score
Has caused multiple (2 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	5
Has caused at least one documented WBDO in U.S. reported by CDC between 2009-2017	4
Has caused documented WBDOs at any time in the U.S.	3
Has caused documented WBDOs in countries other than the U.S.	2
Has never caused WBDOs in any country, but has been epidemiologically associated with water-related disease	1

Although WBDO data are useful tool for supporting the determination of microbial occurrence and exposure routes, there are limitations of WBDO data.

Many WBDOs are speculated to not be reported and therefore not counted. There are many possible circumstances that explain underreporting of WBDOs. For example, some people may not seek health care for their illnesses. For those people that do, laboratory testing may not be performed and if it is, the testing, does not always identify the microbe that caused the illness, and even when a specific microbe is identified, healthcare providers might not report all illnesses to public health agencies. In addition, surveillance, investigation, and reporting capacity varies across states and localities. Furthermore, there are multiple routes of exposure for many pathogens in addition to the drinking water pathway, such as through food, person-to-person, or animal-to-person. Therefore, it can be difficult to link illness to exposure through drinking water.

Section 5.2 Occurrence Data

The second attribute of the scoring process evaluates the occurrence of a pathogen in drinking water and source water. Because water-related illness may also occur in the absence of recognized outbreaks, EPA scored the occurrence (direct detection) of microbes using cultural, immunochemical, or molecular detection of pathogens in drinking water under the Occurrence Protocol. Occurrence characterizes pathogen introduction, survival, and distribution in the environment. Occurrence implies that pathogens are present in water and that they may be capable of surviving and moving through water to cause illness in persons exposed to drinking water by ingestion, inhalation, or dermal contact.

Pathogen occurrence is considered broadly to include treated drinking water, and all waters using a drinking water source for recreational purposes, groundwater, and surface water bodies. This attribute does not characterize the extent to which a pathogen's occurrence poses a public health threat from drinking water exposure. Occurrence was scored on a three-level hierarchy ranging from not detected in the U.S. (score of 1) to detected in drinking water in the U.S. (score of 3) (Table 4).

Table 4. Occurrence Scoring Protocol

Category	Score
Detected in drinking water in the U.S.	3
Detected in source water in the U.S.	2
Not detected in the U.S.	1

5.3 Health Risk Data

The health risk scoring protocol evaluated the extent of illness produced in humans from drinking water. The severity of disease manifestations produced by a pathogen was evaluated across a range of potential endpoints. Pathogens may produce a range of illness from asymptomatic infection to severe illness progressing rapidly to death. The seven-level hierarchy developed for this protocol begins with mild, self-limiting illness (score of 1) and progresses to death (score of 7) (Table 5). The protocol scored the representative or more common clinical presentation for the specific pathogen for the population category under consideration, rather than the extremes. These scores were based on data from recent clinical microbiology manuals (Carroll et al., 2019).

To obtain a representative characterization of health risk in all populations, EPA evaluated separately the general population and four sensitive populations (children, elderly, pregnant women, and persons with chronic diseases) as to the common clinical presentation of illness for that population. EPA added the general population score to the highest score among the four sensitive populations for an overall health risk score. The resulting score acknowledged that sensitive populations have increased risk for waterborne diseases. Table 5 shows the health risk scoring protocol template for general and sensitive populations.

Table 5. Health Risk Scoring Protocol for Pathogens

Outcome Category	Score	Manifestation in Population Class				
		General Population	Children/ Infants	Elderly	Pregnant Women	Chronic Disease[1]

Outcome Category	Score	Manifestation in Population Class				
		General Population	Children/ Infants	Elderly	Pregnant Women	Chronic Disease[1]
Does the organism cause significant mortality (> 1/1,000 cases)?	7					
Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> 1 week)?	6					
Does the illness result in long term or permanent dysfunction or disability (i.e., sequelae)?	5					
Does the illness require short term hospitalization (< 1 week)?	4					
Does the illness require physician intervention?	3					
Is the illness self-limiting within 72 hours (without requiring medical intervention)?	2					
Does the illness result in mild symptoms with minimal or no impact on daily activities?	1					

[1] Chronic diseases are defined broadly as conditions that last one year or more and require ongoing medical attention or limit activities of daily living or both, such as heart disease, cancer, and diabetes (CDC, https://www.cdc.gov/chronicdisease/about/index.htm).

EPA evaluated the possibility of using antibiotic susceptibility as part of the health risk scoring protocol, and/or antibiotic resistance as scoring consideration for microbes as part of the review process for the development of CCL 5. Each microbe on the PCCL was evaluated for its specific antibiotic resistance and mortality rate. The results of the literature search showed that antibiotic resistance cannot be used as a scoring consideration for microbes in the PCCL process at this time because there was too much variability among individual microbes and across all microbial groups to determine a criterion that would effectively apply to the universe of microbes.

Section 5.4 Calculated Data Elements for PCCL Contaminants

The highest of the individual WBDO score or occurrence score was added to the normalized health risk score to produce a composite score for each pathogen on the PCCL. Although the composite score was not shown on the CISs, the scoring summary table at the top left corner of each CIS shows the values used to calculate the composite score. The formula for the pathogen score was as follows:

$$\text{Pathogen Total Score} = \text{Highest Score between WBDO and Occurrence} + \left(\left(\text{General Population Score + Highest Sensitive Population} \right) \times 5/14 \right)$$

EPA normalized the health risk score so that occurrence (or WBDO) score and health risk score had equal value in determining the ranking of the CCL. The highest possible score for WBDO or occurrence was 5 and the highest possible health risk score was 14. To normalize this imbalance in the calculated total score, the Agency multiplied the health risk score by 5⁄14. An example of this calculation is shown in Appendix F.

The CISs that had been developed for CCL 3 were updated for each CCL 5 contaminant and new CIS sheets were developed for those microbes not previously included. The references in the CISs were also updated to reflect information that became available after EPA published the final CCL 3 and CCL 4. Scores were based on new and previous data available for each CCL 5 contaminant. The CIS tables present the final scores for each of the data types under consideration and a brief description of the data used to assign those scores with their respective references. For more information on the microbes scoring process and the CISs, see Appendix F.

Section 5.5 PCCL 5 Composite Score Results

The 35 PCCL pathogens were ranked according to an equal weighting of their summed scores for health risk and the greater of the individual scores for WBDO and occurrence in drinking water. EPA determined that this ranking indicated the most important pathogens to consider for the Final CCL 5. Table 6 displays the resulting composite scores collected from their respective CISs for the 35 microbial contaminants on the PCCL 5.

Table 6. Scores for all the PCCL 5 Pathogens

Pathogen	Ranking	WBDO	Occurrence	Health[1]	Total score[2]
Naegleria fowleri	1	5	3	5.0	10.0
Legionella pneumophila	2	5	3	3.6	8.6

Pathogen	Ranking	WBDO	Occurrence	Health[1]	Total score[2]
Escherichia coli (O157)	3	5	3	3.2	8.2
Pseudomonas aeruginosa	4	5	3	3.2	8.2
Helicobacter pylori	5	1	3	5.0	8.0
Campylobacter jejuni	6	5	3	2.5	7.5
Mycobacterium abscessus	7	4	3	3.2	7.2
Shigella sonnei	8	4	3	3.2	7.2
Caliciviruses	9	5	3	2.1	7.1
Mycobacterium avium	10	4	3	2.9	6.9
Adenovirus	11	2	3	3.6	6.6
Enterovirus	12	2	3	3.6	6.6
Pantoea agglomerans	13	4	3	2.5	6.5
Hepatitis A virus	14	3	2	3.2	6.2
Arcobacter butzleri	15	4	3	2.1	6.1
Fusarium solani	16	1	3	2.9	5.9
Nontuberculous Mycobacteria	17	3	3	2.9	5.9
Hepatitis E virus	18	2	1	3.6	5.6
Cyclospora cayetanensis	19	3	3	2.5	5.5
Rotavirus	20	2	3	2.5	5.5
Salmonella enterica	21	3	3	2.5	5.5
Toxoplasma gondii	22	2	1	3.2	5.2
Aspergillus fumigatus group	23	1	3	2.1	5.1
Entamoeba histolytica	24	3	3	2.1	5.1
Exophiala jeanselmei	25	1	3	2.1	5.1
Vibrio cholerae	26	3	3	2.1	5.1
Aeromonas hydrophila	27	1	3	1.8	4.8
Plesiomonas shigelloides	28	3	3	1.8	4.8
Blastocystis hominis	29	4	1	0.7	4.7
Acinetobacter baumannii	30	1	2	2.5	4.5

Pathogen	Ranking	WBDO	Occurrence	Health[1]	Total score[2]
Comanonas testosteroni	31	1	2	2.5	4.5
Yersinia enterocolitica	32	3	3	1.4	4.4
Astrovirus	33	2	2	1.4	3.4
Microsporidia	34	1	2	1.4	3.4
Isospora belli	35	2	1	1.1	3.1

[1] Normalized health score for that microbe
[2]Total Score = Normalized Health Score + the higher of WBDO or Occurrence.

Chapter 6 CCL 5 Microbes

6.1 Selecting CCL 5 Microbes

To determine which of the 35 PCCL pathogens should be the highest priority for EPA's drinking water program and included on the CCL 5, EPA considered scientific factors and the opportunity to advance public health protection. These factors included the PCCL scores for WBDO, occurrence, and health risks; comments and recommendations from the various expert panels including EPA's internal workgroup and CDC's subject matter experts; and the greatest opportunity to advance public health protection. After consideration of these factors, EPA listed the 12 highest-ranked pathogens for CCL 5 (Table 7). A comparison to previous CCLs to current CCL can be found in Appendix D.

Table 7. The Final Microbial CCL 5

Microorganism	Type of Microorganism
Adenovirus	Virus
Caliciviruses	Virus
Campylobacter jejuni	Bacteria
Escherichia coli (O157)	Bacteria
Enteroviruses	Virus
Helicobacter pylori	Bacteria
Legionella pneumophila	Bacteria
Mycobacterium abscessus	Bacteria
Mycobacterium avium	Bacteria

Microorganism	Type of Microorganism
Naegleria fowleri	Protozoa
Pseudomonas aeruginosa	Bacteria
Shigella sonnei	Bacteria

The selection of microbial pathogens for the Final CCL 5 was similar to the method used for CCL 3 with the exception that there were no "natural" breaks in the pathogen scores, meaning there were no large numerical gaps in the PCCL scores (as was for the previous PCCL 3 microbes) for the Final CCL 5 listing.

EPA determined that the overall rankings strongly reflected the best available scientific data employed in the CCL selection process and reflect those contaminants that are known or anticipated to occur in PWS with the greatest potential for public health concern.

Section 6.2 Supplemental Support for CCL 5 Microbial Contaminants

In addition to following the CCL microbial process that placed the microbial contaminants on the CCL 5, this section provides supplemental information for each of the microbes listed for CCL 5.

Adenovirus

Adenoviruses are a large group of viruses that infect the gastrointestinal tract and are shed through the intestines. Adenoviruses produce diverse symptoms, mostly causing respiratory tract illnesses but they can cause gastrointestinal illness as well. Serious illnesses can also occur including hemorrhagic colitis, hemorrhagic cystitis, and hepatitis (Lynch et al., 2011). There are many different serotypes of adenoviruses. Reported sporadic cases and outbreaks of adenovirus have resulted from exposure to several serotypes of adenoviruses, with types 40 and 41 being of particular concern in drinking water (Chapron et al., 2000).

Adenoviruses have been found in raw sewage, surface water and groundwater drinking water source waters (Mena, 2007). In most cases, human adenovirus reproduces in human cells; therefore, any adenovirus present in water has a human source, most likely from wastewater contamination (Jiang, 2006). Wastewater treatment plants and septic systems do not completely remove viruses, so wastewater containing viruses can be discharged to surface water, sometimes leading to waterborne outbreaks (Leclerc et al., 2002; Reynolds et al., 2008). Adenovirus is susceptible to inactivation by free chlorine (Page et al., 2009); however, it is highly resistant to inactivation by both monochloramine and ultraviolet light (Cromeans et al., 2010; USEPA, 2006c). The prevalence of these enteric adenoviruses in water sources and distribution systems has long been underestimated because they are not easily detected by conventional cell culture (WHO, 2011). In addition, adenoviruses can persist for extended periods of time outside of a host (Mena and Gerba, 2009).

Adenoviruses continue to be a concern for PWSs that use a groundwater source and that do not disinfect and/or systems that are inadequately disinfected. Borchardt et al. (2012) conducted a

community intervention study of 14 communities with an undisinfected water supply and found adenovirus in 13 percent of over 1,200 tap water samples using quantitative PCR (qPCR). Adenovirus was also among the several pathogens identified in groundwater wells sampled during the South Bass Island, Ohio outbreak in 2004 (Fong et al., 2007) and Chapron's et al. (2000) study that detected infectious adenovirus 40 and adenovirus 41 in 14 of 29 surface water samples.

Caliciviruses

Caliciviruses are a group of highly contagious viruses comprised of noroviruses and sapoviruses. Noroviruses are small in size and have surface properties that are favorable to infiltrating through subsurface matrices to contaminate groundwater (Fout et al., 2017). Environmental stability allows norovirus to survive in groundwater and they are believed to remain infectious in groundwater for months. Noroviruses can only be detected by real-time RT-qPCR, a specific quantitative method (that is not a requirement of any regulation). Norovirus is the most common cause of acute gastrointestinal illness (AGI) outbreaks. Borchardt et al.'s (2012) intervention study found a statistically significant association between norovirus (and enterovirus) concentrations measured by qPCR in tap water and AGI health effects in the 14 communities with a water supply that does not disinfect. Caliciviruses remain a concern for groundwater systems that do not disinfect and/or inadequately disinfected systems.

Campylobacter jejuni

As documented in the *Campylobacter* CIS, there were eight *Campylobacter* outbreaks from 2009 to 2017 reported in NORS. *Campylobacter* is a bacterial pathogen that lives in the intestines of many wild and domestic animals. *Campylobacter* poses a risk to human health due to it being widely distributed by bird (avian) and mammalian feces. In August 2016, New Zealand experienced a large outbreak of campylobacteriosis that resulted in four deaths and 5,500 illnesses (including Guillain-Barre paralysis) in a large population consuming groundwater from a system that does not disinfect. The outbreak is thought to have resulted from agricultural runoff containing animal (sheep) fecal material contaminating a pond, with water from this contaminated pond entering a nearby drinking water well through subsurface flow or through a buried wellhead. Total coliform and *Escherichia coli* (*E. coli)* are not failsafe indicators of *Campylobacter* contamination. *E. coli* O157 and *Campylobacter* sometimes co-occur in outbreaks because both are found in animal feces. *Campylobacter jejuni* is of concern for water systems that do not disinfect and/or inadequately disinfected systems.

***Escherichia coli* (O157)**

E. coli O157:H7 produces toxins that can cause hemolytic uremic syndrome (HUS) and can lead to kidney failure. Those most at risk for severe health outcomes from *E.coli* O157 are children (who are less than five years old), the elderly, and people with weakened immune systems (e.g., people who have cancer, HIV/AIDS, or had a transplant). Total coliform presence can signal a contamination pathway however, *E.coli* O157 is not detectable with standard *E. coli* analytical methods and requires specialized growth media for testing.

Enterovirus

Enteroviruses are a group of viruses that are shed via the fecal-oral route. The three most common enteroviruses are coxsackievirus, echovirus, and poliovirus. Enteroviruses are linked to myocarditis and epidemiological studies have shown a strong correlation between diabetes (type 1) and enterovirus infection (Krogvold et al., 2022). According to the Borchardt et al. (2012) intervention study, enterovirus was one of the three viruses that was most frequently found in a water supply that does not add disinfection. In addition, coxsackievirus is somewhat resistant to chlorine disinfection (Kahler et al., 2010), therefore if residual chlorine disinfectant applied in the distribution system is insufficient and/or residual is not maintained throughout the system, the residual may not be sufficient to inactivate these viruses.

Helicobacter pylori

Helicobacter pylori (H. pylori) is readily inactivated by chlorine, and the presence of *H. pylori* in U.S. finished drinking water has not been supported in recent literature; however, there is evidence of the presence of *H. pylori* in U.S. source waters (Richards et al., 2018) and thus a concern for groundwater systems that do not disinfect. *H. pylori* takes a long time to grow and does not cause an immediate WBDO; it may take weeks to months to recognize disease caused by *H. pylori*, therefore it is unlikely that a WBDO would be recognized and reported. Infection with *H. pylori* is the strongest known risk factor for gastric cancer, which is the second leading cause of cancer-related deaths worldwide.

Legionella pneumophila

Legionella pneumophila (L. pneumophila), a pathogenic bacterium, has been identified in numerous WBDOs and is the most common cause of reported drinking water-associated illnesses in the United States. *Legionella* has been found in finished water from drinking water treatment plants and can persist and grow in biofilms within distribution systems (USEPA, 2016d). *L. pneumophila* was detected in 25 percent of the source water samples and four percent of the treated water samples in a study that screened for nine pathogens in source water and in treated water at 25 treatment plants during 2010-2012 (King et al., 2016). *Legionella* bacteria can cause a serious type of pneumonia (lung infection) called Legionnaires' disease. Reported Legionnaires' disease has increased 10-fold in the last 20 years. The occurrence of Legionnaires' disease is believed to be underreported and therefore greater in prevalence than reported. The National Academies of Science report *Management of Legionella in Water Systems* estimated 52,000-70,000 cases of Legionnaires' disease annually, with 3-30 percent mortality (NASEM, 2020). Anyone can develop Legionnaires' disease; however, some risk factors put certain people at greater risk such as being a smoker, male, and/or over 50 years of age.

Mycobacterium abscessus and Mycobacterium avium

Mycobacteria naturally occur in the environment and in water systems. *Mycobacteria* are ubiquitous in natural waters and are found in wastewater, surface water, recreational water, groundwater, and tap water. *Mycobacterium* can occur at high concentrations in drinking water distribution system biofilms and are recognized as opportunistic pathogens. An illness caused by *Mycobacterium is* not a nationally notifiable disease, therefore, the occurrence of disease is difficult to measure and likely to be underestimated. *Mycobacterium abscessus (M. abscessus)* and *Mycobacterium avium (M. avium)* are mycobacterial species that are clinically significant (Donohue et al., 2016; Donohue, 2018) with *M. avium* as the most prevalent *Mycobacterium* in drinking water (Falkinham et al., 2015). Health effects are typically related to lung infections and

occur primarily in those with suppressed immune systems, underlying respiratory conditions, or in the very young or the elderly.

Naegleria fowleri

Naegleria fowleri (N. fowleri) is a free-living thermophilic amoeba found in warm freshwaters (e.g., rivers, lakes), hot springs, and soil. Infection from *N. fowleri* causes sudden onset primary amebic meningoencephalitis (PAM), a severe disease of the central nervous system that occurs when water containing the amoeba enters the nasal cavity, migrates to the brain, multiplies, and destroys host tissue and causes inflammation. Although infection from *N. fowleri* is rare, the mortality rate of PAM is greater than 90 percent (Baig et al., 2014). There have been cases of PAM linked to domestic water supplies (Cope et al., 2015). Two people were infected after performing nasal irrigation using contaminated tap water, and one person was infected by contaminated tap water used on a backyard slip-n-slide.

Treating drinking water with chlorine is an effective measure to manage *N. fowleri* in the drinking water distribution system, however, the loss of disinfectant residual can cause poorly chlorinated sections to be susceptible to colonization by *N. fowleri* (Morgan et al., 2016). Many factors can lead to entry of *N. fowleri* into drinking water distribution systems, such as pipe breaks and pressure fluctuations.

Pseudomonas aeruginosa

Pseudomonas aeruginosa (P. aeruginosa) is ubiquitous in the environment, including in water, soil, plants, animals, and food. *Pseudomonas* species are an opportunistic pathogen that can grow in the distribution system (WHO, 2011). *P. aeruginosa* causes a range of infections but does not usually cause serious disease in healthy individuals. Any type of human tissue compromised by illness or injury, such as burn and surgical wounds, is susceptible to infection by *P. aeruginosa*. This bacterium may invade the body, causing destructive lesions, septicemia, or meningitis (WHO, 2011). *Pseudomonas* has caused severe infections in people who are immunosuppressed or immunocompromised and in those with underlying disease. Infections typically present as bacteremia in immunocompromised individuals; as pneumonia in cystic fibrosis patients; as community-acquired ear and pneumonia infections; and as hospital-acquired outbreaks caused by contaminated solutions or devices. Water is the source of infection in all four of these types of infections (Falkinham et al., 2015). Tap water has been documented as a potential source of infection from *P. aeruginosa* in hospital and healthcare settings and in swimming pools and hot tubs that have not been adequately treated (WHO, 2011). The role of tap water as the source of *P. aeruginosa* disease has been established through direct contact with water and aerosols, aspiration, indirect transfer from moist environmental surfaces, or on the hands of healthcare workers.

Shigella sonnei

Shigella sonnei is a bacterial pathogen that spreads through the oral-fecal route in humans. *Shigella* is associated with bloody diarrhea and like *E. coli* O157:H7, it produces toxins that can cause hemolytic uremic syndrome (HUS), leading to potential chronic kidney disease in children and the elderly. *Shigella* contamination results from human fecal contamination and is a lesser problem than *E.coli* contamination (which has both human and animal sources, especially bovines). Although, human fecal contamination is much less common than animal fecal contamination, it has resulted in outbreaks in public water systems that do not add disinfection.

Shigella has been linked to 20 groundwater outbreaks in the U.S. between 1971 and 2008 (Wallender et al., 2014).

Section 6.3 Microorganisms Covered by Existing Regulations

According to Section 1412(b)(1) of the 1996 SDWA Amendments, EPA must select CCL contaminants that "at the time of publication, are not subject to any proposed or promulgated national primary drinking water regulation." In promulgating regulations for contaminants in drinking water, EPA can set either a legal limit (maximum contaminant level or MCL) and require monitoring for the contaminant in drinking water or, for those contaminants that are difficult to measure, EPA can establish a treatment technique requirement. The Surface Water Treatment Rule (SWTR) (54 FR 27486, USEPA, 1989a) established maximum contaminant level goals (MCLGs) of zero for *Legionella*, *Giardia*, and viruses because any amount of exposure to these contaminants represents some public health risk. Since measuring disease-causing microbes in drinking water was not considered to be feasible at the time of the development of the SWTR, EPA established treatment technique requirements for these contaminants. The purpose of subsequent treatment technique requirements (Interim Enhanced Surface Water Treatment Rule (63 FR 69478, USEPA 1998a), Long Term 1 Surface Water Treatment Rule (67 FR 1813, USEPA, 2002a), and the Long Term 2 Surface Water Treatment Rule (71 FR 654, USEPA, 2006a), which included an MCLG of zero for *Cryptosporidium*, is to reduce disease incidence associated with *Cryptosporidium* and other pathogenic microorganisms in drinking water. These rules apply to all public water systems that use surface water or groundwater under the direct influence of surface water.

The Ground Water Rule (GWR) (71 FR 65573; USEPA, 2006) set treatment technique requirements to control for viruses (and pathogenic bacteria) because it was not feasible to monitor for viruses (or pathogenic bacteria) in drinking water. Under the GWR, if systems detect total coliforms in the distribution system, they are required to monitor for a fecal indicator (*E. coli*, coliphage, or enterococci) in the source water. If fecal contamination is found in the source water, the system must take remedial action to address contamination.

EPA considered *Legionella* and specific viruses in CCL even though they are regulated under the SWTR. EPA listed *Legionella pneumophila,* the primary pathogenic bacterium, on the Final CCL 5 because it has been identified in numerous WBDOs and is the most common cause of reported drinking water-associated outbreaks in the U.S.

EPA also listed certain viruses on the Final CCL 5. Viruses include a wide range of taxa and different viral taxa have been implicated in various WBDOs for which EPA did not have dose response or treatment data when promulgating its treatment technique requirements.

Even though there are MCLGs for *Legionella* and viruses, and these contaminants are subject to limitations as a class through the treatment techniques under the SWTRs, there are no monitoring, treatment, or notification requirements within those NPDWRs that are specific to *Legionella pneumophila,* or the specific viruses listed on CCL5 (although systems may use coliphage for source water monitoring for groundwater systems). Therefore, EPA considers *Legionella pneumophila* and the specific viruses listed on CCL5 to be unregulated contaminants for purposes of eligibility for the CCL. Additionally, EPA received public nomination for viruses

and *Legionella* for the CCL 5, with *Legionella pneumophila* receiving the highest number of nominations.

Section 6.4 Listing Outcomes for the Nominated Microbial Contaminants

All of the microbes nominated for the CCL 5, except for *Salmonella enterica, Aeromonas hydrophila,* and Hepatitis A*,* were listed on the CCL 5. *Salmonella enterica*, *Aeromonas hydrophila* and Hepatitis A did not produce sufficient composite scores to place them on the CCL 5. Although *Salmonella enterica* and Hepatitis A have numerous WBDOs, the route of exposure was not reported as waterborne. Non-tuberculous *Mycobacteria* (NTM) and *Mycobacterium* (species broadly found in drinking water) were nominated for the CCL 5 and were not listed on the CCL 5 as a group; instead, they were listed as *Mycobacterium avium* and *Mycobacterium abscessus*, two species of NTM that are found in drinking water.

Chapter 7 Microbial Data Sources for the Final CCL 5

Multiple data sources were used to gather the information for the development of the Final CCL 5. The data sources used were evaluated by EPA to ensure they were authoritative and appropriate. Under the CCL 3, for microbes, the universe list was defined as all known human pathogens using the compilation of Taylor et al. (2001) as a practical starting point. This list was supplemented with literature searches and nominations from the public. The Final CCL 5 used the previous universes from the CCL 3 and the CCL 4 and was updated with literature searches of peer-reviewed sources and nominations.

The hierarchy of text-based resource materials begin with recently compiled authoritative reference books such as *Manual of Clinical Microbiology* (MCM), 9th Edition, and *Field's Virology*, 5th Edition, both published in 2007. Both of these two-volume reference books have become established as the leading authoritative reference sources in their respective fields. These references have evolved through multiple editions and both publications are considered reference standards to the scientific community for their scope and depth of coverage. They were edited by world-recognized authorities, and chapters were written by an international team of subject experts. *The Parasites of Homo sapiens*, second edition, is a comprehensive source for information on helminths. These and other compiled sources listed in the reference list provided the information for screening the pathogens in the microbial CCL 3 Universe. The 12th edition of the MCM was published in 2019 and was consulted for CCL 5 (Carroll et al., 2019).

Web references were used to find information for screening rarely encountered viruses, protozoa, and fungi, primarily for information related to Criterion 9, "natural habitat in the environment," and to Criterion 10, "pathogen not endemic to North America". Selected web references were evaluated to ensure that the site sponsors possessed the expertise to authoritatively address the issues of habitat and geographical distribution of the pathogen in question, and that the information was presented objectively and reviewed by members of the scientific community. Emphasis was placed upon websites sponsored and supported by government agencies or academic institutions, with evidence of peer review, such as an editorial board and/or expert contributors and reviewers.

Appendix B tabulates the screening decisions for the CCL 5 Microbial Universe and shows the screening reference used to support the decision. The web addresses/links provided are as narrow and specific as they can be, to identify the information related to the screening criterion used.

Many pathogens could be screened by several criteria, however only one criterion is noted in the tabulation. Understanding the complete context and rationale for a screening decision often requires a review of the complete chapter.

The MCM (Carroll et al., 2019) was one of the main sources of information used to inform the scoring of the PCCL microbes for the Final CCL 5. EPA also conducted a literature search covering the time between CCL 4 and CCL 5 (2016-2019). The literature search focused on health risks and occurrence of the nominated microbial contaminants in water.

For CCL 5 WBDOs, the primary source for scoring data was outbreak information pulled from CDC's NORS dashboard. Outbreak information was available from 2009-2017. NORS data was used as an alternative to CDC's MMWRs for more recent outbreak data (as of August 2019, the most recent MMWR report was published in 2017, documenting reported outbreaks from 2014). Appendix F contains additional detail on data sources.

References

Acha, P.N and B. Szyfres (ed.). 2001. Zoonoses and Communicable Diseases Common to Man and Animals, Volume I, Bacterioses and Mycoses. Scientific and Technical Publication No. 580. Pan American Health Organization, Washington, DC.

Allander, T. 2008. Human bocavirus. Journal of Clinical Virology. 41(1): 29-33. https://doi.org/10.1016/j.jcv.2007.10.026.

Ashford, R.W. and W. Crewe. 2003. *The parasites of Homo sapiens: An annotated checklist of the protozoa, helminths and arthropods for which we are home*. Taylor and Francis, London, UK.

Baig, A.M. and N.A. Khan. 2014. Novel chemotherapeutic strategies in the management of primary amoebic meningoencephalitis due to *Naegleria fowleri*. CNS Neuroscience and Therapeutics. 20(3): 289-290. https://doi.org/10.1111/cns.12225.

Baud, D., G. Goy, M.C. Osterheld, A. Croxatto, N. Borel, Y. Vial, A. Pospischil, and G. Greub. 2014. Role of Waddlia chondrophila placental infection in miscarriage. Emerging Infectious Diseases. 20(3): 460-464.

Bennett, J.V., W.R. Jarvis, and P.S. Brachman (eds.). 2007. *Bennett & Brachman's hospital infections*. Lippincott Williams & Wilkins, Philadelphia, PA.

Bofill-Mas, S., J. Rodriguez-Manzano, B. Calgua, A. Carratala, and R. Girones. 2010. Newly described human polyomaviruses Merkel Cell, KI and WU are present in urban sewage and may represent potential environmental contaminants. Virology Journal. 7(1): 1-5. https://doi.org/10.1186/1743-422X-7-141

Borchardt, M.A., S.K. Spencer, B.A. Kieke Jr., E. Lambertini, and F.J. Loge. 2012. Viruses in nondisinfected drinking water from municipal wells and community incidence of acute gastrointestinal illness. Environmental Health Perspectives. 120(9): 1272-1279.

Brown, M.K., B.A. Forbes, K. Stitley, and C.D. Doern. 2016. Defining the Clinical Significance of Alloscardovia omnicolens in the Urinary Tract. Journal of Clinical Microbiology. 54(6): 1552-1556. doi:10.1128/JCM.03084-15.

Carroll, K.C., M.A. Pfaller, M. L Landry, A.J. McAdam, R. Patel, S.S. Richter, and D.W. Warnock (ed). 2019. *Manual of Clinical Microbiology*, 12th Edition. American Society for Microbiology Press, Washington, DC.

Centers for Disease Control and Prevention (CDC). 2013. Lugo Hemorrhagic Fever (LUHF). Available online at: https://www.cdc.gov/vhf/lujo/transmission/index.html.

CDC. 2017. Surveillance for Waterborne-Disease Outbreaks Associated with Drinking Water - United States. Available online at: https://www.cdc.gov/mmwr/publications/index.html.

CDC. 2019. Healthcare-Associated Infections (HAIs)-Diseases and Organisms in Healthcare Settings. Available online at: https://www.cdc.gov/hai/organisms/organisms.html. Accessed May 2022.

CDC. 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard. Accessed August 31, 2020.

CDC. nd. About Chronic Diseases. Available online at: https://www.cdc.gov/chronicdisease/about/index.htm.

Chapron, C.D., N.A. Ballester, J.H. Fontaine, C.N. Frades, and A.B. Margolin. 2000. Detection of astroviruses, enteroviruses, and adenovirus types 40 and 41 in surface waters collected and evaluated by the information collection rule and an integrated cell culture-nested PCR procedure. Applied and Environmental Microbiology. 66(6): 2520-2525.

Ciotti, M., S. Angeletti, M. Minieri, M. Giovannetti, D. Benvenuto, S. Pascarella, C. Sagnelli, M. Bianchi, S. Bernardini, and M. Ciccozzi. 2019. COVID-19 Outbreak: An Overview. Chemotherapy. 64(5-6): 215-223. doi: 10.1159/000507423.

Cope, J.R., R.C. Ratard, V.R. Hill, T. Sokol, J.J. Causey, J.S. Yoder, G. Mirani, B. Mull, K.A. Mukerjee, J. Narayanan, and M. Doucet. 2015. The first association of a primary amebic meningoencephalitis death with culturable *Naegleria fowleri* in tap water from a US treated public drinking water system. Clinical Infectious Diseases. 60(8): e36-e42.

Cromeans, T.L., A.M. Kahler, and V.R. Hill. 2010. Inactivation of adenoviruses, enteroviruses, and murine norovirus in water by free chlorine and monochloramine. Applied and environmental microbiology. 76(4): 1028-1033.

Davis, C.P. 1996. Normal Flora. In Baron S. (ed.) *Medical Microbiology*, 4th Edition. Galveston (TX): University of Texas Medical Branch at Galveston. https://www.ncbi.nlm.nih.gov/books/NBK7617/.

Donohue, M.J. and L. Wymer. 2016. Increasing prevalence rate of nontuberculous mycobacteria infections in five states, 2008–2013. Annals of the American Thoracic Society. 13(12): 2143-2150.

Donohue, M.J. 2018. Increasing nontuberculous mycobacteria reporting rates and species diversity identified in clinical laboratory reports. BMC infectious diseases. 18(1): 1-9.

Drasar, B.S. and P.A. Barrow. 1985. *Intestinal microbiology*. Van Nostrand Reinhold, Berkshire.

Figueroa Castro, C.E., C. Johnson, M. Williams, A. VanDerSlik, M. Graham, D. Letzer, N. Ledeboer, B. Buchan, T. Block, G. Borulaug, and L. Munoz-Price. 2017. *Elizabethkingia anophelis*: Clinical Experience of an Academic Health System in Southeastern Wisconsin. Open Forum Infectious Diseases. 4(4) ofx251. doi:10.1093/ofid/ofx251.

Falkinham III, J.O., E.D. Hilborn, M.J. Arduino, A. Pruden, and M.A. Edwards. 2015. Epidemiology and ecology of opportunistic premise plumbing pathogens: *Legionella pneumophila, Mycobacterium avium*, and *Pseudomonas aeruginosa*. Environmental Health Perspectives. 123(8): 749-758.

Finegold, S.M., S.V.L. Sutter, and G.E. Mathisen. 1983. Normal indigenous intestinal flora, p. 3-31. In D. J. Hentges (ed.) *Human intestinal microflora in health and disease*. Academic Press, New York, NY.

Fong, T.T., L.S. Mansfield, D.L. Wilson, D.J. Schwab, S.L. Molloy, and J.B. Rose. 2007. Massive microbiological groundwater contamination associated with a waterborne outbreak in Lake Erie, South Bass Island, Ohio. Environmental health perspectives. 115(6): 856-864.

Fout, G.S., M.A. Borchardt, B.A. Kieke, and M.R. Karim. 2017. Human virus and microbial indicator occurrence in public-supply groundwater systems: meta-analysis of 12 international studies. Hydrogeology journal. 25(4): 903-919.

Greub, G. 2009. Parachlamydia acanthamoebae, an emerging agent of pneumonia. Clinical Microbiology and Infection.15(1):18-28. doi: 10.1111/j.1469-0691.2008.02633.x.

Howard, D. H. (ed.) 2003. Pathogenic fungi in humans and animals, 2nd Edition. Marcel Dekker, Inc, New York, NY.

Hashimoto, S., E. Tanaka, M. Ueyama, S. Terada, T. Nakanishi, N. Hamao, T. Inao, Y. Kaji, T. Hajiro, and S. Noma. 2017. A Case of Pulmonary Botrytis Species Infection in an Apparently Healthy Individual. American Journal of Respiratory and Critical Care Medicine. 195: A7155.

Isenberg, H. D. and R.F. D'Amato. 1995. Indigenous and Pathogenic Microorganisms of Humans. In Murray, P.R., E.J Baron, M.A. Pfaller, F.C. Tenover, and R.H. Yolken (ed.) *Manual of Clinical Microbiology*, 6th Edition. American Society for Microbiology Press, Washington, DC.

Institut national de santé publique du Québec.nd. Epicoccum purpurascens. Available online at: https://www.inspq.qc.ca/en/moulds/fact-sheets/epicoccum-purpurascens.

Jiang, S.C. 2006. Human adenoviruses in water: occurrence and health implications: a critical review. Environmental science & technology. 40(23): 7132-7140.

Kahler, A.M., T.L. Cromeans, J.M. Roberts, and V.R Hill. 2010. Effects of source water quality on chlorine inactivation of adenovirus, coxsackievirus, echovirus, and murine norovirus. Applied and environmental microbiology. 76(15): 5159-5164.

King, D.N., M.J. Donohue, S.J. Vesper, E.N. Villegas, M.W. Ware, M.E. Vogel, E.F. Furlong, D.W. Kolpin, S.T. Glassmeyer, and S. Pfaller. 2016. Microbial pathogens in source and treated waters from drinking water treatment plants in the United States and implications for human health. Science of the Total Environment. 562: 987-995.

Knipe, D.M. and P.M. Howley (ed.). 2007. *Fields' Virology*, 5th Edition. Wolters-Kluwer, Lippincott Williams & Wilkins, Philadelphia, PA.

Krauss, H., A. Weber, M. Appel, B. Enders, H. D. Isenberg, H. G. Schiefer, W. Slenczka, and A. von Graevenitz, and H. Zahner. 2003. *Zoonoses, Infectious Diseases Transmissible from Animals to Humans*, 3rd Edition. American Society for Microbiology Press, Washington, DC.

Krause, P.J. 2003. Babesiosis diagnosis and treatment. Vector-Borne and Zoonotic Diseases. 3(1): 45-51. doi: 10.1089/153036603765627451.

Krogvold, L., A. Genoni, A. Puggioni, D. Campani, S.J. Richardson, C.S. Flaxman, B. Edwin, T. Buanes, K. Dahl-Jørgensen, and A. Toniolo. 2022. Live enteroviruses, but not other viruses, detected in human pancreas at the onset of type 1 diabetes in the DiViD study. Diabetologia. 1-13.

Leclerc, H., L. Schwartzbrod, and E. Dei-Cas. 2002. Microbial agents associated with waterborne diseases. Critical reviews in microbiology. 28(4): 371-409.

Lynch, J.P., M. Fishbein, and M. Echavarria. 2011. Adenovirus. Seminars in Respiratory and Critical Care Medicine. 32(4): 494-511. doi: 10.1055/s-0031-1283287.

Mandell, G.L., J.E. Bennett, and R. Dolin (eds.). 2005. *Mandell, Douglas and Bennett's Principles and Practice of Infectious Diseases*, 6th Edition. Elsevier, Philadelphia, PA.

Mena, K. D. 2007. Waterborne viruses: Assessing the risks, Chapter 8. In Bosch, A. (ed.) *Human viruses in water*. Elsevier, Amsterdam, The Netherlands.

Mena K.D. and C.P. Gerba. 2009. Waterborne adenovirus. In Whitacre, D.M. (ed.) *Reviews of Environmental Contamination and Toxicology*, p. 133-167. Springer, New York.

Morgan, M.J., S. Halstrom, J.T. Wylie, T. Walsh, A.H. Kaksonen, D. Sutton, K. Braun, and G.J. Puzon. 2016. Characterization of a drinking water distribution pipeline terminally colonized by *Naegleria fowleri.* Environmental Science & Technology. 50(6): 2890-2898.

Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry, and M.A. Pfaller (ed.). 2007. *Manual of Clinical Microbiology*, 9th Edition. American Society for Microbiology Press, Washington, DC.

National Academies of Sciences Engineering, and Medicine (NASEM). 2020. Management of *Legionella* in Water Systems. The National Academies Press, Washington, DC https://doi.org/10.17226/25474.

National Drinking Water Advisory Council (NDWAC). 2004. National Drinking Water Advisory Council Report on the CCL Classification Process to the U. S. Environmental Protection Agency, May 19, 2004.

National Research Council (NRC). 1999a. Setting Priorities for Drinking Water Contaminants. National Academy Press, Washington, DC.

NRC. 1999b. Identifying Future Drinking Water Contaminants. National Academy Press, Washington, DC.

NRC. 2001. Classifying Drinking Water Contaminants for Regulatory Consideration. National Academy Press, Washington DC.

Page, M.A., J.L. Shisler, and B.J. Mariñas. 2009. Kinetics of adenovirus type 2 inactivation with free chlorine. Water Research. 43: 2916–26. doi: 10.1016/j.watres.2009.03.047.

Palmer, S.R., L. Soulsby, and D.I.H. Simpson. 1998. *Zoonoses: biology, clinical practice, and public health control*. Oxford University Press, Oxford, UK.

Portillo, A., P. Santibáñez, A.M. Palomar, S. Santibáñez, and J.A. Oteo. 2018. Candidatus Neoehrlichia mikurensis' in Europe. New Microbes and New Infections. 22: 30-36. doi:10.1016/j.nmni.2017.12.011.

Ramírez-Castillo, F.Y., A. Loera-Muro, M. Jacques, P. Garneau, F.J. Avelar-González, J. Harel, and A.L. Guerrero-Barrera. 2015. Waterborne Pathogens: Detection Methods and Challenges. Pathogens. 4: 307-334. doi:10.3390/pathogens4020307.

Reynolds, K.A., K.D. Mena, and C.P. Gerba. 2008. Risk of waterborne illness via drinking water in the United States. Reviews of Environmental Contamination and Toxicology. pp. 117-158.

Richards, C.L., S.C. Broadaway, M.J. Eggers, J. Doyle, B.H. Pyle, A.K. Camper, and T.E. Ford. 2018. Detection of Pathogenic and Non-pathogenic Bacteria in Drinking Water and Associated Biofilms on the Crow Reservation, Montana, USA. Microbiology Ecology. 76(1): 52-63. doi: 10.1007/s00248-015-0595-6.

Sharp, C.P., M. Vermeulen, Y. Nébié, C. F. Djoko, M. LeBreton, U. Tamoufe, A.W. Rimoin, P. K. Kayembe, J. K. Carr, A. Servant-Delmas, S. Laperche, G.L. Abby Harrison, O.G. Pybus, E. Delwart, N.D. Wolfe, A. Saville, Jean-Jacques Lefrère, and P. Simmonds. 2010. Changing epidemiology of human parvovirus 4 infection in sub-Saharan Africa. Emerging Infectious Diseases. (16)10: 1605-1607. doi:10.3201/eid1610.101001.

Taylor, L.H., S.M. Latham, and M.E. Woolhouse. 2001. Risk factors for human disease emergence. Philosophical Transactions of the Royal Society of London, Volume 356, Series B: Biological Sciences. pp. 983-989.

Tyler, K.T., E.S. Barton, M.L. Ibach, C. Robinson, J.A. Campbell, S.M. O'Donnell, T. Valyi-Nagy, P. Clarke, J.D. Wetzel, and T.S. Dermody. 2004. Isolation and molecular characterization of a novel type 3 reovirus from a child with meningitis. Journal of Infectious Diseases. 189(9): 1664-1675.

United States Environmental Protection Agency (USEPA). 1989. National Primary Drinking Water Regulations; Filtration, Disinfection; Turbidity, *Giardia Lamblia*, Viruses, *Legionella*, and Heterotrophic Bacteria; Final Rule. Part III. 54 FR 27486. June 29, 1989.

USEPA. 1998a. Announcement of the Drinking Water Contaminant Candidate List; *Notice.* 63 FR 10274. March 2, 1998.

USEPA. 1998b. Interim Enhanced SurfaceWater Treatment; *Final Rule*. 63 FR 69478. December 16, 1998.

USEPA. 2002. Long Term 1 Enhanced SurfaceWater Treatment Rule; *Final Rule.* 67 FR 1812 January 14, 2002.

USEPA. 2005. Drinking water Contaminant Candidate List 2; *Final Notice*. 70 FR 9071. February 24, 2005.

USEPA. 2006a. Long Term 2 Enhanced Surface Water Treatment Rule; *Final Rule*. 71 FR 654. January 5, 2006.

USEPA. 2006b. National Primary Drinking Water Regulations: Ground Water Rule; *Final Rule.*71 FR 65573. November 8, 2006.

USEPA. 2006c. Ultraviolet Disinfection Guidance Manual for the Final Long Term 2 Enhanced Surface Water Treatment Rule. EPA 815-R-06-007. November 2006.

USEPA. 2009a. Drinking Water Contaminant Candidate List 3; *Final Notice*. 74 FR 51850. October 18, 2009.

USEPA. 2009b. Final Contaminant Candidate List 3 Microbes: Screening to the PCCL. EPA 815-R-09-0005. August 2009.

USEPA. 2009c. Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process. EPA 815-R-09-009. August 2009.

USEPA. 2016a. Drinking Water Contaminant Candidate List 4—*Final*. 81 FR 81099. November 17, 2016.

USEPA. 2016b. Screening Document for the Fourth Preliminary Contaminant Candidate List 4 (PCCL 4). EPA 815-R-16-008. November 2016.

USEPA. 2016c. Response to the Science Advisory Board's Recommendations on the Draft Fourth Contaminant Candidate List (CCL 4). EPA 815-R-16-005. November 2016.

USEPA. 2016d. Technologies for *Legionella* control in Premise Plumbing Systems: Scientific Literature Review. EPA 810-R-16-001. September 2016.

USEPA. 2018. Request for Nominations of Drinking Water Contaminants for the Fifth Contaminant Candidate List. 83 FR 50364. October 5, 2018.

USEPA. 2022. Technical Support Document for the Final Fifth Contaminant Candidate List (CCL 5) - Chemical Contaminants. EPA 815-R-22-002. September 2022.

Wallender, E.K., E.C. Ailes, J.S. Yoder, V.A. Roberts, and J.M. Brunkard. 2014. Contributing factors to disease outbreaks associated with untreated groundwater. Groundwater. 52(6): 886-897.

Wenzel, R.P. (ed.). 2003. *Prevention and control of nosocomial infections*. Lippincott Williams & Wilkins, Philadelphia, PA.

World Health Organization (WHO). 2011. Guidelines for drinking-water quality, 4th Edition. World Health Organization, Geneva.

Appendix A: List of CCL 5 Microbial Nominations

Common Name	Nominator(s)	Health Risk Information Provided with Nomination	Occurrence Information Provided with Nomination	Additional Information Provided with Nomination	CCL Universe	PCCL 5	Final CCL 5
Aeromonas hydrophila	C.J. Volk	No information provided	No information provided	No information provided	X	X	
Adenovirus*	G. Tracy Mehan, AWWA	No information provided	No information provided	No information provided	X	X	X
Caliciviruses*	G. Tracy Mehan, AWWA	No information provided	No information provided	No information provided	X	X	X
*Campylobacter jejuni**	C.J. Volk	No information provided	No information provided	No information provided	X	X	X
	G. Tracy Mehan, AWWA	No information provided	No information provided	No information provided			
CCL 4 contaminants (12 microbes)*	Mae Wu and Anna Reade, NRDC	Known public health threats.	No information provided	No information provided	X	X	
Enterovirus*	G. Tracy Mehan, AWWA	No information provided	No information provided	No information provided	X	X	X
Escherichia coli (O157)*	C.J. Volk	No information provided	No information provided	No information provided	X	X	X
	G. Tracy Mehan, AWWA	No information provided	No information provided	No information provided			
*Helicobacter pylori**	C.J. Volk	No information provided	No information provided	No information provided	X	X	X
	G. Tracy Mehan, AWWA	No information provided	No information provided	No information provided			
Hepatitis A virus*	G. Tracy Mehan, AWWA	No information provided	No information provided	No information provided	X	X	
*Legionella pneumophila**[a]	Anonymous	No information provided	Typically found in biofilms	No information provided	X	X	X
	Paul McDermott, PJM-HS Consulting Ltd	No information provided	No information provided	No information provided			
	Jason Dobranic, EMSL	No information	No information	No information			

Common Name	Nominator(s)	Health Risk Information Provided with Nomination	Occurrence Information Provided with Nomination	Additional Information Provided with Nomination	CCL Universe	PCCL 5	Final CCL 5
	Analytical, Inc.	provided	provided	provided			
	Matthew Freije, hcinfo.com	No information provided	No information provided	No information provided			
	Anonymous	No information provided	No information provided	No information provided			
	Cam Pham, Enthalpy Analytical, LLC	No information provided	No information provided	No information provided			
	W.E. Pearson II, BPEARSON Consulting LLC	No information provided	No information provided	No information provided			
	C.J. Volk	No information provided	No information provided	No information provided			
	Sharon Sweeney, Central Arkansas Water	No information provided	No information provided	No information provided			
	Philippe Hartemann	No information provided	No information provided	No information provided			
	Anonymous	No information provided	No information provided	No information provided			
	Patsy Root, IDEXX Laboratories, Inc.	No information provided	No information provided	No information provided			
	Paul R. Easley, Central Arkansas Water	No information provided	No information provided	No information provided			
	Stan Hazan, NSF	According to the CDC, reported cases of legionella increased 286% during the time period 2000-2014.	The bacterium is known to propagate in premise plumbing and other mechanical systems. This places the elderly and individuals with compromised immune systems at risk when water contaminated with the bacteria aerosolizes and disperses.	No information provided			
	Robert Bohannon, City of	No information	No information	No information			

Common Name	Nominator(s)	Health Risk Information Provided with Nomination	Occurrence Information Provided with Nomination	Additional Information Provided with Nomination	CCL Universe	PCCL 5	Final CCL 5
	Moline, Illinois	provided	provided	provided			
	Mae Wu and Anna Reade, NRDC	No information provided	No information provided	No information provided			
	G. Tracy Mehan, AWWA	No information provided	No information provided	No information provided			
	Jennifer Clancy, ESPRI	There are 8,000 to 18,000 people hospitalized with LD each year and estimates of ten times that many cases that are unrecognized. CDC estimates that it costs $434,000,000 to treat LD in the US annually; LD is now the #1 cause of WBDOs in the US (CDC, 2015).	Based on CDC outbreak data, LD is responsible for 66% of waterborne disease outbreaks (WBDO) attributable to the distribution system.	No information provided			
*Mycobacterium avium**	C.J. Volk	No information provided	No information provided	No information provided	X	X	X
	G. Tracy Mehan, AWWA	No information provided	No information provided	No information provided			
Mycobacterium species predominantly found in finished drinking water	Anonymous	No information provided	Typically found in biofilms	No information provided	X		
*Naegleria fowleri**	G. Tracy Mehan, AWWA	No information provided	No information provided	No information provided	X	X	
Nontuberculous mycobacteria (NTM)	Jennifer Clancy, ESPRI	*Pseudomonas aeruginosa* which is the most common cause of hospital-acquired pneumonia and nontuberculous mycobacteria (NTM), an increasing cause of lung infections in both	In the chloraminated system, NTM colonized the pipe loops by the first sampling round and continued to be observed in the bulk water of all pipe materials, with greater numbers recovered	No information provided	X	X	

Common Name	Nominator(s)	Health Risk Information Provided with Nomination	Occurrence Information Provided with Nomination	Additional Information Provided with Nomination	CCL Universe	PCCL 5	Final CCL 5
		immunocompromised and otherwise heath individuals.	consistently from the high use pipe loops.				
Pseudomonas aeruginosa	Anonymous		Typically found in biofilms		X	X	X
	C.J. Volk	No information provided	No information provided	No information provided			
	Jennifer Clancy, ESPRI	*Pseudomonas aeruginosa* which is the most common cause of hospital-acquired pneumonia and nontuberculous mycobacteria (NTM), an increasing cause of lung infections in both immunocompromised and otherwise heath individuals.	No information provided	No information provided			
*Salmonella enterica**	C.J. Volk	No information provided	No information provided	No information provided	X	X	
	G. Tracy Mehan, AWWA	No information provided	No information provided	No information provided			
*Shigella sonnei**	C.J. Volk	No information provided	No information provided	No information provided	X	X	X
	G. Tracy Mehan, AWWA	No information provided	No information provided	No information provided			

*CCL 4 microbes

Appendix B: The CCL 5 Microbial Universe

The CCL 5 Microbial Universe

Table B-1 presents the CCL 5 Universe and the exclusion criteria used to keep a microbe in the universe. The source used for the exclusion criteria is listed in the reference column. Those microbes for which a source could not found to support exclusion moved forward to the PCCL.

The CCL 5 Microbes Exclusion Screening Criteria:

1. All anaerobes.
2. Obligate intracellular fastidious pathogens.
3. Transmitted by contact with blood or body fluids.
4. Transmitted by vectors.
5. Indigenous to the gastrointestinal tract, skin and mucous membranes.
6. Transmitted solely by respiratory secretions.
7. Life cycle incompatible with drinking water transmission.
8. Drinking water-related transmission is not implicated.
9. Natural habitat is in the environment without epidemiological evidence of drinking water-related disease and without evidence of drinking water-related nosocomial infection.
10. Not endemic to North America.
11. Represented by a pathogen for the entire genus or species (that are closely related).
12. Current taxonomy changed from taxonomy used in Universe.

Table B-1: The CCL 5 Microbial Universe and Exclusion Criteria

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Abiotrophia defectiva					x									MCM-12th Edition
Achromobacter piechaudii									x					MCM-12th Edition
Achromobacter xylosoxidans									x					MCM-12th Edition
Acidaminococcus fermentans	x													MCM-12th Edition
Acinetobacter baumannii													*Acinetobacter baumannii*	
Acinetobacter calcoaceticus									x					MCM-12th Edition
Acinetobacter haemolyticus									x					MCM-12th Edition
Acinetobacter johnsonii									x					MCM-12th Edition
Acinetobacter junii									x					MCM-12th Edition
Acinetobacter lwoffii									x					MCM-12th Edition
Acinetobacter radioresistens									x					MCM-12th Edition
Actinobacillus equuli			x											MCM-12th Edition
Actinobacillus hominis			x											MCM-12th Edition
Actinobacillus lignieresii			x											MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Actinobacillus pleuropneumoniae			x											MCM-12th Edition
Actinobacillus suis			x											MCM-12th Edition
Actinobacillus ureae					x									MCM-12th Edition
Actinomyces georgiae	x													MCM-12th Edition
Actinomyces gerencseriae	x													MCM-12th Edition
Actinomyces israelii	x													MCM-12th Edition
Actinomyces meyeri	x													MCM-12th Edition
Actinomyces naeslundii	x													MCM-12th Edition
Actinomyces neuii	x													MCM-12th Edition
Actinomyces odontolyticus	x													MCM-12th Edition
Actinomyces radingae	x													MCM-12th Edition
Actinomyces turicensis	x													MCM-12th Edition
Aerococcus viridans									x					MCM-12th Edition
Aeromonas caviae									x					MCM-12th Edition
Aeromonas hydrophila													*Aeromonas hydrophila*	
Aeromonas sobria									x					MCM-12th Edition
Aeromonas veronii									x					MCM-12th Edition
Aggregatibacter actinomycetemcomitans					x									MCM-12th Edition
Aggregatibacter aphrophilus					x									MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Alcaligenes odorans					x									MCM-12th Edition
Alloprevotella tannerae	x													MCM-12th Edition
Alloscardovia omnicolens					x									Brown, M et al., 2016
Amycolatopsis orientalis									x					MCM-12th Edition
Anaplasma phagocytophilum				x										MCM-12th Edition
Arcanobacterium heamolyticum					x									MCM-12th Edition
Arcobacter butzleri													*Arcobacter butzleri*	
Arcobacter cryaerophilus											x			MCM-12th Edition
Bacillus anthracis									x					MCM-12th Edition
Bacillus cereus									x					MCM-12th Edition
Bacillus circulans									x					MCM-12th Edition
Bacillus coagulans									x					MCM-12th Edition
Bacillus licheniformis									x					MCM-12th Edition
Bacillus mycoides									x					MCM-12th Edition
Bacillus pumilus									x					MCM-12th Edition
Bacillus subtilis									x					MCM-12th Edition
Bacillus thuringiensis									x					MCM-12th Edition
Bacteroides caccae	x													MCM-12th Edition
Bacteroides eggerthii	x													MCM-12th Edition
Bacteroides fragilis	x													MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Bacteroides galacturonicus	x													MCM-12th Edition
Bacteroides ovatus	x													MCM-12th Edition
Bacteroides pectinophilus	x													MCM-12th Edition
Bacteroides stercoris	x													MCM-12th Edition
Bacteroides thetaiotaomicron	x													MCM-12th Edition
Bacteroides uniformis	x													MCM-12th Edition
Bacteroides vulgatus	x													MCM-12th Edition
Bartonella bacilliformis				x										MCM-12th Edition
Bartonella elizabethae				x										MCM-12th Edition
Bartonella henselae				x										MCM-12th Edition
Bartonella quintana				x										MCM-12th Edition
Bergeyella zoohelcum					x									MCM-12th Edition
Bifidobacterium dentium	x													MCM-12th Edition
Bilophila wadsworthia	x													MCM-12th Edition
Blautia producta	x													MCM-12th Edition
Bordetella avium						x								MCM-12th Edition
Bordetella bronchiseptica						x								MCM-12th Edition
Bordetella parapertussis						x								MCM-12th Edition
Bordetella pertussis						x								MCM-12th Edition
Borrelia brasiliensis				x										MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Borrelia burgdorferi				x										MCM-12th Edition
Borrelia caucasica				x										MCM-12th Edition
Borrelia crocidurae				x										MCM-12th Edition
Borrelia duttonii				x										MCM-12th Edition
Borrelia hermsii				x										MCM-12th Edition
Borrelia hispanica				x										MCM-12th Edition
Borrelia latyschewii				x										MCM-12th Edition
Borrelia mazzottii				x										MCM-12th Edition
Borrelia parkeri				x										MCM-12th Edition
Borrelia persica				x										MCM-12th Edition
Borrelia recurrentis				x										MCM-12th Edition
Borrelia turicatae				x										MCM-12th Edition
Borrelia venezuelensis				x										MCM-12th Edition
Brevibacillus brevis									x					MCM-12th Edition
Brevundimonas diminuta									x					MCM-12th Edition
Brevundimonas vesicularis									x					MCM-12th Edition
Brucella melitensis		x												MCM-12th Edition
Burkholderia cepacia									x					MCM-12th Edition
Burkholderia mallei										x				MCM-12th Edition
Burkholderia pseudomallei									x					MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Campylobacter coli											x			MCM-12th Edition
Campylobacter concisus					x									MCM-12th Edition
Campylobacter curvus					x									MCM-12th Edition
Campylobacter fetus								x						MCM-12th Edition
Campylobacter gracilis					x									MCM-12th Edition
Campylobacter hyointestinalis								x						MCM-12th Edition
Campylobacter jejuni													*Campylobacter jejuni*	
Campylobacter lari											x			MCM-12th Edition
Campylobacter rectus					x									MCM-12th Edition
Campylobacter sputorum								x						MCM-12th Edition
Campylobacter upsaliensis								x						MCM-12th Edition
Campylobacter ureolyticus	x													MCM-12th Edition
Capnocytophaga canimorsus					x									MCM-12th Edition
Capnocytophaga cynodegmi					x									MCM-12th Edition
Capnocytophaga gingivalis					x									MCM-12th Edition
Capnocytophaga ochracea					x									MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Capnocytophaga sputigena					x									MCM-12th Edition
Cardiobacterium hominis					x									MCM-12th Edition
Cedecea davisae									x					MCM-12th Edition
Cedecea lapagei									x					MCM-12th Edition
Cedecea neteri									x					MCM-12th Edition
Cellulomonas turbata									x					MCM-12th Edition
Cellulosimicrobium cellulans									x					MCM-12th Edition
Centipeda periodontii	x													MCM-12th Edition
Chlamydia trachomatis			x											MCM-12th Edition
Chlamydophila pneumoniae		x												MCM-12th Edition
Chlamydophila psittaci		x												MCM-12th Edition
Chromobacterium violaceum								x						MCM-12th Edition
Chryseobacterium balustinum									x					MCM-12th Edition
Citrobacter amalonaticus					x									MCM-12th Edition
Citrobacter braakii					x									MCM-12th Edition
Citrobacter farmeri					x									MCM-12th Edition
Citrobacter freundii					x									MCM-12th Edition
Citrobacter koseri					x									MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Citrobacter rodentium					x									MCM-12th Edition
Citrobacter sedlakii					x									MCM-12th Edition
Citrobacter werkmanii					x									MCM-12th Edition
Citrobacter youngae					x									MCM-12th Edition
Clostridium baratii	x													MCM-12th Edition
Paraclostridium bifermentans	x													MCM-12th Edition
Clostridium botulinum	x													MCM-12th Edition
Clostridium butyricum	x													MCM-12th Edition
Clostridium chauvoei	x													MCM-12th Edition
Clostridoides difficile	x													MCM-12th Edition
Clostridium fallax	x													MCM-12th Edition
Clostridium histolyticum	x													MCM-12th Edition
Clostridium novyi	x													MCM-12th Edition
Clostridium perfringens	x													MCM-12th Edition
Clostridium ramosum	x													MCM-12th Edition
Clostridium septicum	x													MCM-12th Edition
Clostridium sordellii	x													MCM-12th Edition
Clostridium sporogenes	x													MCM-12th Edition
Clostridium tertium	x													MCM-12th Edition
Clostridium tetani	x													MCM-12th Edition
Collinsella aerofaciens	x													MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Comamonas testosteroni													*Comamonas testosteroni*	
Corynebacterium afermentans					x									MCM-12th Edition
Corynebacterium argentoratense					x									MCM-12th Edition
Corynebacterium bovis					x									MCM-12th Edition
Corynebacterium diphtheriae						x								MCM-12th Edition
Corynebacterium jeikeium					x									MCM-12th Edition
Corynebacterium kutscheri					x									MCM-12th Edition
Corynebacterium macginleyi					x									MCM-12th Edition
Corynebacterium minutissimum					x									MCM-12th Edition
Corynebacterium propinquum					x									MCM-12th Edition
Corynebacterium pseudodiphthericum					x									MCM-12th Edition
Corynebacterium pseudotuberculosis					x									MCM-12th Edition
Corynebacterium striatum					x									MCM-12th Edition
Corynebacterium ulcerans					x									MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Corynebacterium urealyticum					x									MCM-12th Edition
Corynebacterium xerosis					x									MCM-12th Edition
Coxiella burnetii		x												MCM-12th Edition
Cronobacter sakazakii									x					MCM-12th Edition
Cutibacterium acnes					x									MCM-12th Edition
Cutibacterium avidum					x									MCM-12th Edition
Cutibacterium granulosum					x									MCM-12th Edition
Delftia acidovorans									x					MCM-12th Edition
Dermatophilus congolensis									x					MCM-12th Edition
Dichelobacter nodosus	x													MCM-12th Edition
Edwardsiella hoshinae									x					MCM-12th Edition
Edwardsiella tarda									x					MCM-12th Edition
Eggerthella lenta	x													MCM-12th Edition
Ehrlichia chaffeensis				x										MCM-12th Edition
Ehrlichia equi				x										MCM-12th Edition
Ehrlichia ewingii				x										MCM-12th Edition
Eikenella corrodens					x									MCM-12th Edition
Elizabethkingia anophelis									x					Figueroa Castro, Carlos E et al., 2017

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Elizabethkingia meningoseptica									x					MCM-12th Edition
Enterobacter amnigenus									x					MCM-12th Edition
Enterobacter asburiae									x					MCM-12th Edition
Enterobacter cancerogenus									x					MCM-12th Edition
Enterobacter cloacae									x					MCM-12th Edition
Enterobacter gergoviae									x					MCM-12th Edition
Enterobacter hormaechei									x					MCM-12th Edition
Enterococcus avium									x					MCM-12th Edition
Enterococcus casseliflavus									x					MCM-12th Edition
Enterococcus durans									x					MCM-12th Edition
Enterococcus faecalis									x					MCM-12th Edition
Enterococcus faecium									x					MCM-12th Edition
Enterococcus flavescens									x					MCM-12th Edition
Enterococcus gallinarum									x					MCM-12th Edition
Enterococcus hirae									x					MCM-12th Edition
Enterococcus mundtii									x					MCM-12th Edition
Enterococcus raffinosus									x					MCM-12th Edition
Erysipelothrix rhusiopathiae									x					MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Escherichia coli													*Escherichia coli*	
Eubacterium brachy	x													MCM-12th Edition
Eubacterium cylindroides	x													MCM-12th Edition
Eubacterium limosum	x													MCM-12th Edition
Eubacterium moniliforme	x													MCM-12th Edition
Eubacterium multiforme	x													MCM-12th Edition
Eubacterium nodatum	x													MCM-12th Edition
Eubacterium rectale	x													MCM-12th Edition
Eubacterium saburreum	x													MCM-12th Edition
Eubacterium saphenum	x													MCM-12th Edition
Eubacterium sulci	x													MCM-12th Edition
Eubacterium tenue	x													MCM-12th Edition
Ewingella americana					x									MCM-12th Edition
Faecalicatena contorta	x													MCM-12th Edition
Fibrobacter intestinalis	x													MCM-12th Edition
Filifactor alocis	x													MCM-12th Edition
Finegoldia magna	x													MCM-12th Edition
Fluoribacter bozemanae												x		MCM-12th Edition
Fluoribacter dumoffii												x		MCM-12th Edition
Fluoribacter gormanii												x		MCM-12th Edition
Francisella tularensis				x										MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Fusobacterium mortiferum	x													MCM-12th Edition
Fusobacterium necrophorum	x													MCM-12th Edition
Fusobacterium nucleatum	x													MCM-12th Edition
Fusobacterium periodonticum	x													MCM-12th Edition
Fusobacterium ulcerans	x													MCM-12th Edition
Fusobacterium varium	x													MCM-12th Edition
Gardnerella vaginalis					x									MCM-12th Edition
Gemella morbillorum					x									MCM-12th Edition
Gordonia amarae									x					MCM-12th Edition
Gordonia bronchialis									x					MCM-12th Edition
Gordonia rubropertincta									x					MCM-12th Edition
Gordonia sputi									x					MCM-12th Edition
Gordonia terrae									x					MCM-12th Edition
Granulicatella adiacens					x									MCM-12th Edition
Haemophilus ducreyi			x											MCM-12th Edition
Haemophilus haemolyticus					x									MCM-12th Edition
Haemophilus influenzae					x									MCM-12th Edition
Haemophilus parahaemolyticus					x									MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Haemophilus parainfluenzae					x									MCM-12th Edition
Haemophilus paraphrophilus					x									MCM-12th Edition
Haemophilus segnis					x									MCM-12th Edition
Hafnia alvei									x					MCM-12th Edition
Helicobacter cinaedi											x			MCM-12th Edition
Helicobacter fennelliae											x			MCM-12th Edition
Helicobacter heilmannii											x			MCM-12th Edition
Helicobacter pullorum											x			MCM-12th Edition
Helicobacter pylori													*Helicobacter pylori*	
Kingella denitrificans					x									MCM-12th Edition
Kingella kingae					x									MCM-12th Edition
Klebsiella aerogenes									x					MCM-12th Edition
Klebsiella granulomatis									x					MCM-12th Edition
Klebsiella oxytoca									x					MCM-12th Edition
Klebsiella pneumoniae									x					MCM-12th Edition
Kluyvera ascorbata									x					MCM-12th Edition
Kluyvera cryocrescens									x					MCM-12th Edition
Lactobacillus sp.	x													MCM-12th Edition
Legionella anisa											x			MCM-12th Edition
Legionella birminghamensis											x			MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Legionella cherrii											x			MCM-12th Edition
Legionella cincinnatiensis											x			MCM-12th Edition
Legionella feeleii											x			MCM-12th Edition
Legionella hackeliae											x			MCM-12th Edition
Legionella jordanis											x			MCM-12th Edition
Legionella lansingensis											x			MCM-12th Edition
Legionella longbeachae											x			MCM-12th Edition
Legionella oakridgensis											x			MCM-12th Edition
Legionella pneumophila													*Legionella pneumophila*	
Legionella rubrilucens											x			MCM-12th Edition
Legionella sainthelensi											x			MCM-12th Edition
Legionella tucsonensis											x			MCM-12th Edition
Legionella wadsworthii											x			MCM-12th Edition
Leifsonia aquatica									x					MCM-12th Edition
Leptospira borgpetersenii								x						MCM-12th Edition
Leptospira inadai								x						MCM-12th Edition
Leptospira interrogans								x						MCM-12th Edition
Leptospira kirschneri								x						MCM-12th Edition
Leptospira meyeri								x						MCM-12th Edition
Leptospira noguchii								x						MCM-12th Edition
Leptospira santarosai								x						MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Leptospira weilii								x						MCM-12th Edition
Leptotrichia buccalis	x													MCM-12th Edition
Listeria ivanovii								x						MCM-12th Edition
Listeria monocytogenes								x						MCM-12th Edition
Listeria seeligeri								x						MCM-12th Edition
Listeria welshimeri								x						MCM-12th Edition
Lysinibacillus sphaericus									x					MCM-12th Edition
Mannheimia haemolytica					x									MCM-12th Edition
Megamonas hypermegale	x													MCM-12th Edition
Megasphaera sp.	x													MCM-12th Edition
*Methylobacterium mesophilicum**								x						MCM-12th Edition
*Methylobacterium zatmanii**								x						MCM-12th Edition
Micromonas micros	x													MCM-12th Edition
Mogibacterium timidum	x													MCM-12th Edition
Moraxella atlantae					x									MCM-12th Edition
Moraxella bovis					x									MCM-12th Edition
Moraxella catarrhalis					x									MCM-12th Edition
Moraxella caviae					x									MCM-12th Edition
Moraxella cuniculi					x									MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Moraxella lacunata					x									MCM-12th Edition
Moraxella lincolnii					x									MCM-12th Edition
Moraxella liquefaciens					x									MCM-12th Edition
Moraxella nonliquefaciens					x									MCM-12th Edition
Moraxella osloensis					x									MCM-12th Edition
Moraxella ovis					x									MCM-12th Edition
Morganella morganii					x									MCM-12th Edition
Mycobacterium abscessus													*Mycobacterium abscessus*	
Mycobacterium africanum										x				MCM-12th Edition
Mycobacterium asiaticum									x					MCM-12th Edition
Mycobacterium avium													*Mycobacterium avium*	
Mycobacterium bovis		x												MCM-12th Edition
Mycobacterium celatum									x					MCM-12th Edition
Mycobacterium chelonae									x					MCM-12th Edition
Mycobacterium conspicuum									x					MCM-12th Edition
Mycobacterium fortuitum									x					MCM-12th Edition
Mycobacterium genavense									x					MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Mycobacterium gordonae									x					MCM-12th Edition
Mycobacterium haemophilum									x					MCM-12th Edition
Mycobacterium kansasii									x					MCM-12th Edition
Mycobacterium leprae		x												MCM-12th Edition
Mycobacterium malmoense									x					MCM-12th Edition
Mycobacterium marinum									x					MCM-12th Edition
Mycobacterium mucogenicum									x					MCM-12th Edition
Mycobacterium peregrinum									x					MCM-12th Edition
Mycobacterium porcinum									x					MCM-12th Edition
Mycobacterium scrofulaceum									x					MCM-12th Edition
Mycobacterium senegalense									x					MCM-12th Edition
Mycobacterium shimoidei									x					MCM-12th Edition
Mycobacterium simiae									x					MCM-12th Edition
Mycobacterium smegmatis									x					MCM-12th Edition
Mycobacterium szulgai									x					MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Mycobacterium tuberculosis						x								MCM-12th Edition
Mycobacterium ulcerans									x					MCM-12th Edition
Mycobacterium xenopi									x					MCM-12th Edition
Mycoplasma fermentans		x												MCM-12th Edition
Mycoplasma genitalium		x												MCM-12th Edition
Mycoplasma hominis		x												MCM-12th Edition
Mycoplasma pneumoniae		x												MCM-12th Edition
Mycoplasma salivarium		x												MCM-12th Edition
Myroides odoratus								x						MCM-12th Edition
Neisseria cinerea					x									MCM-12th Edition
Neisseria elongata					x									MCM-12th Edition
Neisseria flava					x									MCM-12th Edition
Neisseria flavescens					x									MCM-12th Edition
Neisseria gonorrhoeae			x											MCM-12th Edition
Neisseria lactamica					x									MCM-12th Edition
Neisseria meningitidis						x								MCM-12th Edition
Neisseria mucosa					x									MCM-12th Edition
Neisseria perflava					x									MCM-12th Edition
Neisseria sicca					x									MCM-12th Edition
Neisseria subflava					x									MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Neisseria weaveri					x									MCM-12th Edition
Neoehrlichia mikurensis				x										Portillo, A et al., 2018
Neorickettsia sennetsu				x										MCM-12th Edition
Nocardia asteroides									x					MCM-12th Edition
Nocardia brasiliensis									x					MCM-12th Edition
Nocardia caviae									x					MCM-12th Edition
Nocardia farcinica									x					MCM-12th Edition
Nocardia nova									x					MCM-12th Edition
Nocardia otitidiscaviarum									x					MCM-12th Edition
Nocardia pseudobrasiliensis									x					MCM-12th Edition
Nocardia transvalensis									x					MCM-12th Edition
Ochrobactrum anthropi									x					MCM-12th Edition
Odoribacter splanchnicus	x													MCM-12th Edition
Oligella ureolytica					x									MCM-12th Edition
Oligella urethralis					x									MCM-12th Edition
Orientia tsutsugamushi		x												MCM-12th Edition
Paenibacillus alvei									x					MCM-12th Edition
Paenibacillus macerans									x					MCM-12th Edition
Pantoea agglomerans													*Pantoea agglomerans*	
Parabacteroides distasonis	x													MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Parabacteroides merdae	x													MCM-12th Edition
Parachlamydia acanthamoebae		x												Greub, G., 2009
Pasteurella aerogenes					x									MCM-12th Edition
Pasteurella caballi					x									MCM-12th Edition
Pasteurella canis					x									MCM-12th Edition
Pasteurella dagmatis					x									MCM-12th Edition
Pasteurella multocida					x									MCM-12th Edition
Pasteurella stomatis					x									MCM-12th Edition
Peptococcus niger	x													MCM-12th Edition
Peptostreptococcus anaerobius	x													MCM-12th Edition
Peptostreptococcus asaccharolyticus	x													MCM-12th Edition
Peptostreptococcus lactolyticus	x													MCM-12th Edition
Peptostreptococcus prevotii	x													MCM-12th Edition
Peptostreptococcus vaginalis	x													MCM-12th Edition
Photobacterium damselae									x					MCM-12th Edition
Plesiomonas shigelloides													*Plesiomonas shigelloides*	

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Porphyromonas asaccharolytica	x													MCM-12th Edition
Porphyromonas catoniae	x													MCM-12th Edition
Porphyromonas circumdentaria	x													MCM-12th Edition
Porphyromonas endodontalis	x													MCM-12th Edition
Porphyromonas gingivalis	x													MCM-12th Edition
Porphyromonas levii	x													MCM-12th Edition
Porphyromonas macacae	x													MCM-12th Edition
Prevotella bivia	x													MCM-12th Edition
Prevotella buccae	x													MCM-12th Edition
Prevotella buccalis	x													MCM-12th Edition
Prevotella corporis	x													MCM-12th Edition
Prevotella dentalis	x													MCM-12th Edition
Prevotella denticola	x													MCM-12th Edition
Prevotella disiens	x													MCM-12th Edition
Prevotella enoeca	x													MCM-12th Edition
Prevotella heparinolytica	x													MCM-12th Edition
Prevotella intermedia	x													MCM-12th Edition
Prevotella loescheii	x													MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Prevotella melaninogenica	x													MCM-12th Edition
Prevotella nigrescens	x													MCM-12th Edition
Prevotella oralis	x													MCM-12th Edition
Prevotella oris	x													MCM-12th Edition
Prevotella oulora	x													MCM-12th Edition
Prevotella ruminicola	x													MCM-12th Edition
Prevotella veroralis	x													MCM-12th Edition
Prevotella zoogleoformans	x													MCM-12th Edition
Propionibacterium propionicus	x													MCM-12th Edition
Proteus mirabilis									x					MCM-12th Edition
Proteus penneri									x					MCM-12th Edition
Proteus vulgaris									x					MCM-12th Edition
Providencia alcalifaciens									x					MCM-12th Edition
Providencia rettgeri									x					MCM-12th Edition
Providencia stuartii									x					MCM-12th Edition
Pseudomonas aeruginosa													*Pseudomonas aeruginosa*	
Pseudomonas alcaligenes									x					MCM-12th Edition
Pseudomonas fluorescens									x					MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Pseudomonas pseudoalcaligenes									x					MCM-12th Edition
Pseudomonas putida									x					MCM-12th Edition
Pseudomonas stutzeri									x					MCM-12th Edition
Pseudonocardia autotrophica									x					MCM-12th Edition
Pseudoramibacter alactolyticus	x													MCM-12th Edition
Psychrobacter phenylpyruvicus									x					MCM-12th Edition
Rahnella aquatilis									x					MCM-12th Edition
Ralstonia pickettii									x					MCM-12th Edition
Raoultella ornithinolytica									x					MCM-12th Edition
Rhodococcus equi									x					MCM-12th Edition
Rhodococcus erythropolis									x					MCM-12th Edition
Rhodococcus fascians									x					MCM-12th Edition
Rhodococcus rhodnii									x					MCM-12th Edition
Rhodococcus rhodochrous									x					MCM-12th Edition
Rickettsia africae				x										MCM-12th Edition
Rickettsia akari				x										MCM-12th Edition
Rickettsia australis				x										MCM-12th Edition
Rickettsia conorii				x										MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Rickettsia felis				x										MCM-12th Edition
Rickettsia honei				x										MCM-12th Edition
Rickettsia japonica				x										MCM-12th Edition
Rickettsia massiliae				x										MCM-12th Edition
Rickettsia prowazekii				x										MCM-12th Edition
Rickettsia rickettsii				x										MCM-12th Edition
Rickettsia sibirica				x										MCM-12th Edition
Rickettsia typhi				x										MCM-12th Edition
Rodentibacter pneumotropicus					x									MCM-12th Edition
Rothia dentocariosa					x									MCM-12th Edition
Saccharomonospora viridis									x					MCM-12th Edition
Saccharopolyspora rectivirgula									x					MCM-12th Edition
Salmonella bongori											x			MCM-12th Edition
Salmonella choleraesuis											x			MCM-12th Edition
Salmonella enteritidis											x			MCM-12th Edition
Salmonella typhi											x			MCM-12th Edition
Salmonella typhimurium													*Salmonella enterica*	
Sebaldella termitidis	x													MCM-12th Edition
Selenomonas artemidis	x													MCM-12th Edition
Selenomonas dianae	x													MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Selenomonas flueggei	x													MCM-12th Edition
Selenomonas infelix	x													MCM-12th Edition
Selenomonas noxia	x													MCM-12th Edition
Serratia ficaria									x					MCM-12th Edition
Serratia marcescens									x					MCM-12th Edition
Serratia odorifera									x					MCM-12th Edition
Serratia plymuthica									x					MCM-12th Edition
Serratia proteamaculans									x					MCM-12th Edition
Serratia rubidaea									x					MCM-12th Edition
Shigella boydii											x			MCM-12th Edition
Shigella dysenteriae											x			MCM-12th Edition
Shigella flexneri											x			MCM-12th Edition
Shigella sonnei													*Shigella sonnei*	
Sphingomonas paucimobilis									x					MCM-12th Edition
Spirillum minus		x												MCM-12th Edition
Staphylococcus aureus					x									MCM-12th Edition
Staphylococcus epidermidis					x									MCM-12th Edition
Staphylococcus haemolyticus					x									MCM-12th Edition
Staphylococcus hyicus					x									MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Staphylococcus intermedius					x									MCM-12th Edition
Staphylococcus lugdunensis					x									MCM-12th Edition
Staphylococcus saprophyticus					x									MCM-12th Edition
Staphylococcus warneri					x									MCM-12th Edition
Stenotrophomonas maltophilia									x					MCM-12th Edition
Streptobacillus moniliformis			x											MCM-12th Edition
Streptococcus acidominimus					x									MCM-12th Edition
Streptococcus agalactiae					x									MCM-12th Edition
Streptococcus anginosus					x									MCM-12th Edition
Streptococcus bovis					x									MCM-12th Edition
Streptococcus canis					x									MCM-12th Edition
Streptococcus constellatus					x									MCM-12th Edition
Streptococcus criceti					x									MCM-12th Edition
Streptococcus equi					x									MCM-12th Edition
Streptococcus gordonii					x									MCM-12th Edition
Streptococcus intermedius					x									MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Streptococcus milleri					x									MCM-12th Edition
Streptococcus mitis					x									MCM-12th Edition
Streptococcus mutans					x									MCM-12th Edition
Streptococcus pneumoniae					x									MCM-12th Edition
Streptococcus pyogenes					x									MCM-12th Edition
Streptococcus salivarius					x									MCM-12th Edition
Streptococcus sanguis					x									MCM-12th Edition
Streptococcus sobrinus					x									MCM-12th Edition
Streptococcus suis					x									MCM-12th Edition
Streptococcus uberis					x									MCM-12th Edition
Sutterella wadsworthensis	x													MCM-12th Edition
Suttonella indologenes					x									MCM-12th Edition
Tanerella forsythia	x													MCM-12th Edition
Tatlockia maceachernii												x		MCM-12th Edition
Tatlockia micdadei												x		MCM-12th Edition
Tatumella ptyseos								x						MCM-12th Edition
Treponema carateum								x						MCM-12th Edition
Treponema pallidum			x											MCM-12th Edition
Tropheryma whippelii									x					MCM-12th Edition
Trueperella bernardiae					x									MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Trueperella pyogenes					x									MCM-12th Edition
Tsukamurella inchonensis									x					MCM-12th Edition
Tsukamurella paurometabola									x					MCM-12th Edition
Tsukamurella pulmonis									x					MCM-12th Edition
Tsukamurella tyrosinosolvens									x					MCM-12th Edition
Ureaplasma urealyticum		x												MCM-12th Edition
Veillonella atypica	x													MCM-12th Edition
Veillonella dispar	x													MCM-12th Edition
Veillonella parvula	x													MCM-12th Edition
Vibrio alginolyticus									x					MCM-12th Edition
Vibrio cholerae													*Vibrio cholerae*	
Vibrio cincinnatiensis									x					MCM-12th Edition
Vibrio fluvialis									x					MCM-12th Edition
Vibrio furnissii									x					MCM-12th Edition
Vibrio hollisae									x					MCM-12th Edition
Vibrio mimicus									x					MCM-12th Edition
Vibrio parahaemolyticus									x					MCM-12th Edition
Vibrio vulnificus									x					MCM-12th Edition
Waddlia chondrophila		x												Baud, David et al., 2014
Wolinella succinogenes	x													MCM-12th Edition

Bacteria	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Reference
Yersinia bercovieri								x						MCM-12th Edition
Yersinia enterocolitica													*Yersinia enterocolitica*	
Yersinia frederiksenii								x						MCM-12th Edition
Yersinia intermedia								x						MCM-12th Edition
Yersinia kristensenii								x						MCM-12th Edition
Yersinia mollaretii								x						MCM-12th Edition
Yersinia pestis				x										MCM-12th Edition
Yersinia pseudotuberculosis									x					MCM-12th Edition
Yersinia rohdei								x						MCM-12th Edition
Yersinia ruckeri								x						MCM-12th Edition

Viruses	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Andes virus										x				MCM-12th Edition
Apoi virus				x										Field's Virology, 5th Ed., p. 1153-1158, 1206
Australian bat lyssavirus				x										Field's Virology, 5th Ed., p. 1364
Bagaza virus				x										Field's Virology, 5th Ed., p. 1153-1158, 1199
Bangui virus				x										MCM-12th Edition
Banna virus				x										MCM-12th Edition
Banzi virus				x										MCM-12th Edition

Viruses	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Barmah Forest virus				x										MCM-12th Edition
Batken virus				x										http://phene.cpmc.columbia.edu/7thReport/sites/descriptions/Orthomyxoviridae/thogotovirus.htm
Bayou virus				x										MCM-12th Edition
Bebaru virus				x										Field's Virology, 5th. Ed., p. 1024
Bhanja virus				x										MCM-12th Edition
BK virus			x											MCM-12th Edition
Black creek canal virus				x										MCM-12th Edition
Borna disease virus						x								Field's Virology, 5th Ed., p. 1835
Bovine Ephemeral Fever virus				x										Field's Virology, 5th Ed., p. 1367
Bovine Papular Stomatitis virus			x											Field's Virology, 5th Ed., p. 2948, 2955-2956, 2963
Bovine Spongiform Encephalopathy (BSE) agent										x				MCM-12th Edition
Buffalopox virus								x						Field's Virology, 5th Ed. p. 2955-2956
Bunyamwera virus				x										MCM-12th Edition
Bussuquara virus				x										MCM-12th Edition
Bwamba virus				x										MCM-12th Edition

Viruses	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
California encephalitis virus				x										MCM-12th Edition
Candiru virus complex				x										MCM-12th Edition
Caraparu virus				x										MCM-12th Edition
Catu virus				x										MCM-12th Edition
Cercopithecine herpes virus 1								x						Field's Virology, 5th Ed., p. 2895-2897
Chandipura virus				x										MCM-12th Edition
Changuinola virus				x										MCM-12th Edition
Chikungunya virus				x										MCM-12th Edition
Chim virus				x										http://phene.cpmc.columbia.edu/ICTVdB/11000000.htm
Creutzfeld-Jokob Disease (CJD) agent								x						Field's Virology, 5th Ed., p. 443-444, 3077-3078
Colorado tick fever virus				x										MCM-12th Edition
Cote d'Ivoire Ebola virus										x				Field's Virology, 5th. Ed., p. 619, 1411-1412, 1432-1434
Cowpox virus										x				MCM-12th Edition
Crimea-Congo Haemorrhagic Fever Virus										x				MCM-12th Edition
Dakar bat virus								x						Field's Virology, 5th Ed., p. 1158, 1206
Dengue virus				x										MCM-12th Edition
Dhori virus				x										MCM-12th Edition

Viruses	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Dobrava-Belgrade virus										x				MCM-12th Edition
Dugbe virus				x										MCM-12th Edition
Duvenhage virus										x				Field's Virology, 5th Ed., p. 1364
Eastern equine encephalitis virus				x										MCM-12th Edition
Edge Hill virus				x										MCM-12th Edition
Encephalomyocarditis virus								x						Field's Virology, 5th Ed., p. 796, 840, 858-860
European bat lyssavirus 1										x				Field's Virology, 5th Ed., p. 1364
European bat lyssavirus 2										x				Field's Virology, 5th Ed., p. 1364
European Tick-borne encephalitis virus				x										Field's Virology, 5th Ed., p. 1153-1158, 1200-1203
Everglades virus				x										MCM-12
Eyach virus				x										Krauss et al., 2003 p. 87-89
Far eastern Tick-borne encephalitis virus				x										Field's Virology, 5th Ed., p. 1153-1158, 1200-1203
Foot and mouth disease virus								x						Field's Virology, 5th Ed., p. 796, 840, 858-860
Ganjam virus				x										MCM-12th Edition
Getah virus				x										Field's Virology, 5th Ed., p. 1024
Guama virus				x										MCM-12th Edition

Viruses	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Guanarito virus										x				MCM-12th Edition
Guaroa virus				x										MCM-12th Edition
Hantaan virus										x				MCM-12th Edition
Hendra virus										x				MCM-12th Edition
Hepatitis A virus													Hepatitis A	
Hepatitis B virus			x											MCM-12th Edition
Hepatitis C virus			x											MCM-12th Edition
Hepatitis delta virus			x											MCM-12th Edition
Hepatitis E virus													Hepatitis E	
Hepatitis G virus			x											MCM-12th Edition
HU39694 virus				x										http://www.cdc.gov/ncidod/diseases/hanta/hps/noframes/phys/ecology.htm
Hughes virus				x										Field's Virology, 5th Ed., p. 1743-1745
Human adenovirus A													Adenovirus	
Human adenovirus B						x								MCM-12th Edition
Human adenovirus C											x			MCM-12th Edition
Human adenovirus D						x								MCM-12th Edition
Human adenovirus E						x								MCM-12th Edition
Human adenovirus F											x			MCM-12th Edition
Human astrovirus													Astrovirus	
Human bocavirus								x						Allander, T., 2008

Viruses	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PCCL**	**Page Reference**
Human Coronavirus 229E						x								MCM-12th Edition
Human Coronavirus OC43						x								MCM-12th Edition
Human coronavirus SARS-CoV-2						x								Ciotti, et al., 2019
Human enterovirus 68											x			MCM-12th Edition
Human enterovirus 70											x			MCM-12th Edition
Human enterovirus A													Enterovirus	
Human enterovirus B											x			MCM-12th Edition
Human enterovirus C											x			MCM-12th Edition
Human enterovirus D											x			MCM-12th Edition
Human Herpesvirus 1			x											MCM-12th Edition
Human Herpesvirus 2			x											MCM-12th Edition
Human Herpesvirus 3			x											MCM-12th Edition
Human Herpesvirus 4			x											MCM-12th Edition
Human Herpesvirus 5			x											MCM-12th Edition
Human Herpesvirus 6			x											MCM-12th Edition
Human Herpesvirus 7			x											MCM-12th Edition
Human Herpesvirus 8			x											MCM-12th Edition
Human Immunodeficiency Virus 1			x											MCM-12th Edition

Viruses	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Human Immunodeficiency Virus 2			x											MCM-12th Edition
Human papillomavirus			x											MCM-12th Edition
Human parainfluenza virus 1			x											MCM-12th Edition
Human parainfluenza virus 2						x								MCM-12th Edition
Human parainfluenza virus 3						x								MCM-12th Edition
Human parainfluenza virus 4						x								MCM-12th Edition
Human parechovirus type 1								x						MCM-12th Edition
Human parechovirus type 2								x						MCM-12th Edition
Human Respiratory Syncytial virus						x								MCM-12th Edition
Human Rhinovirus A						x								MCM-12th Edition
Human Rhinovirus B						x								MCM-12th Edition
Human T-Lymphotropic Virus 1			x											MCM-12th Edition
Igbo-ora virus				x										Field's Virology, 5th Ed., p. 1024, 1048
Ilheus virus				x										MCM-12th Edition
Influenza A virus						x								MCM-12th Edition

Viruses	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Influenza B virus						x								MCM-12th Edition
Influenza C virus						x								MCM-12th Edition
Issyk-Kul virus				x										MCM-12th Edition
Japanese encephalitis virus				x										MCM-12th Edition
JC virus			x											MCM-12th Edition
Junin virus			x											MCM-12th Edition
Juquitiba virus				x										Field's Virology, 5th Ed., p. 1743-1745
KI polyomavirus			x											Bofill-Mas, S., et al., 2010
Karshi virus										x				MCM-12th Edition
Kasokero virus				x										http://phene.cpmc.columbia.edu/ICTVdB/11000000.htm
Kedougou virus				x										Field's Virology, 5th Ed., p. 1153-1158, 1199
Kemerovo virus				x										MCM-12th Edition
Kobuvirus								x						Ramírez-Castillo et al., 2015
Kokobera virus				x										MCM-12th Edition
Koutango virus				x										MCM-12th Edition
Kyasanur forest disease virus				x										MCM-12th Edition
Laguna Negra virus										x				MCM-12th Edition
Lanjan virus				x										http://phene.cpmc.columbia.edu/ICTVdB/11000000.htm

Viruses	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Lassa virus										x				MCM-12th Edition
Lebombo virus				x										MCM-12th Edition
Lechiguanas virus				x										http://phene.cpmc.columbia.edu/7thReport/sites/descriptions/Bunyaviridae/hantavirus.htm
Louping ill virus				x										MCM-12th Edition
Lujo virus			x											https://www.cdc.gov/vhf/lujo/transmission/index.html
Lymphocytic choriomeningitis virus								x						MCM-12th Edition
Machupo virus										x				MCM-12th Edition
Madrid virus				x										MCM-12th Edition
Marburg virus			x											MCM-12th Edition
Marituba virus				x										MCM-12th Edition
Mayaro virus				x										MCM-12th Edition
Measles virus						x								MCM-12th Edition
Menangle virus										x				http://www.cdc.gov/ncidod/eid/vol4no2/philbey.htm
Mimivirus[1]								x						Field's Virology, 5th Ed., p. 627-628, 637-638
Mokola virus				x										Field's Virology, 5th Ed., p. 1363-1364
Molluscum contagiosum virus			x											MCM-12th Edition

Viruses	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Monkeypox virus										x				MCM-12th Edition
Monongahela virus				x										http://phene.cpmc.columbia.edu/7thReport/sites/descriptions/Bunyaviridae/hantavirus.htm
Mucambo virus				x										MCM-12th Edition
Mumps virus			x											MCM-12th Edition
Murray Valley encephalitis virus				x										MCM-12th Edition
New York virus				x										MCM-12th Edition
Newcastle disease virus						x								Field's Virology, 5th Ed., p. 1497-1498
Nipah virus										x				MCM-12th Edition
Norwalk-like viruses													Calicivirus	
Nyando virus				x										MCM-12th Edition
Ockelbo virus				x										MCM-12th Edition
Omsk haemorrhagic fever virus				x										MCM-12th Edition
O'nyong-nyong virus				x										MCM-12th Edition
Oran virus				x										http://phene.cpmc.columbia.edu/7thReport/sites/descriptions/Bunyaviridae/hantavirus.htm
Orf virus								x						MCM-12th Edition
Oriboca virus				x										MCM-12th Edition

Viruses	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Oropouche virus				x										MCM-12th Edition
Orungo virus				x										MCM-12th Edition
Parvovirus 4			x											Sharp, C. P., et al., 2010
Parvovirus B19						x								MCM-12th Edition
Phnom-Penh bat virus								x						Field's Virology, 5th Ed., p. 1153-1158, 1206
Picobirnavirus								x						MCM-12th Edition
Piry virus				x										MCM-12th Edition
Poliovirus											x			MCM-12th Edition
Powassan virus				x										MCM-12th Edition
Pseudocowpox virus			x											Field's Virology, 5th Ed., p. 2948, 2960, 2963
Punta Toro virus				x										MCM-12th Edition
Puumala virus										x				MCM-12th Edition
Quaranfil Virus				x										MCM-12th Edition
Rabies virus							x							MCM-12th Edition
Reovirus								x						Field's Virology, 5th Ed., p. 1897-1900
Reston Ebola virus										x				MCM-12th Edition
Rift Valley fever virus										x				MCM-12th Edition
Rio Bravo virus								x						Field's Virology, 5th Ed., p. 1153-1158, 1206
Rocio virus				x										MCM-12th Edition

Viruses	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Ross River virus				x										MCM-12th Edition
Rotavirus A													Rotavirus	
Rotavirus B										x				MCM-12th Edition
Rotavirus C										x				MCM-12th Edition
Rotavirus D										x				MCM-12th Edition
Rotavirus E										x				MCM-12th Edition
Rotavirus F										x				MCM-12th Edition
Royal Farm virus				x										Field's Virology, 5th Ed., p. 1153-1158, 1204
Rubella virus						x								MCM-12th Edition
Sabia virus										x				MCM-12th Edition
Saimiriine herpesvirus 1								x						Field's Virology, 4th Ed., p. 2383, 2483, 2511, 2848
Salehabad virus				x										http://phene.cpmc.columbia.edu/ICTVdB/11041008.htm
Sandfly fever Naples virus				x										MCM-12th Edition
Sandfly fever virus group				x										MCM-12th Edition
Saumarez Reef virus				x										Field's Virology, 5th Ed., p. 1153-1158,1206
Sealpox virus								x						MCM-12th Edition
Semliki Forest virus				x										MCM-12th Edition
Seoul virus				x										MCM-12th Edition
Sepik virus										x				MCM-12th Edition

Viruses	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Sin Nombre virus				x										MCM-12th Edition
Sindbis virus										x				MCM-12th Edition
St. Louis encephalitis virus				x										MCM-12th Edition
Sudan Ebola virus										x				MCM-12th Edition
Suid herpesvirus								x						Field's Virology, 4th Ed., p. 2385, 2484, 2707
Swine vesicular disease virus										x				Field's Virology, 5th Ed., p. 963
Tacaiuma virus				x										MCM-12th Edition
Tamdy virus				x										MCM-12th Edition
Tanapox virus										x				MCM-12th Edition
Tataguine virus				x										MCM-12th Edition
Thogoto virus				x										MCM-12th Edition
Trubanaman virus				x										MCM-12th Edition
Tyuleniy virus				x										Field's Virology, 5th Ed., p. 1153-1158, 1206
Usutu virus				x										MCM-12th Edition
Variola virus			x											MCM-12th Edition
Venezuelan Equine Encephalitis virus				x										MCM-12th Edition
Vesicular stomatitis virus				x										MCM-12th Edition
Wad Medani virus				x										Field's Virology, 5th Ed., p. 1975-1977

Viruses	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Wanowrie virus				x										MCM-12th Edition
Wesselsbron virus				x										MCM-12th Edition
West Nile virus				x										MCM-12th Edition
Western Equine Encephalitis virus				x										MCM-12th Edition
WU polyomavirus						x								Bofill-Mas, S., 2010
Wyeomyia virus				x										MCM-12th Edition
Yaba monkey tumor virus										x				MCM-12th Edition
Yellow fever virus				x										MCM-12th Edition
Yogue virus				x										http://phene.cpmc.columbia.edu/ICTVdB/11000000.htm
Zaire Ebola virus										x				MCM-12th Edition
Zika virus										x				MCM-12th Edition
Zinga virus				x										http://www.cdc.gov/mmwr/preview/mmwrhtml/00001253.htm

Protozoa	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Acanthamoeba astronyxis									x					MCM-12th Edition
Acanthamoeba castellani									x					MCM-12th Edition

Protozoa	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Acanthamoeba culbertsoni									x					MCM-12th Edition
Acanthamoeba hatchetti									x					MCM-12th Edition
Acanthamoeba palestinensis									x					MCM-12th Edition
Acanthamoeba polyphaga									x					MCM-12th Edition
Acanthamoeba rhysodes									x					MCM-12th Edition
Babesia bovis				x										MCM-12th Edition
Babesia divergens				x										MCM-12th Edition
Babesia gibsoni				x										MCM-12th Edition
Babesia microti				x										MCM-12th Edition
Balamuthia mandrillaris								x						MCM-12th Edition
Balantidium coli								x						MCM-12th Edition
Blastocystis hominis													*Blastocystis hominis*	
Cryptosporidium parvum[1]														
Cyclospora cayetanensis													*Cyclospora cayetanensis*	
Dientamoeba fragilis							x							MCM-12th Edition
Encephalitozoon cuniculi											x			MCM-12th Edition
Encephalitozoon hellem											x			MCM-12th Edition
Encephalitozoon intestinalis													Microsporidia	

Protozoa	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Entamoeba chattoni											x			http://www.itg.be/itg/DistanceLearning/LectureNotesVandenEndenE/06_Amoebiasisp2.htm#IX_450
Entamoeba histolytica													*Entamoeba histolytica*	
Entamoeba moshkovskii											x			http://www.itg.be/itg/DistanceLearning/LectureNotesVandenEndenE/06_Amoebiasisp2.htm#IX_450
Enterocytozoon bieneusi											x			MCM-12th Edition
Giardia duodenalis[1]														
Isospora belli													*Isospora belli*	
Leishmania aethiopica				x										MCM-12th Edition
Leishmania amazonensis				x										MCM-12th Edition
Leishmania braziliensis				x										MCM-12th Edition
Leishmania chagasi				x										MCM-12th Edition
Leishmania donovani				x										MCM-12th Edition
Leishmania guyanensis				x										MCM-12th Edition
Leishmania infantum				x										MCM-12th Edition
Leishmania lainsoni				x										MCM-12th Edition
Leishmania major				x										MCM-12th Edition
Leishmania mexicana				x										MCM-12th Edition
Leishmania naiffi				x										MCM-12th Edition

Protozoa	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Leishmania panamensis				x										MCM-12th Edition
Leishmania peruviana				x										MCM-12th Edition
Leishmania pifanoi				x										MCM-12th Edition
Leishmania shawi				x										MCM-12th Edition
Leishmania tropica				x										MCM-12th Edition
Leishmania venezuelensis				x										MCM-12th Edition
Naegleria fowleri													*Naegleria fowleri*	
Nosema africanum								x						MCM-12th Edition
Nosema ceylonensis								x						MCM-12th Edition
Nosema connori								x						MCM-12th Edition
Nosema ocularum								x						MCM-12th Edition
Pentatrichomonas hominis					x									MCM-12th Edition
Plasmodium falciparum				x										MCM-12th Edition
Plasmodium knowlesi				x										MCM-12th Edition
Plasmodium malariae				x										MCM-12th Edition
Plasmodium ovale				x										MCM-12th Edition
Plasmodium simium				x										MCM-12th Edition
Plasmodium vivax				x										MCM-12th Edition
Retortamonas intestinalis					x									MCM-12th Edition
Sarcocystis hominis							x							MCM-12th Edition

Protozoa	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Sarcocystis lindermanni							x							MCM-12th Edition
Sarcocystis suihominis							x							MCM-12th Edition
Toxoplasma gondii													*Toxoplasma gondii*	
Trachipleistophora hominis											x			MCM-12th Edition
Trichomonas tenax					x									MCM-12th Edition
Trichomonas vaginalis			x											MCM-12th Edition
Trypanosoma brucei				x										MCM-12th Edition
Trypanosoma cruzi				x										MCM-12th Edition
Vittaforma corneae								x						MCM-12th Edition

Helminths	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Acanthocephalus rauschi							x							Ashford and Crewe, 2003
Achillurbainia nouveli										x				Ashford and Crewe, 2003
Achillurbainia recondita							x							Ashford and Crewe, 2003
Alaria americana							x							Ashford and Crewe, 2003
Alaria marcianae							x							Ashford and Crewe, 2003
Amphimerus pseudofelineus										x				Ashford and Crewe, 2003
Anatrichosoma cutaneum										x				Ashford and Crewe, 2003

Helminths	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Ancylostoma braziliense							x							Ashford and Crewe, 2003
Ancylostoma caninum										x				Ashford and Crewe, 2003
Ancylostoma ceylanicum										x				Ashford and Crewe, 2003
Ancylostoma duodenale							x							Ashford and Crewe, 2003
Ancylostoma malayanum										x				Ashford and Crewe, 2003
Anisakis physeteris							x							Ashford and Crewe, 2003
Anisakis simplex							x							Ashford and Crewe, 2003
Aonchotheca philippinensis										x				Ashford and Crewe, 2003
Apophallus donicus							x							Ashford and Crewe, 2003
Artyfechinostomum mehrai										x				Ashford and Crewe, 2003
Ascaris lumbricoides							x							Ashford and Crewe, 2003
Ascaris suum							x							Ashford and Crewe, 2003
Ascocotyle sp.							x							Ashford and Crewe, 2003
Australobilharzia terrigalensis										x				Ashford and Crewe, 2003
Baylisascaris procyonis							x							Ashford and Crewe, 2003
Bertiella mucronata							x							Ashford and Crewe, 2003
Bertiella studeri										x				Ashford and Crewe, 2003
Bilharziella polonica										x				Ashford and Crewe, 2003
Bolbosoma sp.										x				Ashford and Crewe, 2003

Helminths	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Brugia beaveri				x										Ashford and Crewe, 2003
Brugia guyanensis				x										Ashford and Crewe, 2003
Brugia malayi				x										Ashford and Crewe, 2003
Brugia pahangi				x										Ashford and Crewe, 2003
Brugia timori				x										Ashford and Crewe, 2003
Bunostomum phlebotomum							x							Ashford and Crewe, 2003
Calodium hepaticum							x							Ashford and Crewe, 2003
Carneocephallus brevicaea										x				Ashford and Crewe, 2003
Cathaemasia cabrerai										x				Ashford and Crewe, 2003
Centrocestus armatus										x				Ashford and Crewe, 2003
Centrocestus formosanus										x				Ashford and Crewe, 2003
Cheilospirura sp.										x				Ashford and Crewe, 2003
Clinostomum complanatum										x				Ashford and Crewe, 2003
Contracaecum osculatum										x				Ashford and Crewe, 2003
Corynosoma strumosum							x							Ashford and Crewe, 2003
Cryptocotyle lingua										x				Ashford and Crewe, 2003
Cyclodontostomum purvisi										x				Ashford and Crewe, 2003
Dicrocoelium dendriticum							x							Ashford and Crewe, 2003

Helminths	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Dicrocoelium hospes										x				Ashford and Crewe, 2003
Dioctophyme renale							x							Ashford and Crewe, 2003
Dipetalonema arbuta				x										Ashford and Crewe, 2003
Dipetalonema reconditum				x										MCM-8, p. 634, 1209
Diphyllobothrium cameroni										x				Ashford and Crewe, 2003
Diphyllobothrium cordatum							x							Ashford and Crewe, 2003
Diphyllobothrium dalliae							x							Ashford and Crewe, 2003
Diphyllobothrium dendriticum							x							Ashford and Crewe, 2003
Diphyllobothrium elegans										x				Ashford and Crewe, 2003
Diphyllobothrium erinaceieuropaei										x				Ashford and Crewe, 2003
Diphyllobothrium hians										x				Ashford and Crewe, 2003
Diphyllobothrium houghtoni										x				Ashford and Crewe, 2003
Diphyllobothrium nihonkaiense										x				Ashford and Crewe, 2003
Diphyllobothrium lanceolatum							x							Ashford and Crewe, 2003
Dibothriocephalus latus							x							Ashford and Crewe, 2003
Diphyllobothrium mansonoides							x							Ashford and Crewe, 2003

Helminths	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Diphyllobothrium klebanovskii										x				Ashford and Crewe, 2003
Diphyllobothrium orcini										x				Ashford and Crewe, 2003
Adenocephalus pacificus										x				Ashford and Crewe, 2003
Diphyllobothrium scoticum										x				Ashford and Crewe, 2003
Diphyllobothrium stemmacephalum							x							Ashford and Crewe, 2003
Diphyllobothrium theileri										x				Ashford and Crewe, 2003
Diplogonoporus balaenopterae										x				Ashford and Crewe, 2003
Diplogonoporus brauni										x				Ashford and Crewe, 2003
Diplogonoporus balaenopterae										x				Ashford and Crewe, 2003
Diplostomum spathaceum										x				Ashford and Crewe, 2003
Dipylidium caninum							x							Ashford and Crewe, 2003
Dirofilaria immitis				x										Ashford and Crewe, 2003
Dirofilaria repens				x										Ashford and Crewe, 2003
Dirofilaria striata				x										Ashford and Crewe, 2003
Dirofilaria subdermata				x										Ashford and Crewe, 2003
Dirofilaria tenuis				x										Ashford and Crewe, 2003
Dirofilaria ursi				x										Ashford and Crewe, 2003
Dracunculus insignis										x				Ashford and Crewe, 2003

Helminths	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Dracunculus medinensis										x				Ashford and Crewe, 2003
Drepanidotaenia lanceolata							x							Ashford and Crewe, 2003
Echinochasmus japonicus										x				Ashford and Crewe, 2003
Echinochasmus jiufoensis										x				Ashford and Crewe, 2003
Echinochasmus perfoliatus										x				Ashford and Crewe, 2003
Echinococcus granulosus							x							Ashford and Crewe, 2003
Echinococcus multilocularis							x							Ashford and Crewe, 2003
Echinococcus oligarthus										x				Ashford and Crewe, 2003
Echinococcus vogeli										x				Ashford and Crewe, 2003
Echinoparyphium recurvatum										x				Ashford and Crewe, 2003
Echinostoma cinetorchis										x				Ashford and Crewe, 2003
Echinostoma echinatum										x				Ashford and Crewe, 2003
Echinostoma hortense										x				Ashford and Crewe, 2003
Echinostoma ilocanum										x				Ashford and Crewe, 2003
Echinostoma jassyense										x				Ashford and Crewe, 2003
Echinostoma macrorchis										x				Ashford and Crewe, 2003
Echinostoma malayanum										x				Ashford and Crewe, 2003

Helminths	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Echinostoma revolutum										x				Ashford and Crewe, 2003
Enterobius gregorii							x							Ashford and Crewe, 2003
Enterobius vermicularis							x							Ashford and Crewe, 2003
Episthmium caninum										x				Ashford and Crewe, 2003
Eucoleus aerophilus							x							Ashford and Crewe, 2003
Eurytrema pancreaticum							x							Ashford and Crewe, 2003
Eustrongylides sp.							x							Ashford and Crewe, 2003
Fasciola indica							x							Ashford and Crewe, 2003
Fasciola hepatica							x							Ashford and Crewe, 2003
Fasciola indica							x							Ashford and Crewe, 2003
Fasciolopsis buski										x				Ashford and Crewe, 2003
Neodiplostomum seoulense										x				Ashford and Crewe, 2003
Gastrodiscoides hominis										x				Ashford and Crewe, 2003
Gigantobilharzia huttoni							x							Ashford and Crewe, 2003
Gigantobilharzia sturniae										x				Ashford and Crewe, 2003
Gnathostoma doloresi										x				Ashford and Crewe, 2003
Gnathostoma hispidum										x				Ashford and Crewe, 2003
Gnathostoma nipponicum										x				Ashford and Crewe, 2003
Gnathostoma spinigerum							x							Ashford and Crewe, 2003

Helminths	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Gongylonema pulchrum							x							Ashford and Crewe, 2003
Gymnophalloides sp.										x				Ashford and Crewe, 2003
Haemonchus contortus										x				Ashford and Crewe, 2003
Haplorchis pumilo										x				Ashford and Crewe, 2003
Haplorchis taichui										x				Ashford and Crewe, 2003
Haplorchis vanissima							x							Ashford and Crewe, 2003
Haplorchis yokogawai							x							Ashford and Crewe, 2003
Heterobilharzia americana							x							Ashford and Crewe, 2003
Heterophyes dispar										x				Ashford and Crewe, 2003
Heterophyes										x				Ashford and Crewe, 2003
Heterophyes nocens										x				Ashford and Crewe, 2003
Heterophyopsis continua										x				Ashford and Crewe, 2003
Himasthala muehlensi							x							Ashford and Crewe, 2003
Hymenolepis diminuta							x							Ashford and Crewe, 2003
Hymenolepis nana							x							Ashford and Crewe, 2003
Hypoderaeum conoideum										x				Ashford and Crewe, 2003
Inermicapsifer madagascariensis										x				Ashford and Crewe, 2003
Isoparorchis hypselobagri										x				Ashford and Crewe, 2003
Lagochilascaris minor							x							Ashford and Crewe, 2003

Helminths	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Ligula intestinalis										x				Ashford and Crewe, 2003
Loa				x										Ashford and Crewe, 2003
Macracanthorhynchus hirudinaceus										x				Ashford and Crewe, 2003
Macracanthorhynchus ingens							x							Ashford and Crewe, 2003
Mammomonogamus laryngeus										x				Ashford and Crewe, 2003
Mammomonogamus nasicola										x				Ashford and Crewe, 2003
Mansonella ozzardi				x										Ashford and Crewe, 2003
Mansonella perstans				x										Ashford and Crewe, 2003
Mansonella rodhaini				x										Ashford and Crewe, 2003
Mansonella semiclarum				x										Ashford and Crewe, 2003
Mansonella streptocerca				x										Ashford and Crewe, 2003
Marshallagia marshalli										x				Ashford and Crewe, 2003
Mathevotaenia symmetrica										x				Ashford and Crewe, 2003
Mecistocirrus digitatus							x							Ashford and Crewe, 2003
Meningonema peruzzii										x				Ashford and Crewe, 2003
Mesocestoides lineatus										x				Ashford and Crewe, 2003
Mesocestoides variabilis							x							Ashford and Crewe, 2003
Metagonimus minutus										x				Ashford and Crewe, 2003

Helminths	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Metagonimus yokogawai										x				Ashford and Crewe, 2003
Metastrongylus apri							x							Ashford and Crewe, 2003
Metorchis albidus							x							Ashford and Crewe, 2003
Metorchis conjunctus							x							Ashford and Crewe, 2003
Microfilaria bolivarensis				x										Ashford and Crewe, 2003
Micronema deletrix							x							Ashford and Crewe, 2003
Moniezia expansa							x							Ashford and Crewe, 2003
Moniliformis							x							Ashford and Crewe, 2003
Multiceps brauni										x				Ashford and Crewe, 2003
Taenia glomeratus										x				Ashford and Crewe, 2003
Multiceps longihamatus										x				Ashford and Crewe, 2003
Multiceps							x							Ashford and Crewe, 2003
Taenia serialis							x							Ashford and Crewe, 2003
Nanophyetus salmincola							x							Ashford and Crewe, 2003
Necator americanus							x							Ashford and Crewe, 2003
Nematodirus abnormalis							x							Ashford and Crewe, 2003
Neodiplostomum sp.										x				Ashford and Crewe, 2003
Oesophagostomum aculeatum										x				Ashford and Crewe, 2003
Oesophagostomum bifurcum										x				Ashford and Crewe, 2003

Helminths	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Oesophagostomum stephanostomum							x							Ashford and Crewe, 2003
Onchocerca volvulus				x										Ashford and Crewe, 2003
Opisthorchis (Chlonorchis) sinensis										x				Ashford and Crewe, 2003
Opisthorchis felineus										x				Ashford and Crewe, 2003
Opisthorchis noverca							x							Ashford and Crewe, 2003
Opisthorchis viverrini										x				Ashford and Crewe, 2003
Orientobilharzia turkestanica										x				Ashford and Crewe, 2003
Ornithobilharzia sp.										x				Kolářová, 2007
Ostertagia ostertagi										x				Ashford and Crewe, 2003
Paragonimus africanus										x				Ashford and Crewe, 2003
Paragonimus bankokensis							x							Ashford and Crewe, 2003
Paragonimus caliensis							x							Ashford and Crewe, 2003
Paragonimus heterotremus										x				Ashford and Crewe, 2003
Paragonimus hueitungensis										x				Ashford and Crewe, 2003
Paragonimus kellicotti							x							Ashford and Crewe, 2003
Paragonimus mexicanus							x							Ashford and Crewe, 2003
Paragonimus miyazakii										x				Ashford and Crewe, 2003
Paragonimus ohirai										x				Ashford and Crewe, 2003

Helminths	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Paragonimus phillipinensis										x				Ashford and Crewe, 2003
Paragonimus sadoensis										x				Ashford and Crewe, 2003
Paragonimus siamensis										x				Palmer et al., 1998, p. 736
Paragonimus skrjabini										x				Ashford and Crewe, 2003
Paragonimus uterobilateralis										x				Ashford and Crewe, 2003
Paragonimus westermani										x				Ashford and Crewe, 2003
Parascaris equorum							x							Ashford and Crewe, 2003
Parastrongylus cantonensis										x				Ashford and Crewe, 2003
Parastrongylus costaricensis							x							Ashford and Crewe, 2003
Pearsonema plica							x							MCM-8 Edition, p. 1134
Pelodera strongyloides										x				Ashford and Crewe, 2003
Phaneropsolus bonnei										x				Ashford and Crewe, 2003
Philophthalmus lacrymosus										x				Ashford and Crewe, 2003
Pseudoterranova decipiens							x							Ashford and Crewe, 2003
Physaloptera caucasica							x							Ashford and Crewe, 2003
Physaloptera transfuga										x				Ashford and Crewe, 2003
Plagiorchis harinasutai										x				Ashford and Crewe, 2003
Plagiorchis javensis										x				Ashford and Crewe, 2003

Helminths	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Plagiorchis muris										x				Ashford and Crewe, 2003
Plagiorchis philippinensis										x				Ashford and Crewe, 2003
Poikilorchis congolensis										x				Ashford and Crewe, 2003
Procerovum calderoni										x				Ashford and Crewe, 2003
Prohemistomum vivax										x				Ashford and Crewe, 2003
Prosthodendrium molenkampi										x				Ashford and Crewe, 2003
Pseudamphistomum aethiopicum										x				Ashford and Crewe, 2003
Pseudamphistomum truncatum										x				Ashford and Crewe, 2003
Psilorchis hominis							x							Ashford and Crewe, 2003
Pygidiopsis summa										x				Ashford and Crewe, 2003
Pyramicocephalus anthrocephalus							x							Ashford and Crewe, 2003
Raillietina celebensis										x				Ashford and Crewe, 2003
Raillietina demerariensis							x							Ashford and Crewe, 2003
Rhabditis elongata										x				Ashford and Crewe, 2003
Rhabditis inermis										x				Ashford and Crewe, 2003
Rhabditis niellyi							x							Ashford and Crewe, 2003
Rhabditis pellioditis							x							Ashford and Crewe, 2003
Rictularia sp.							x							Ashford and Crewe, 2003

Helminths	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Schistocephalus solidus							x							Ashford and Crewe, 2003
Schistosoma bovis										x				Ashford and Crewe, 2003
Schistosoma haematobium										x				Ashford and Crewe, 2003
Schistosoma intercalatum										x				Ashford and Crewe, 2003
Schistosoma japonicum										x				Ashford and Crewe, 2003
Schistosoma malayensis										x				Ashford and Crewe, 2003
Schistosoma mansoni							x							Ashford and Crewe, 2003
Schistosoma mattheei										x				Ashford and Crewe, 2003
Schistosoma mekongi										x				Ashford and Crewe, 2003
Schistosoma rodhaini										x				Ashford and Crewe, 2003
Schistosoma spindale										x				Ashford and Crewe, 2003
Schistosomatium douthitti							x							Ashford and Crewe, 2003
Setaria equina				x										Ashford and Crewe, 2003
Spirocerca lupi										x				Ashford and Crewe, 2003
Stellantchasmus falcatus							x							Ashford and Crewe, 2003
Stictodora fuscata										x				Ashford and Crewe, 2003
Strongyloides fuelleborni										x				Ashford and Crewe, 2003
Strongyloides papillosus							x							Ashford and Crewe, 2003
Strongyloides ransomi							x							Ashford and Crewe, 2003

Helminths	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Strongyloides stercoralis							x							Ashford and Crewe, 2003
Strongyloides westeri							x							Ashford and Crewe, 2003
Syphacea obvelata										x				Ashford and Crewe, 2003
Taenia crassiceps							x							Ashford and Crewe, 2003
Taenia saginata							x							Ashford and Crewe, 2003
Taenia solium							x							Ashford and Crewe, 2003
Taenia taeniaeformis										x				Ashford and Crewe, 2003
Teladorsagia circumcincta										x				Ashford and Crewe, 2003
Ternidens deminutus										x				Ashford and Crewe, 2003
Thelazia californiensis				x										Ashford and Crewe, 2003
Thelazia callipaeda										x				Ashford and Crewe, 2003
Thelazia rhodesi										x				MCM-8, p. 363
Toxascaris leonina							x							Ashford and Crewe, 2003
Toxocara canis							x							Ashford and Crewe, 2003
Toxocara cati							x							Ashford and Crewe, 2003
Trichinella britovi										x				Ashford and Crewe, 2003
Trichinella nativa							x							Ashford and Crewe, 2003
Trichinella nelsoni										x				Ashford and Crewe, 2003
Trichinella pseudospiralis										x				Ashford and Crewe, 2003
Trichinella spiralis							x							Ashford and Crewe, 2003

Helminths	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Trichinella T5							x							Ashford and Crewe, 2003
Trichobilharzia brevis										x				Ashford and Crewe, 2003
Trichobilharzia ocellata							x							Ashford and Crewe, 2003
Trichobilharzia stagnicolae							x							Ashford and Crewe, 2003
Trichostrongylus affinis							x							Ashford and Crewe, 2003
Trichostrongylus axei							x							Ashford and Crewe, 2003
Trichostrongylus brevis										x				Ashford and Crewe, 2003
Trichostrongylus calcaratus										x				Ashford and Crewe, 2003
Trichostrongylus capricola										x				Ashford and Crewe, 2003
Trichostrongylus colubriformis							x							Ashford and Crewe, 2003
Trichostrongylus instabilis										x				Ashford and Crewe, 2003
Trichostrongylus lerouxi										x				Ashford and Crewe, 2003
Trichostrongylus orientalis										x				Ashford and Crewe, 2003
Trichostrongylus probolurus										x				Ashford and Crewe, 2003
Trichostrongylus skrjabini										x				Ashford and Crewe, 2003
Trichostrongylus vitrinus										x				Ashford and Crewe, 2003
Trichuris suis							x							Ashford and Crewe, 2003

Helminths	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Trichuris trichiura							x							Ashford and Crewe, 2003
Trichuris vulpis							x							Ashford and Crewe, 2003
Uncinaria stenocephala							x							Ashford and Crewe, 2003
Watsonius macaci										x				Ashford and Crewe, 2003
Wuchereria bancrofti				x										Ashford and Crewe, 2003
Wuchereria lewisi				x										Ashford and Crewe, 2003

Fungi	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Absidia corymbifera									x					MCM-12th Edition
Acremonium kiliense									x					MCM-12th Edition
Acremonium potronii									x					MCM-12th Edition
Acremonium recifei									x					MCM-12th Edition
Acremonium strictum									x					MCM-12th Edition
Acrophialophora fusispora									x					MCM-12th Edition
Actinomadura madurae									x					MCM-12th Edition
Actinomadura pelletieri									x					MCM-12th Edition
Alternaria alternata									x					MCM-12th Edition
Alternaria caespitosa									x					Howard, 2003 p. 575

Fungi	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Alternaria chlamydospora									x					MCM-12th Edition
Alternaria dianthicola									x					MCM-12th Edition
Alternaria infectoria									x					MCM-12th Edition
Alternaria longipes									x					MCM-12th Edition
Alternaria stemphyloides									x					http://www.doctorfungus.org/thefungi/Alternaria.htm
Alternaria tenuissima									x					MCM-12th Edition
Aphanoascus fulvescens									x					MCM-12th Edition
Apophysomyces elegans									x					MCM-12th Edition
Arachnomyces nodosetosus									x					MCM-12th Edition
Arthrinium phaeospermum									x					http://www.doctorfungus.org/thefungi/Arthrinium.htm
Arthroderma uncinatum									x					MCM-12th Edition
*Arthrographis kelrae**									x					Warris et al., 2001
Aspergillus candidus									x					MCM-12th Edition
Aspergillus clavatus									x					MCM-12th Edition
Aspergillus fisherianus									x					MCM-12th Edition
Aspergillus flavipes									x					MCM-12th Edition
Aspergillus flavus group									x					MCM-12th Edition
Aspergillus fumigatus group													*Aspergillus fumigatus*	

Fungi	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Aspergillus glaucus									x					MCM-12th Edition
Aspergillus nidulans group									x					MCM-12th Edition
Aspergillus niger									x					MCM-12th Edition
Aspergillus oryzae									x					MCM-12th Edition
Aspergillus terreus group									x					MCM-12th Edition
Aspergillus versicolor									x					MCM-12th Edition
Aspergillus wentii									x					MCM-12th Edition
Aureobasidium pullulans									x					MCM-12th Edition
Basidiobolus ranarum									x					MCM-12th Edition
Beauveria bassiana									x					MCM-12th Edition
Bipolaris australiensis									x					MCM-12th Edition
Blastomyces dermatitidis									x					MCM-12th Edition
Botryosphaeria subglobosa									x					http://newportal.gbif.org/species/14373513 and http://www.cabri.org/CABRI/srs-bin/wgetz?-newId+-e+-page+qResult+[CABI_FIL-id:'IMI%20287616']
Botrytsis cinerea						x								Hashimoto et al., 2017
Byssochlamys spectabilis									x					MCM-12th Edition
Candida acidothermophilum									x					MCM-12th Edition

Fungi	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Candida albicans									x					MCM-12th Edition
Candida catenulata									x					MCM-12th Edition
Candida famata									x					MCM-12th Edition
Candida fimetaria var. fimetaria									x					MCM-12th Edition
Candida glabrata					x									MCM-12th Edition
Candida haemulonis									x					MCM-12th Edition
Candida intermedia									x					http://www.doctorfungus.org/thefungi/Candida_spp.htm
Candida lodderae									x					MCM-12th Edition
Candida mycoderma var. annulata									x					MCM-12th Edition
Candida parapsilosis									x					MCM-12th Edition
Candida tropicalis									x					MCM-12th Edition
Cephaliophora irregularis									x					http://www.doctorfungus.org/imageban/synonyms/Cephaliophora.htm
Cerinosterus cyanescens									x					http://www.doctorfungus.org/thefungi/Sporothrix.htm
Chaetomium atrobrunneum									x					MCM-12th Edition
Chaetomium funicola									x					http://www.doctorfungus.org/thefungi/Chaetomium.htm
Chaetomium globosum									x					MCM-12th Edition

Fungi	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Chaetomium perpulchrum									x					http://www.doctorfungus.org/thefungi/Chaetomium.htm
Chaetomium strumarium									x					MCM-12th Edition
Chaetophoma dermo-unguis									x					http://www.doctorfungus.org/imageban/synonyms/Chaetophoma.htm
Chlamydoabsidia padenii									x					http://www.doctorfungus.org/imageban/synonyms/Chlamydoabsidia.htm
Chlorella protothecoides									x					http://pcp.oxfordjournals.org/cgi/content/abstract/9/1/87
*Chrysosporium zonatum**									x					Arvanitidou et al., 1999
Cladophialophora arxii									x					MCM-12th Edition
Cladophialophora bantiana									x					MCM-12th Edition
Cladophialophora boppii									x					MCM-12th Edition
Cladophialophora carrionii									x					MCM-12th Edition
Cladophialophora devriesii									x					MCM-12th Edition
Cladorrhinum bulbillosum									x					http://uwadmnweb.uwyo.edu/botany/Soil%20Microfungal%20Collection/RMF%20collection%20(Rocky%20Mountain%20Fungi)partII.htm

Fungi	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Cladosporium cladosporioides									x					MCM-12th Edition
Cladosporium elatum									x					http://www.doctorfungus.org/thefungi/Cladosporium.htm
Cladosporium oxysporum									x					http://www.doctorfungus.org/thefungi/Cladosporium.htm
Cladosporium sphaerosphermum									x					MCM-12th Edition
Clavispora lusitaniae									x					MCM-12th Edition
Coccidioides immitis									x					MCM-12th Edition
Cochliobolus pallescens									x					Howard, 2003 p. 584-586
Cokeromyces recurvartus									x					MCM-12th Edition
Colletotrichum coccodes									x					Howard, 2003 p. 662-664
Colletotrichum gloeosporioides									x					Howard, 2003 p. 662-664
Conidiobolus coronatus									x					MCM-12th Edition
Conidiobolus incongruus									x					MCM-12th Edition
Conidiobolus lamprauges									x					Howard, 2003 p. 133-137
Coniochaeta hoffmannii									x					MCM-12th Edition
Coniochaeta mutabilis									x					MCM-12th Edition
Coniothyrium fuckelii									x					http://www.doctorfungus.org/imageban/synonyms/Coniothyrium.htm

Fungi	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Coprinopsis cinerea									x					MCM-12th Edition
Cryptococcus neoformans									x					MCM-12th Edition
Cunninghamella bertholletiae									x					MCM-12th Edition
Curvularia brachyspora									x					Howard, 2003 p. 584-586
Curvularia clavata									x					Howard, 2003 p. 584-586
Curvularia geniculata									x					MCM-12th Edition
Curvularia hawaiiensis									x					MCM-12th Edition
Curvularia lunata									x					MCM-12th Edition
Curvularia senegalensis									x					Howard 2003 p. 584-586
Curvularia spicifera									x					MCM-12th Edition
Curvularia verucculosa									x					Howard, 2003 p. 584-586
Dichotomophthora portulacae									x					http://www.doctorfungus.org/imageban/synonyms/Dichotomophthora.htm
Dichotomophthoropsis nymphaerum									x					http://www.doctorfungus.org/imageban/synonyms/Dichotomophthoropsis.htm
Dissitimurus exedrus									x					Howard, 2003 p. 588
Diutina rugosa									x					MCM-12
Doratomyces stemonitis									x					http://www.doctorfungus.org/imageban/synonyms/Doratomyces.htm
Emmonsia crescens									x					MCM-12th Edition

Fungi	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Emmonsia parva									x					MCM-12th Edition
Epiccocum purpurascens						x								https://www.inspq.qc.ca/en/moulds/fact-sheets/epicoccum-purpurascens
Epidermophyton floccosum									x					MCM-12th Edition
Exophiala dermatitidis									x					MCM-12th Edition
Exophiala jeanselmei													*Exophiala jeanselmei*	
Exophiala moniliae									x					Howard, 2003 p. 590-596
Exophiala pisciphila									x					Howard, 2003 p. 590-596
Exophiala psychrophila									x					http://www.doctorfungus.org/thefungi/exophiala.htm
Exophiala salmonis									x					Howard, 2003 p. 590-596
Exophiala spinifera									x					MCM-12th Edition
Exosporium dematium									x					Howard, 2003 p. 662-664
Exserohilum longirostratum									x					MCM-12th Edition
Exserohilum macginnisii									x					Howard, 2003 p. 596-597
Falciformispora senegalensis									x					MCM-12th Edition
Falciformispora tompkinsii									x					MCM-12th Edition
Fonsecaea compacta									x					http://www.doctorfungus.org/thefungi/Fonsecaea.htm

Fungi	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Fusarium aquaeductuum									x					Howard, 2003 p. 402
Fusarium chlamydosporum									x					MCM-12th Edition
Fusarium dimerum									x					MCM-12th Edition
Fusarium falciforme									x					MCM-12th Edition
Fusarium moniliforme									x					MCM-12th Edition
Fusarium napiforme									x					MCM-12th Edition
Fusarium neocosmosporiellum									x					Howard, 2003 p. 434-436
Fusarium nivale									x					Howard, 2003 p. 431
Fusarium oxysporum									x					MCM-12th Edition
Fusarium pallidoroseum									x					Howard p. 320, 418-421
Fusarium proliferatum									x					MCM-12th Edition
Fusarium sacchari									x					MCM-12th Edition
Fusarium solani													*Fusarium solani*	
Fusarium subglutinans									x					MCM-12th Edition
Fusarium ventricosum									x					http://www.doctorfungus.org/thefungi/fusarium.htm
Fusarium verticillioides									x					MCM-12th Edition
*Geotrichum candidum**									x					Rosenzweig et al., 1986
Gliomastix roseogrisea									x					Howard, 2003 p. 384
Hansenula anomala									x					MCM-12th Edition

Fungi	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Histoplasma capsulatum									x					MCM-12th Edition
Hortaea werneckii									x					MCM-12th Edition
Humicola lanuginosa									x					Howard, 2003 p. 623
Hypocrea pseudokoningii									x					MCM-12th Edition
Kiflimonium curvulum									x					MCM-12th Edition
Kluyveromyces marxianus									x					MCM-12th Edition
Lasiodiplodia theobromae									x					MCM-12th Edition
Lophophyton gallinae									x					MCM-12th Edition
Madurella ikedae									x					MCM-12th Edition
Magnusiomyces capitatus									x					MCM-12th Edition
Malassezia globosa					x									MCM-12th Edition
Malassezia obtusa					x									MCM-12th Edition
Malassezia pachydermatis					x									MCM-12th Edition
Malassezia restricta					x									MCM-12th Edition
Malassezia sloofiae					x									MCM-12th Edition
Malassezia sympodialis					x									MCM-12th Edition
Meyerozyma guilliermondii									x					MCM-12th Edition
Microascus cinereus									x					MCM-12th Edition

Fungi	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Microascus cirrosus									x					MCM-12th Edition
Microsporum audouinii									x					MCM-12th Edition
Microsporum canis									x					MCM-12th Edition
Microsporum equinum									x					MCM-12th Edition
Microsporum ferrugineum									x					MCM-12th Edition
Microsporum nanum									x					MCM-12th Edition
Microsporum praecox									x					MCM-12th Edition
Moniliella suaveolens									x					http://www.doctorfungus.org/imageban/synonyms/Moniliella.htm
Mucor circinelloides									x					MCM-12th Edition
Mucor hiemalis									x					MCM-12th Edition
Mucor indicus									x					Howard p. 70, 98-99, 101
Mucor racemosus									x					MCM-12th Edition
Mucor ramosissimus									x					MCM-12th Edition
Myceliophthora thermophila									x					MCM-12th Edition
Mycocentrospora acerina									x					Howard, 2003 p. 602-603
Mycoleptodiscus indicus									x					Howard, 2003 p. 602-603
Myriodontium keratinophilum									x					MCM-12th Edition
Nannizzia cajetani									x					Howard, 2003 p. 155

Fungi	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Nannizzia fulva									x					MCM-12th Edition
Nannizzia gypsea									x					MCM-12th Edition
Nannizzia persicolor									x					MCM-12th Edition
Nannizzia racemosa									x					MCM-12th Edition
Nattrassia mangiferae									x					MCM-12th Edition
Neocosmospora cyanescens									x					MCM-12th Edition
Neocosmospora keratoplastica									x					Howard, 2003 p. 394
Neocosmospora lichenicola									x					MCM-12th Edition
Neoscytalidium hyalinum									x					MCM-12th Edition
Neotestudina rosatii									x					MCM-12th Edition
Neurospora sitophila									x					http://www.doctorfungus.org/imageban/synonyms/Chrysonilia.htm
Nigrospora sphaerica									x					http://www.doctorfungus.org/thefungi/Nigrospora.htm
Ochroconis gallopava									x					MCM-12th Edition
Ochroconis tshawytschae									x					Howard, 2003 p. 617
Oidiodendron cereale									x					http://www.doctorfungus.org/imageban/synonyms/Oidiodendron.htm
Oidium chartarum									x					Doggett, 2000

Fungi	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Oospora sulphureo-ochracea									x					Howard, 2003 p. 230-232
Ovadendron ochraceum									x					http://www.catalogueoflife.org/show_species_details.php?record_id=3330913
Paecilomyces farinosus									x					http://www.doctorfungus.org/thefungi/Paecilomyces.htm
Paecilomyces fumerosoreus									x					Howard, 2003 p. 361-362
Paecilomyces javanicus									x					MCM-12th Edition
Paecilomyces lilacinus									x					MCM-12th Edition
Paecilomyces marquandii									x					MCM-12th Edition
Paecilomyces viridis									x					Howard, 2003 p. 357-359
Paracoccidioides brasiliensis									x					http://www.doctorfungus.org/thefungi/Lacazia.htm
Paracoccidioides brasiliensis									x					MCM-12th Edition
Parendomyces zeylanoides									x					MCM-12th Edition
Parengyodontium album									x					MCM-12th Edition
Penicillium chrysogenum									x					MCM-12th Edition
Penicillium citrinum									x					MCM-12th Edition
Penicillium commune									x					MCM-12th Edition

Fungi	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Penicillium decumbens									x					MCM-12th Edition
Penicillium expansum									x					MCM-12th Edition
Penicillium marneffei									x					MCM-12th Edition
Penicillium purpurogenum									x					MCM-12th Edition
Phaeoanellomyces elegans									x					Howard, 2003 p. 605-606
Phaeoanellomyces werneckii									x					MCM-12th Edition
Phaeosclera dematioides									x					http://www.doctorfungus.org/imageban/synonyms/Phaeosclera.htm
Phaeotrichoconis crotalariae									x					Howard, 2003 p. 606-607
Phanerochaete chrysosporium									x					Doggett, 2000
Phialemoniopsis curvata									x					MCM-12th Edition
Phialemonium obovatum									x					MCM-12th Edition
Phialophora bubakii									x					Howard, 2003 p. 607-612
Phialophora pedrosoi									x					http://www.doctorfungus.org/thefungi/Fonsecaea.htm
Phialophora richardsiae									x					MCM-12th Edition
Phialophora verrucosa									x					MCM-12th Edition
Phoma cava									x					http://www.doctorfungus.org/thefungi/phoma.htm

Fungi	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Phoma cruris-hominis									x					Howard, 2003 p. 666-668
Phoma eupyrena									x					Howard, 2003 p. 666-668
Phoma glomerata									x					Howard, 2003 p. 666-668
Phoma herbarum									x					http://www.doctorfungus.org/thefungi/phoma.htm
Phoma hibernica									x					Howard, 2003 p. 666-668
Phoma minutella									x					Howard, 2003 p. 666-668
Phoma oculo-hominis									x					Howard, 2003 p. 666-668
Phyllosticta citricarpa									x					http://www.doctorfungus.org/thefungi/phoma.htm
Piedraia hortae									x					MCM-12th Edition
Pityrosporum orbiculare					x									MCM-12th Edition
Pleurophoma pleurospora									x					Howard, 2003 p. 666-668
Pleurostoma repens									x					MCM-12th Edition
Pneumocystis carinii						x								MCM-12th Edition
Prototheca wickerhamii									x					MCM-12th Edition
Prototheca zopfii									x					MCM-12th Edition
Pseudoallescheria boydii									x					MCM-12th Edition
Pseudomicrodochium suttonii									x					MCM-12th Edition
Pyrenochaeta mackinnonii									x					MCM-12th Edition

Fungi	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Pyrenochaeta romeroi									x					MCM-12th Edition
Pyrenochaeta unguis-hominis									x					Howard, 2003 p. 666-668
Pyrenophora biseptata									x					Howard, 2003 p. 588-589
Pythium insidiosum									x					MCM-12th Edition
Ramichloridium obovoidea									x					http://www.doctorfungus.org/imageban/synonyms/Ramichloridium.htm
Rhinocladiella aquaspersa									x					MCM-12th Edition
Rhinocladiella schulzeri									x					http://www.doctorfungus.org/imageban/synonyms/Ramichloridium.htm
Rhinosporidium seeberi									x					MCM-12th Edition
Rhizomucor miehei									x					MCM-12th Edition
Rhizomucor pusillus									x					MCM-12th Edition
Rhizopus azygosporus									x					MCM-12th Edition
Rhizopus microsporus									x					MCM-12th Edition
Rhizopus oryzae									x					MCM-12th Edition
Rhizopus stolonifer									x					MCM-12th Edition
Rhodotorula glutinis					x									MCM-12th Edition
Rhodotorula minuta					x									MCM-12th Edition
Rhodotorula mucilaginosa					x									MCM-12th Edition
Rhodotorula rubra					x									MCM-12th Edition

Fungi	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Saccharomyces cerevisiae									x					MCM-12th Edition
Saksenaea vasiformis									x					MCM-12th Edition
Sarcinomyces phaeomuriformis									x					MCM-12th Edition
Scedosporium prolificans									x					MCM-12th Edition
Schizophyllum commune									x					MCM-12th Edition
Scolecobasidium humicola									x					Howard, 2003 p. 617
Scopulariopsis acremonium									x					MCM-12th Edition
Scopulariopsis asperula									x					MCM-12th Edition
Scopulariopsis brevicaulis									x					MCM-12th Edition
Scopulariopsis brumptii									x					MCM-12th Edition
Scopulariopsis candida									x					MCM-12th Edition
Scopulariopsis flava									x					MCM-12th Edition
Scopulariopsis fusca									x					MCM-12th Edition
Scytalidium infestans									x					http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0036-46651999000500009&lng=pt&nrm=iso&tlng=pt
Septonema exile									x					Howard, 2003 p. 621
Setosphaeria rostrata									x					MCM-12th Edition

Fungi	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Sporothrix schenckii									x					MCM-12th Edition
*Stemphylium macrosporoideum**									x					West, 1986
Stenella araguata									x					http://www.doctorfungus.org/imageban/synonyms/Stenella.htm
Streptomyces somaliensis									x					MCM-12th Edition
Taeniolella stilbaspora									x					Howard, 2003 p. 621
Tetraploa aristata									x					Howard, 2003 p. 621-623
Thermomyces dupontii									x					Howard, 2003 p. 340-346
Thielavia terrestris									x					MCM-12th Edition
Torulopsis magnoliae									x					http://www.doctorfungus.org/imageban/synonyms/Torulopsis.htm
Trematosphaeria grisea									x					MCM-12th Edition
Trichoderma viride									x					MCM-12th Edition
Trichomaris invadens									x					http://www.pac.dfo-mpo.gc.ca/sci/shelldis/pages/chitfdcb_e.htm
Trichophyton concentricum									x					MCM-12th Edition
Trichophyton equinum									x					MCM-12th Edition
Trichophyton gallinae									x					MCM-12th Edition
Trichophyton gourvilii									x					MCM-12th Edition

Fungi	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Trichophyton megninii									x					MCM-12th Edition
Trichophyton mentagrophytes									x					MCM-12th Edition
Trichophyton rubrum									x					MCM-12th Edition
Trichophyton schoenleinii									x					MCM-12th Edition
Trichophyton simii									x					MCM-12th Edition
Trichophyton soudanense									x					MCM-12th Edition
Trichophyton tonsurans									x					MCM-12th Edition
Trichophyton verrucosum									x					MCM-12th Edition
Trichophyton violaceum									x					MCM-12th Edition
Trichosporon asahii									x					MCM-12th Edition
Trichosporon beigelii									x					MCM-12th Edition
Trichosporon cutaneum									x					MCM-12th Edition
Trichosporon inkin									x					MCM-12th Edition
Trichosporon mucoides									x					MCM-12th Edition
Trichosporon ovoides									x					MCM-12th Edition
Tritirachium oryzae									x					http://www.doctorfungus.org/imageban/synonyms/Tritirachium.htm
Tubercularia vulgaris									x					Howard, 2003 p. 448-449
Ulocladium chartarum									x					Howard, 2003 p. 623-624

Fungi	1	2	3	4	5	6	7	8	9	10	11	12	PCCL	Page Reference
Veronaea botryosa									x					http://www.doctorfungus.org/imageban/synonyms/Veronaea.htm
Verticillium nigrescens									x					Howard, 2003 p. 449-450
Volutella cinerescens									x					Howard, 2003 p. 451
Yarrowia lipolytica									x					MCM-12th Edition

Appendix C: PCCL 5 Pathogen Scores

Pathogen	WBDO	Occurrence	Normalized health score	Total score
Naegleria fowleri	5	3	5.0	10.0
Legionella pneumophila	5	3	3.6	8.6
Escherichia coli (O157)	5	3	3.2	8.2
Pseudomonas aeruginosa	5	3	3.2	8.2
Campylobacter jejuni	5	3	2.5	7.5
Mycobacterium abscessus	4	3	3.2	7.2
Shigella sonnei	4	3	3.2	7.2
Caliciviruses	5	3	2.1	7.1
Helicobacter pylori	1	2	5.0	7.0
Mycobacterium avium	4	3	2.9	6.9
Adenovirus	2	3	3.6	6.6
Enterovirus	2	3	3.6	6.6
Pantoea agglomerans	4	3	2.5	6.5
Hepatitis A virus	3	2	3.2	6.2
Fusarium solani	1	3	2.9	5.9
Nontuberculous Mycobacteria (NTM)	3	3	2.9	5.9
Hepatitis E virus	2	1	3.6	5.6
Cyclospora cayetanensis	3	3	2.5	5.5
Rotavirus	2	3	2.5	5.5
Salmonella enterica	3	3	2.5	5.5
Toxoplasma gondii	2	1	3.2	5.2
Aspergillus fumigatus group	1	3	2.1	5.1
Entamoeba histolytica	3	3	2.1	5.1
Exophiala jeanselmei	1	3	2.1	5.1
Vibrio cholerae	3	3	2.1	5.1
Aeromonas hydrophila	1	3	1.8	4.8
Plesiomonas shigelloides	3	3	1.8	4.8
Blastocystis hominis	4	1	0.7	4.7
Acinetobacter baumannii	1	2	2.5	4.5
Comanonas testosteroni	1	2	2.5	4.5
Yersinia enterocolitica	3	3	1.4	4.4

Astrovirus	2	2	1.4	3.4
Microsporidia	1	2	1.4	3.4
Isospora belli	2	1	1.1	3.1

Appendix D: The Final CCL 5 for Microbes

Microbe	Final CCL 3	Final CCL 4	Final CCL 5[1]
Adenovirus	X	X	X
Caliciviruses	X	X	X
Campylobacter jejuni	X	X	X
Enterovirus	X	X	X
Escherichia coli (O157)	X	X	X
Helicobacter pylori	X	X	X
Legionella pneumophila	X	X	X
Mycobacterium abscessus			X
Mycobacterium avium	X	X	X
Naegleria fowleri	X	X	X
Pseudomonas aerugionosa			X
Shigella sonnei	X	X	X

[1]Hepatitis A and *Salmonella enterica* were listed on CCL 3 and CCL 4 but are not listed on CCL 5.

Appendix E: Documented PCCL 5 Microbes WBDOs in the U.S. Reported by CDC Between 2009-2017

Microorganism	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
Acinetobacter baumannii										0
Adenovirus										0
Aeromonas hydrophila										0
Arcobacter butzleri										0
Aspergillus fumigatus										0
Astrovirus										0
Blastocystis hominis				**1**						1
Caliciviruses		1		1		2	1			4
Campylobacter jejuni	1	4		1			2		1	9
Comamonas testosteroni										0
Cyclospora cayetanensis										0
Entamoeba histolytica										0
Enterovirus										0
Escherichia coli (O157)		1	1		1	1		1		5
Exophiala jeanselmei										0
Fusarium solani										0
Helicobacter pylori										0
Hepatitis A virus										0
Hepatitis E virus										0
Isospora belli										0
Legionella pneumophila	9	12	11	12	6	17	13	24	21	125
Microsporidia										0

Microorganism	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
Mycobacterium abscessus						1				1
Mycobacterium avium								1		1
Naegleria fowleri									1	1
Nontuberculous Mycobacteria (NTM)										0
Pantoea agglomerans				1						1
Plesiomonas shigelloides										0
Pseudomonas aeruginosa					1			1		2
Rotavirus										0
Salmonella enterica										0
Shigella sonnei							1			1
Toxoplasma gondii										0
Vibrio cholerae										0
Yersinia enterocolitica										0

Appendix F: Microbial Contaminant Information Sheets (CISs)

Microbes Infographics

Selection of microbes from the CCL Universe for placement on the PCCL is based upon exclusionary screening criteria that assess the potential of water-related transmission (occurrence) and the plausibility of causing waterborne disease by ingestion, inhalation, or dermal contact (health risk). Microbes that met any of the exclusionary criteria were not included on the PCCL.

Elements of each CIS include:

Scoring Summary – shows the scores used to calculate the final composite score for each microbial contaminant which included the highest score between the WBDO and occurrence, the health risk score for the general population, and the highest health risk score of the sensitive populations.

Data Table – shows the categories for each potential score, the scoring data, if applicable, and reference(s) used to support a score. The highest-ranking score for each of the three scoring categories is shown in bold font. The WBDOs scoring results are presented first, followed by the occurrence results and the health risks.

References – presents the full references for the data presented in the table.

The pages below provide examples of the CCL decision making process Adenovirus, which was included on the CCL 5. Following the example are CISs for each of the PCCL 5 and nominated microbes.

This infographic shows **Adenovirus** as an example of a contaminant that was listed on the CCL 5.

The graphic shows a box for each of the three attributes (Occurrence, WBDO, and Health Risk) that serve as input to the scoring model.

The attribute boxes show:

- The data used for scoring each attribute, in bold, and indicated by a “yes” in the right hand column.
- The score the contaminant received for that particular attribute (in the left hand column).
- The occurrence score (of 3) for Adenovirus was chosen, as shown in the upper left hand corner, because it is greater than the WBDO score (of 2).
- The health risk scores for the general population (of 6) and the sensitive population (of 4) are added together (equaling 10) and multiplied by 5/14 (the health risk score equalizing value), which equals 3.6.
- The occurrence score is added to the adjusted health risk score for a total score for Adenovirus of 6.6,

$$\text{Pathogen Total Score} = \text{Highest Score between WBDO and Occurrence} + \left(\left(\text{General Population Score + Highest Sensitive Population} \right) \times 5/14 \right)$$

Example: Calculation of Adenovirus Total Score

Adenovirus *Total Score* = **3** (Occurrence Score) + ((**6** (General Population Score) + **4** (Children/CD) x 5/14); Adenovirus *Total Score* = 3 + 3.6;

Adenovirus *Total Score* = **6.6**

Adenovirus: Microbe Included on the CCL 5

Scoring Summary	
Occurrence	**3**
Health Risk	
General population	**6**
Sensitive population	**4**

Total Score: 6.6

Occurrence		
Score	**Data Element**	**Scoring Data**
3	**Detected in drinking water in the US**	**Yes[2,3]**
2	Detected in Source water in the US	
1	Not detected in the US	

Waterborne Disease Outbreaks		
Score	**Data Element**	**Scoring Data**
5	Multiple WBDOs in US (2009-2017)	
4	At least one WBDOs in US (2009-2017)	
3	Caused WBDOs at any time in US	
2	**Caused WBDOs in countries other than US**	**Yes: Europe[1]**
1	Never caused WBDOs, associated w/ water related disease	

Health Risk		
Score	**Data Element**	**Scoring Data**
7	Does the organism cause significant mortality (> 1/1,000 cases)	
6	**Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?**	**[General population] A frequent cause of pneumonia among (unvaccinated) military recruits. Two deaths in previously-healthy adults.[4]** **ARD is still significant problem in military. Less common manifestations include fatal neonatal disease, meningoencephalitis and myocarditis.[5]**
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?	
4	***Does the illness require short term hospitalization (< week)?***	***[Chronic Disease] Children with chronic disease required respiratory ventilation.[6]*** ***[Children] Young adults may contract acute respiratory disease.[7]***
3	Does the illness require physician intervention?	
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?	
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?	

Pathogen Total Score = Highest Score between WBDO and Occurrence + ((General Population Score + Highest Sensitive population Score) x 5/14)

Adenovirus *Total Score* = **3** (Occurrence Score) + ((**6** (General Population Score) + **4** (Children/CD) x 5/14); Adenovirus *Total Score* = 3 + 3.6 = 6.6

[1] Kukkula, M., Arstila P., Klossner M.L., Maunula L., Bonsdorff C.H., and P. Jaatinen. 1997. Scandinavian Journal of Infectious Disease, 29(4): 415-418.
[2] O'Reilly, C.E., A.B. Bowen, E.P. Nytzia, J.P. Sarisky, C.A. Shepherd, M.D. Miller, B.C. Hubbard, M. Herring, S.D. Buchanan, C.C. Fitzgerald, V. Hill, M.J. Arrowood, L.X. Xiao, R.M. Hoekstra, E.D. Mintz, M.F. Lynch, and the Outbreak Working Group. 2007. A Waterborne Outbreak of Gastroenteritis with Multiple Etiologies among Resort Island Visitors and Residents: Ohio, 2004. Clinical Infectious Diseases, 44:506-512.
[3] Fong, T., L. Mansfield, D. Wilson, D. Schwab, S. Molloy and J. Rose. 2007. Massive Microbiological Groundwater Contamination Associated with a Waterborne Outbreak in Lake Erie, South Bass Island, OH. Environmental Health Perspectives. 115(6): 856-864.
[4] Gray, G.C., P.R. Goswami, M.D. Malasig, A.W. Hawksworth, D.H. Trump, M.A. Ryan and D.P. Schnurr. 2001. Adult Adenovirus Infections: Loss of Orphaned Vaccines Precipitates Military Respiratory Disease Epidemics. Clinical Infectious Diseases, 31: 663-70.
[5] Robinson, C. and M. Echavarria. 2007. Adenoviruses. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry, and M.A. Pfaller (ed.) Manual of Clinical Microbiology, 9th. edition, American Society for Microbiology, Washington, DC. Vol. 2: p. 1592.
[6] CDC, 1983. Adenovirus type 7 outbreak in a pediatric chronic-care facility – Pennsylvania. 1972. MMWR, 1983:32;258-60.
[7] CDC, 1998. Surveillance for Waterborne-Disease Outbreaks Associated with Drinking Water --- United States, 1995—1996. MMWR Surveillance Summaries, 47(SS-5); 1-33.

Acinetobacter baumannii Scoring Data

Scoring Summary[1,2]	
Occurrence	**2**
Health Risk	
General population	**1**
Sensitive subpopulation(s) [CD, P]	**6**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (2 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
3	Has caused documented WBDOs at any time in the U.S.?		
2	Has caused WBDOs in countries other than the U.S.?		
1	Has never caused WBDOs in any country, but has been epidemiologically associated	Yes. Outbreaks occur most commonly in hospitals to very ill patients by person to	CDC, 2010

Score[2]	Data Element	Scoring Data	Reference[3]
	with water related disease?	person contact or via contaminated surfaces. However, it is still can occur and be transmitted in water.	
	Occurrence		
3	Detected in drinking water in the U.S.?		
2	**Detected in source water in the U.S.?**	**Yes. It was detected in untreated groundwater used as drinking water in Preston County, W. VA.**	**Bifulco, 1989**
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)		
6 [CD, P]	**Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?**	**People with weakened immune systems due to chronic diseases or serious illnesses are the most susceptible. It causes various diseases including pneumonia and serious blood or wound infections. *Acinetobacter baumannii* infection during pregnancy can lead to premature contractions and chorioamnionitis. it**	**CDC, 2010** **Aivazova, 2009** **Cools et al. in MCM, 2019**

Score[2]	Data Element	Scoring Data	Reference[3]
		can also cause septic complications in the puerperium associated with long duration of hospitalization.	
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?		
4	Does the illness require short term hospitalization (< week)?		
3	Does the illness require physician intervention?		
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?		
1 [G, C, E]	**Does the illness result in mild symptoms with minimal or no impact on daily activities?**	**[G, C, E] *Acinetobacter baumannii* poses a very limited health threat to individuals without a health condition. Most studies only report outbreaks in hospitals with patients that have a health condition.**	**CDC, 2010**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Aivazova, V., F. Kainer, K. Friese, and I. Mylonas. 2010. *Acinetobacter baumannii* infection during pregnancy and puerperium. Archives of Gynecology and Obstetrics. 281(1): 171-174.

Bifulco, J.M., J.J. Shirey, and G.K. Bissonnette. 1989. Detection of Acinetobacter spp. in rural drinking water supplies. Applied and Environmental Microbiology. 55(9): 2214-2219.

Centers for Disease Control and Prevention (CDC). 2010. *Acinetobacter* in Healthcare Settings. (2010, November 24). Available online at: https://www.cdc.gov/hai/organisms/acinetobacter.html.

CDC, 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Cools, P., A. Nemec, P. Kampfer, and M. Vaneechoutte. 2019. *Acinetobacter, Chryseobacterium, Moraxella*, and Other Nonfermaentive Gram-Negative Rods. In Carroll, K.C., M.A. Pfaller, M.L. Landry, A.J. McAdam, R. Patel, S.S. Richter, and D.W. Warnock (ed). *Manual of Clinical Microbiology*, 12th Edition, pp. 829-857. American Society for Microbiology Press, Washington, DC.

Adenovirus Scoring Data

Scoring Summary[1,2]	
Occurrence	**3**
Health Risk	
General population	**6**
Sensitive subpopulation(s) [CD, C]	**4**

[1] Bolded text indicates the highest score for that particular protocol. For the health riss protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (2 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
3	Has caused documented WBDOs at any time in the U.S.?		
2	**Has caused WBDOs in countries other than the U.S.?**	**Yes** **Europe; S. Korea**	**Kukkula et al., 1997** **Lee et al., 2002**
1	Has never caused WBDOs in any country, but has been epidemiologically associated		

Score[2]	Data Element	Scoring Data	Reference[3]
	with water related disease?		
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes** **PCR in connection with an outbreak.**	**O'Reilly et al., 2007** **Fong et al., 2007**
2	Detected in source water in the U.S.?	Yes 38% of surface water samples collected as part of the Information Collection Rule contained Adenovirus 40 and Adenovirus 41.	USEPA, 2007
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?		
6 [G]	**Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?**	**[G] A frequent cause of pneumonia among (unvaccinated) military recruits. Two deaths in previously-healthy adults.** **ARD is still a significant problem in military. Less common manifestations include fatal neonatal disease, meningoencephalitis and myocarditis.**	**Gray et al., 2001** **Robinson in MCM, 2010** **Heim in MCM, 2019**

Score[2]	Data Element	Scoring Data	Reference[3]
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?	None reported	
4 [C, CD]	**Does the illness require short term hospitalization (< week)?**	**[CD] Children with chronic disease required respiratory ventilation.** **[C] Young adults may contract acute respiratory disease.**	**CDC, 1983** **CDC, 1998**
3	Does the illness require physician intervention?	Physician office visits are indicated for ocular infections.	Robinson in MCM, 2010
2 [E, P]	Is the illness self-limiting within 72 hours (without requiring medical intervention)?	[E, P] Approximately 50% of cases are asymptomatic, symptomatic cases usually present as upper respiratory infections similar to the common cold.	Robinson in MCM, 2010
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Centers for Disease Control and Prevention (CDC). 1983. Adenovirus type 7 outbreak in a pediatric chronic-care facility – Pennsylvania. 1972. MMWR. 32: 258-260.

CDC. 1998. Civilian Outbreak of Adenovirus Acute Respiratory Disease – South Dakota, 1997. MMWR. 47(27): 567-570.

CDC. 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Fong, T., L. Mansfield, D. Wilson, D. Schwab, S. Molloy, and J Rose. 2007. Massive Microbiological Groundwater Contamination Associated with a Waterborne Outbreak in Lake Erie, South Bass Island, OH. Environmental Health Perspective. 115(6): 856-864.

Gray, G.C., P.R. Goswami, M.D. Malasig, A.W. Hawksworth, D.H. Trump, M.A. Ryan, and D.P. Schnurr. 2001. Adult Adenovirus Infections: Loss of Orphaned Vaccines Precipitates Military Respiratory Disease Epidemics. Clinical Infectious Diseases. 31: 663-70.

Heim, A. and R.T. Hayden. 2019. Adenoviruses. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry, and M.A. Pfaller (ed.) *Manual of Clinical Microbiology*, 12th Edition, pp. 1831-1846. American Society for Microbiology Press, Washington DC.

Kukkula, M., P. Arstila, M.L. Klossner, L. Maunula, C.H. Bonsdorff, and P. Jaatinen. 1997. Waterborne outbreak of viral gastroenteritis. Scandinavian Journal of Infectious Disease. 29(4): 415-418.

Lee, S. and S. Kim. 2002. Detection of infectious enteroviruses and adenoviruses in tap water in urban areas in Korea. Water Research. 36(1): 248-256. doi:10.1016/S0043-1354(01)00199-3.

O'Reilly, C.E., A.B. Bowen, E.P. Nytzia, J.P. Sarisky, C.A. Shepherd, M.D. Miller, B.C. Hubbard, M. Herring, S.D. Buchanan, C.C. Fitzgerald, V. Hill, M.J. Arrowood, L.X. Xiao, R.M. Hoekstra, E.D. Mintz, M.F. Lynch, and the Outbreak Working Group. 2007. A Waterborne Outbreak of Gastroenteritis with Multiple Etiologies among Resort Island Visitors and Residents: Ohio, 2004. Clinical Infectious Diseases. 44: 506-512.

Robinson, C. and M. Echavarria. 2010. Adenoviruses. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry, and M.A. Pfaller (ed.) *Manual of Clinical Microbiology*, 10th Edition, Volume 2, p.1600. American Society for Microbiology Press, Washington, DC.

United States Environmental Protection Agency. 2007. Adenovirus Health and Criteria Document (Draft).

Aeromonas hydrophila Scoring Data

Scoring Summary[1,2]	
Occurrence	**3**
Health Risk	
General population	**2**
Sensitive subpopulation(s) [C]	**3**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (1 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	**CDC-NORS, 2020**
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	No	CDC, 1991 – CDC, 2017
3	Has caused documented WBDOs at any time in the U.S.?	No	
2	Has caused WBDOs in countries other than the U.S.?	No	
1	**Has never caused WBDOs in any country, but has been epidemiologically associated**	**Yes**	**Gavriel et al., 1998**

Score[2]	Data Element	Scoring Data	Reference[3]
	with water related disease?		
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes** **EPA found *A. hydrophila* in the distribution systems of 42 public water systems out of 293 systems tested.**	**EPA, 2006 and EPA, 2003**
2	Detected in source water in the U.S.?	Yes	Holmes et al., 1996 EPA, 2006
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?	Wound infections are usually preceded by injury that occurs in contact with water. These infections range from cellulitis to myronecrotic infections with a poor prognosis.	Horneman and Ali in MCM, 2010
6	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?	Septicemia occurs rarely in immunocompetent hosts. Can cause HUS.	Horneman and Ali in MCM, 2010
5	Does the illness result in long		

Score[2]	Data Element	Scoring Data	Reference[3]
	term or permanent dysfunction or disability, i.e. sequelae?		
4	Does the illness require short term hospitalization (< week)?		
3 [C]	**Does the illness require physician intervention?**	**[C] Children may require hospitalization due to dehydration.**	**Horneman and Ali in MCM, 2010**
2 [G, P, E, CD]	**Is the illness self-limiting within 72 hours (without requiring medical intervention)?**	**[G, P, E, CD] Acute watery disease is the most common form as well as abdominal pain, vomiting, fever.**	**Horneman and Ali in MCM, 2010**
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Centers for Disease Control and Prevention (CDC). 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Gavriel, A.A., J.P.B. Landre, and A.J. Lamb. 1998. Incidence of mesophilic *Aeromonas* within a public drinking water supply in northeast Scotland. Journal of Applied Bacteriology. 84: 383-392.

Holmes, P., L.M. Niccolls, and D.P. Sartory. 1996. The ecology of mesophilic *Aeromonas* in the aquatic environment. In Austin, B., M. Altwegg, P.J. Gosling, and S. Joseph, (ed.) *The Genus Aeromonas*. John Wiley & Sons, Inc. Chichester, UK.

Horneman, A. and A. Al. 2010. *Aeromonas*. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry, and M.A. Pfaller (ed.) *Manual of Clinical Microbiology*, 10th Edition, Volume 1, p.658, American Society for Microbiology Press, Washington, DC.

United States Environmental Protection Agency (USEPA). 2003. Unpublished data on occurrence results from the Unregulated Contaminant Monitoring Rule. FR 49094. August 22, 2005.

USEPA. 2006. *Aeromonas:* Human Health Criteria Document.

Arcobacter butzleri Scoring Data

Scoring Summary[1, 2]	
Waterborne Disease Outbreak	**4**
Health Risk	
General population	**3**
Sensitive subpopulation(s) [CD, C, P, E]	**3**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (1 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	**CDC-NORS, 2020**
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	**Yes** **Not listed in CDC's MMWR, however, linked to outbreak and drinking water. Symptom severity also suggests *Arcobacter*.**	**Fong et al., 2007**
3	Has caused documented WBDOs at any time in the U.S.?		
2	Has caused WBDOs in countries other than the		

Score[2]	Data Element	Scoring Data	Reference[3]
	U.S.?		
1	Has never caused WBDOs in any country, but has been epidemiologically associated with water related disease?		
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes**	**Fong et al., 2007**
2	Detected in source water in the U.S.?	Yes *Arcobacter butzleri* was isolated from groundwater in Idaho after a WBDO.	Rice et al., 1999
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?	Unknown	
6	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?	Persons with underlying disease such as liver disease, cirrhosis, or alcoholism may be at increased risk of complications. Has been isolated from patients with bacteremia, endocarditis, peritonitis and diarrhea. Clinical significance unknown.	Hsueh et al., 1997 Lerner et al., 1994 Yan et al., 2000 Fitzgerald in MCM, 2010

Score[2]	Data Element	Scoring Data	Reference[3]
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?		
4	Does the illness require short term hospitalization (< week)?		
3 [G, C, P, E, CD]	**Does the illness require physician intervention?**	**[All populations] Displays clinical features similar to *Campylobacter jejuni*, however is more frequently associated with a persistent diarrhea. Twenty-six percent of Belgian patients required antibiotics.**	**Vandenberg et al., 2004**
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?	Usual symptoms are diarrhea, abdominal pain, vomiting, and nausea resolving in < 3 days.	Wybo et al., 2004 Rice et al., 1999
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Centers for Disease Control and Prevention (CDC). 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Fitzgerald, C. and I. Nachamkin. 2010. *Campylobacter* and *Arcobacter*. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry, and M.A. Pfaller (ed.) *Manual of Clinical Microbiology*, 10th Edition, Volume 1, p.885. American Society for Microbiology Press, Washington, DC.

Fong, T., L. Mansfield, D. Wilson, D. Schwab, S. Molloy, and J. Rose. 2007. Massive Microbiological Groundwater Contamination Associated with a Waterborne Outbreak in Lake Erie, South Bass Island, OH. Environmental Health Perspectives. 115(6): 856-864.

Hsueh, P.R., L.J. Teng, P.C. Yang, S.K. Wang, S.C. Chang, S.W. Ho, W.C. Hsieh, and K.T Luh. 1997. Bacteremia caused by *Arcobacter cryaerophilus* 1B. Journal of Clinical Microbiology. 35(2): 489-491.

Nachamkin. 2019. *Campylobacter* and *Arcobacter*. In Carroll, K.C., M.A. Pfaller, M.L. Landry, A.J. McAdam, R. Patel, R., S.S. Richter, and D.W. Warnock (ed). 2019. *Manual of Clinical Microbiology*, 12th Edition. American Society of Microbiology Press, Washington, DC.

Lerner, J., V. Brumberger, and V. Preac-Mursic. 1994. Severe diarrhea associated with *Arcobacter butzleri*. European Journal of Clinical Microbiology and Infectious Diseases. 13(8): 660-662.

Rice, E.W., M.R. Rodgers, I.V. Wesley, C.H. Johnson, and S.A. Tanner. 1999. Isolation of *Arcobacter butzleri* from ground water. Letters in Applied Microbiology. 28: 31-35.

Vandenberg, O., A. Dediste, K. Houg, S. Ibekwen, H. Souayah, S. Cadranel, N. Douat, G. Zissis, J. Butzler, and P. Vandamme. 2004. *Arcobacter* Species in Humans. Emerging Infectious Diseases. 10(10): 1863.

Wybo, I., J. Breynaert, S. Lauwers, F. Lindenburg, and K. Houf. 2004. Isolation of *Arcobacter skirrowii* from a patient with chronic diarrhea. Journal of Clinical Microbiology. 42(4): 1851-1852.

Yan, J.J., W.C. Ko, A.H. Huang, H.M. Chen, Y.T. Jin, and J.J Wu. 2000. *Arcobacter butzleri* bacteremia in a patient with liver cirrhosis. Journal of the Formosan Medical Association. 99(2): 166-169.

Aspergillus fumigatus Scoring Data

Scoring Summary[1,2]	
Occurrence	**3**
Health Risk	
General population	**3**
Sensitive subpopulation(s) [C, P, E, CD]	**3**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (1 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	No	CDC, 1991 – CDC, 2017
3	Has caused documented WBDOs at any time in the U.S.?	No	
2	Has caused WBDOs in countries other than the U.S.?	No	
1	**Has never caused WBDOs in any country, but has been epidemiologically**	**Yes** **Study on two bone marrow transplantation**	**Anaissie et al., 2002**

Score[2]	Data Element	Scoring Data	Reference[3]
	associated with water related disease?	**units at a Little Rock, AR hospital.**	**Anaissie et al., 2003** **Warris et al., 2003**
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes**	**Anaissie et al., 2002** **Anaissie et al., 2003** **Nagy and Olson, 1982** **Rosenzweig et al., 1986** **Doggett, 2000** **Vesper et al., 2007**
2	Detected in source water in the U.S.?	Yes	Nagy and Olson, 1982
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?	Invasive infections caused by *Aspergillus* species are associated with high rates of morbidity and mortality, especially in immunosuppressed patients.	Verweij and Brandt in MCM, 2010 Chen in MCM, 2019
6	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?	Sporadic cases of invasive aspergillosis have been reported in immunocompetent hosts (chronic meningitis, endocarditis, pericarditis, osteomyelitys).	Bodey and Vartivarian, 1989

Score[2]	Data Element	Scoring Data	Reference[3]
		Invasive aspergillosis is primarily an infection of severely immunocompromised patients. Serious infection can also occur in patients with more modest impairments of host immune system such as diabetics.	Nagy and Olson, 1982
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?	None reported.	
4	Does the illness require short term hospitalization (< week)?	Requirement for hospitalization depends upon the manifestation of disease (e.g., superficial skin and ear infections do not require hospitalization).	Bodey and Vartivarian, 1989
3 [G, C, P, E, CD]	**Does the illness require physician intervention?**	**[All populations] Most infections and allergies caused by this organism require physician intervention.**	**Bodey and Vartivarian, 1989** **CDC, 2019**
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?		

Score[2]	Data Element	Scoring Data	Reference[3]
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?	*Aspergillus* spores are allergens and persons who become sensitized experience symptoms of allergy and asthma.	Horner et al., 1995

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Anaissie, E.J., S.L. Stratton, M.C. Dignani, R.C. Summerbell, J.H. Rex, T.P. Monson, T. Spencer, M. Kasai, A. Francesconi, and T.J. Walsh. 2002. Pathogenic *Aspergillus* species recovered from a hospital water system: a 3-year prospectie study. Clinical Infectious Diseases. 34: 780-789.

Anaissie, E.J., S.L. Stratton, M.C. Dignani, C. Lee, R.C. Summerbell, J.H. Rex, T.P. Monson, and T.J. Walsh. 2003. Pathogenic molds (including *Aspergillus* species) in hospital water distribution systems: a 3-year prospective study and clinical implications for patients with hematologic malignancies. Blood. 101(7): 2542-2546.

Bodey, G.P. and S. Vartivarian. 1989. Aspergillosis. European Journal of Clinical Microbiology and infectious diseases. 8(5): 413-437.

Centers for Disease Control and Prevention (CDC). 2019. *Aspergillus* homepage. Available online at: www.cdc.gov/fungal/diseases/aspergillosis/index.html.

CDC, 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Chen, S.C.-A., W. Meyer, T.C. Sorrell, and C. L. Halliday. 2019. *Apergillus*, *Talarmyces*, and *Penicillium*. In Carroll, K.C., M.A. Pfaller, M. L. Landry, A.J. McAdam, R. Patel, S.S. Richter, and D.W. Warnock (ed). *Manual of Clinical Microbiology*, 12th Edition. American Society of Microbiology Press, Washington, DC.

Doggett, M.S. 2000. Characterization of fungal biofilms within a municipal water distribution system. Applied and Environmental Microbiology. 66(3): 1249-1251.

Horner, W.E., A. Helbling, J.E. Salvaggio, and S.B. Lehrer. 1995. Fungal allergens. Clinical Microbiology Reviews. 8(2): 161-179.

Nagy, L.A. and B.H. Olson. 1982. The occurrence of filamentous fungi in drinking water distribution systems. Canadian Journal of Microbiology. 28: 667-671.

Rosenzweig, W.D., H. Minnigh, and W.O. Pipes. 1986. Fungi in potable water distribution systems. Journal of the American Water Works Association. 78(1): 53-55.

Verweij, P.E. and M.E. Brandt. 2010. *Aspergillus, Fusarium,* and Other Opportunistic Moniliaceous Fungi. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry, and M.A. Pfaller (ed.) *Manual of Clinical Microbiology*, 10th Edition, Volume 2, p. 1836. American Society for Microbiology Press, Washington, DC.

Vesper, S.J., M.E. Rogers, A.N. Neely, and R.A. Haugland. 2007. Opportunistic *Aspergillus* pathogens measured in home and hospital tap water by quantitative PCR (QPCR). Journal of Water and Health. 5(3): 427-431.

Warris, A., C.H. Klassen, J.F. Meis, M.T. De Ruiter, H.A. de Valk, T.G. Abrahamsen, P. Gaustaad, and P.E. Verweij. 2003. Molecular epidemiology of *Aspergillus fumigatus* isolates recovered from water, air, and patients shows two clusters of genetically distinct strains. Journal of Clinical Microbiology. 41(9): 4101-4106.

Astrovirus Scoring Data

Scoring Summary[1, 2]	
Waterborne Disease Outbreak	**2**
Health Risk	
General population	**2**
Sensitive subpopulation(s) [C, P, E, CD]	**2**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (1 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	No	CDC, 1991 – CDC, 2017
3	Has caused documented WBDOs at any time in the U.S.?	No	
2	**Has caused WBDOs in countries other than the U.S.?**	**Yes** **England and Wales**	**Smith et al., 2006**
1	Has never caused WBDOs in any country, but has been epidemiologically	Yes	Gofti-Laroche et al., 2003

Score[2]	Data Element	Scoring Data	Reference[3]
	associated with water related disease?		
	Occurrence		
3	Detected in drinking water in the U.S.?	No	
2	**Detected in source water in the U.S.?**	**Yes** **Astrovirus was detected in 15 of 29 samples collected under the Information Collection Rule.**	**Chapron et al., 2000**
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?	No	
6	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?	No	
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?	No	
4	Does the illness require short term hospitalization (< week)?	No	

Score[2]	Data Element	Scoring Data	Reference[3]
3	Does the illness require physician intervention?	No	
2 [G, C, P, E, CD]	**Is the illness self-limiting within 72 hours (without requiring medical intervention)?**	**[All populations] Asymptomatic infections common. Moderate self-limiting gastroenteritis (vomiting and diarrhea).**	**Farkas in MCM, 2010**
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Centers for Disease Control and Prevention (CDC). 1991. Surveillance for Waterborne-Disease Outbreaks Associated with Drinking Water ---United States, 1989—1990. MMWR Surveillance Summaries. 40(SS-3): 1-21.

CDC. 1993. Surveillance for Waterborne-Disease Outbreaks Associated with Drinking Water --- United States, 1991—1992. MMWR Surveillance Summaries. 42(SS-5): 1-22.

CDC. 1996. Surveillance for Waterborne-Disease Outbreaks Associated with Drinking Water --- United States, 1993—1994. MMWR Surveillance Summaries. 45(SS-1): 1-33.

CDC. 1998. Surveillance for Waterborne-Disease Outbreaks Associated with Drinking Water --- United States, 1995—1996. MMWR Surveillance Summaries. 47(SS-5): 1-33.

CDC. 2000. Surveillance for Waterborne-Disease Outbreaks Associated with Drinking Water --- United States, 1997—1998. MMWR Surveillance Summaries. 49(SS-4): 1-35.

CDC. 2002. Surveillance for Waterborne-Disease Outbreaks Associated with Drinking Water --- United States, 1999—2000. MMWR Surveillance Summaries. 51(SS-8): 1-36.

CDC. 2004. Surveillance for Waterborne-Disease Outbreaks Associated with Drinking Water --- United States, 2001—2002. MMWR Surveillance Summaries. 53(SS08): 23-45.

CDC. 2006. Surveillance for Waterborne-Disease Outbreaks Associated with Drinking Water --- United States, 2003—2004. MMWR Surveillance Summaries. 55(SS12): 31-58.

CDC. 2008. Surveillance for Waterborne Disease and Outbreaks Associated with Drinking Water and Water not Intended for Drinking — United States, 2005–2006. MMWR. 60(SS12): 38-68.

CDC. 2011. Surveillance for Waterborne Disease Outbreaks Associated with Drinking Water — United States, 2007–2008. MMWR. 60(SS12): 38–68

CDC. 2013. Surveillance for waterborne disease outbreaks associated with drinking water and other nonrecreational water — United States, 2009–2010. MMWR. 62(35): 714-20.

CDC. 2015. Surveillance for waterborne disease outbreaks associated with drinking water — United States, 2011–2012. MMWR. 64(31): 842-848.

CDC. 2017. Surveillance for waterborne disease outbreaks associated with drinking water — United States, 2013–2014. MMWR. 66 (44): 1216-21.

CDC. 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Chapron, C.D., N.A. Ballester, J.H. Fontaine, C.N. Frades, and A.B. Margolin. 2000. Detection of astroviruses, enteroviruses, and adnovirus types 40 and 41 in surface waters collected and evaluated by the information collection rule and an integrated cell culture-nested PCR procedure. Applied and Environmental. Microbiology. 66(6): 2520-2525.

Farkas, T. and X. Jiang. 2010. Rotaviruses, Caliciviruses, Astroviruses, Enteric Adenoviruses, and Other Diarrheic Viruses. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.A. Pfaller, and R.H. Yolken (ed.) *Manual of Clinical Microbiology*, 10th Edition, Volume 2, p.1456. American Society for Microbiology Press, Washington, DC.

Gofti-Laroche, L., B. Gratacap-Cavallier, D. Demanse, O. Genoulaz, J.–M. Segneurin, and D. Zmirou. 2003. Are waterborne astrovirus implicated in acute digestive morbidity (E. MI. RA study)? Journal of Clinical Virology. 27: 74-82.

Pang, X.L. and M. Smieja. Gastroenteritis Viruses. In Carroll, K.C., M.A. Pfaller, M.L. Landry, A.J. McAdam, R. Patel, S.S. Richter, and D.W. Warnock (ed). 2019. *Manual of Clinical Microbiology*, 12th Edition. American Society of Microbiology Press, Washington, D.C.

Smith, A., M. Reacher, W. Smerdon, G.K. Adak, G. Nichols, and R.M. Chalmers. 2006. Outbreaks of waterborne infectious intestinal disease in England and Wales, 1992-2003. Epidemiology & Infection. 134(6): 1141-1149.

Blastocystis hominis Scoring Data

Scoring Summary[1, 2]	
Waterborne Disease Outbreak	**4**
Health Risk	
General population	**1**
Sensitive subpopulation(s) [C, P, E, CD]	**1**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (1 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	**Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017**	**Yes** **2012: 1 Transient noncommunity (suspected)**	**CDC-NORS, 2020**
3	Has caused documented WBDOs at any time in the U.S.?	No	
2	Has caused WBDOs in countries other than the U.S.?	No	
1	Has never caused WBDOs in any country,	Yes Drinking untreated water	Leelayoova et al.,

Score[2]	Data Element	Scoring Data	Reference[3]
	but has been epidemiologically associated with water related disease?	has been associated with infection.	2004 Stenzel and Boreham, 1996 Taamasri et al., 2000
	Occurrence		
3	Detected in drinking water in the U.S.?	No	
2	Detected in source water in the U.S.?	No	
1	**Not detected in the U.S.?**	**Yes**	**Karanis, 2006**
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?	No	
6	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?	No	
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?	No	
4	Does the illness require short term hospitalization (< week)?	No	
3	Does the illness require physician intervention?	No	

Score[2]	Data Element	Scoring Data	Reference[3]
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?	Symptoms may be more pronounced and prolonged in immunocompromised; neoplasia and abnormal intestinal tract function.	Leber in MCM, 2010
1 [G, C, P, E, CD]	**Does the illness result in mild symptoms with minimal or no impact on daily activities?**	**[All populations] Pathogenicity of *B. hominis* is controversial. Symptoms may include diarrhea, vomiting and abdominal pain.**	**Leber in MCM, 2010; Novak-Weekly and Leber in MCM, 2019**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Centers for Disease Control and Prevention (CDC), 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Karanis, P. 2006. A review of an emerging waterborne medical important parasitic protozoan. Japanese Journal of Protozoology. 39(1): 5-19.

Leber, A. and S. Novak-Weekley. 2010. Intestinal and Urogenital Amebae, Flagellates, and Ciliates. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry, and M.A. Pfaller (ed.) *Manual of Clinical Microbiology*, 10th. Edition, Volume 2, p. 2149. American Society for Microbiology Press, Washington, DC.

Leelayoova, S., R. Rangsin, P. Taamasri, T. Naaglor, U. Thathaisong, and M. Mungthin. 2004. Evidence of waterborne transmission of *Blastocystis hominis*. American Journal of Tropical Medicine & Hygiene. 70(6): 658-662.

Novak-Weekly, S. and A. Leber. 2019. Intestinal and Urogenital Amebae, Flagellates, and Ciliates. In Carroll, K.C., M.A Pfaller, M.L. Landry, A.J. McAdam, R. Patel, S.S. Richter, and D.W. Warnock (ed). *Manual of Clinical Microbiology*, 12th Edition. American Society of Microbiology Press, Washington, DC.

Stenzel, D.J. and P.F. Boreham. 1996. *Blastocystis hominis* revisited. Clinical Microbiology Reviews. 9(4): 563-584.

Taamasri, P., M. Mungthin, R. Rangsin, B. Tongupprakarn, W. Areekul, and S. Leelayoova. 2000. Transmission of intestinal blastocystosis related to the quality of drinking water. Southeast Asian Journal of Tropical Medicine & Public Health. 31(1): 112-117.

Calicivirus Scoring Data

Scoring Summary[1,2]	
Waterborne Disease Outbreak	**5**
Health Risk	
General population	**2**
Sensitive subpopulation(s) [C, E, CD]	**4**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (2 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	**Yes** **2010: 1 Nontransient noncommunity** **2012: 1 Transient noncommunity** **2014: 2 Transient noncommunity** **2015: 1 community**	**CDC-NORS, 2020**
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017		

Score[2]	Data Element	Scoring Data	Reference[3]
3	Has caused documented WBDOs at any time in the U.S.?	1971-2008: 11 Community 30 Noncommunity	CDC-NORS, 2020
2	Has caused WBDOs in countries other than the U.S.?		
1	Has never caused WBDOs in any country, but has been epidemiologically associated with water related disease?		
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes** **Detection by PCR.**	**Huffman et al., 2003**
2	Detected in source water in the U.S.?	Yes Detected in groundwater by PCR.	Borchardt et al., 2003 Fout et al., 2003
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?		
6	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness	No long term sequelae have been reported.	CDC, 2001

Score[2]	Data Element	Scoring Data	Reference[3]
	necessitating long term hospitalization (> week)?		
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?	No	CDC, 2001
4 [C, E, CD]	**Does the illness require short term hospitalization (< week)?**	**[E, CD] (Norovirus) Although rare, severe dehydration can be fatal, with this outcome occurring among susceptible persons (e.g., older persons with debilitating health conditions).** **[C] Sappoviruses cause disease mainly in children.**	**CDC, 2019** **Farkas in MCM, 2007**
3	Does the illness require physician intervention?		
2 [G, P]	**Is the illness self-limiting within 72 hours (without requiring medical intervention)?**	**[G, P] Acute gastroenteritis. Highly contagious, able to cause large outbreaks and environmentally stable.**	**Farkas in MCM, 2007**
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher

score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Borchardt, M.A., P.D. Bertz, S.K. Spencer, and D.A. Battigelli. 2003. Incidence of enteric viruses in groundwater from household wells in Wisconsin. Applied and Environmental. Microbiology. 69: 1172-1180.

Centers for Disease Control and Prevention (CDC). 2001. Norwalk-like viruses: Public health consequences and outbreak management. Morbidity and Mortality Weekly Report (MMWR). 50(RR-9):1-18.

CDC. 2003. Managing acute gastroenteritis among children. MMWR. 52(RR-16):1-16.

CDC. 2019. Norovirus home page. Available online at: https://www.cdc.gov/norovirus/index.html

CDC. 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Farkas, T. and X. Jiang. 2007. Rotaviruses, Caliciviruses, Astroviruses, Enteric Adenoviruses, and Other Diarrheic Viruses. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.A. Pfaller, and R.H. Yolken (ed.) *Manual of Clinical Microbiology*, 9th Edition, Volume 2, pp. 1454-1457. American Society for Microbiology Press, Washington, DC.

Fout, G.S., B.C. Martinson, M.W. Moyer, and D.R. Dahling. 2003. A multiplex reverse transcription-PCR method for detection of human enteric viruses in groundwater. Applied and Environmental Microbiology. 69: 3158-3164.

Huffman, D.E., K.L. Nelson, and J.B. Rose. 2003. Calicivirus – an emerging contaminant in water: state of the art. Environmental Engineering Science. 20: 503-515.

Pang, X. and M. Smieja. Gastroenteritis Viruses. In Carroll, K.C., M.A. Pfaller, M.L. Landry, A.J. McAdam, R. Patel, S.S. Richter, and D.W. Warnock (ed). *Manual of Clinical Microbiology*, 12th Edition. American Society of Microbiology Press, Washington, DC.

Campylobacter jejuni Scoring Data

Scoring Summary[1,2]	
Waterborne Disease Outbreak	**5**
Health Risk	
General population	**3**
Sensitive subpopulation(s) [C, E]	**4**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	**Has caused multiple (2 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017**	**Yes** **2009: 1 Community** **2010: 3 Community** **1 Nontransient Noncommunity** **2012: 1 Community (*Campylobacter* unknown)** **2015: 2 Community** **2017: 1 Community**	**CDC-NORS, 2020**
4	Has caused at least one documented WBDOs in		

Score[2]	Data Element	Scoring Data	Reference[3]
	U.S. reported by CDC between 2009-2017		
3	Has caused documented WBDOs at any time in the U.S.?	Yes 1971-2008: 13 Community and 15 Noncommunity	CDC-NORS, 2020
2	Has caused WBDOs in countries other than the U.S.?	Yes Finland, New Zealand	Kuusi, 2005; waterandhealth.org
1	Has never caused WBDOs in any country, but has been epidemiologically associated with water related disease?		
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes**	**Sacks et al., 1986** **O'Reilly, 2007**
2	Detected in source water in the U.S.?	Yes	Carter et al., 1987
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?	Death is uncommon.	Fitzgerald in MCM, 2007
6	Does the organism cause pneumonia,	Complications include hepatitis, bacteremia	Fitzgerald in MCM, 2007

Score[2]	Data Element	Scoring Data	Reference[3]
	meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?	cholecystitis, pancreatitis, nephritis, abortion and neonatal sepsis, urinary tract infection, meningitis and septic arthritis. Bacteremia occurs in 0.15% of intestinal infections with elderly mostly affected.	
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?		
4 [C, E]	**Does the illness require short term hospitalization (< week)?**	**[C, E] Most cases do not require hospitalization, pediatric cases and elderly are more likely to require hospitalization than normal adult cases.** **The highest incidence is in children and infants.** **Bacteremia occurs at 1.5 per 1,000 cases with the highest rate occurring in the elderly.**	**Fitzgerald in MCM, 2007**
3 [G, P, CD]	**Does the illness require physician intervention?**	**[G, P, CD] Guillain-Barré syndrome, reactive arthritis.** **Guillain-Barré 1/1000 cases.** **Reactive arthritis 1/100 cases.**	**Fitzgerald in MCM, 2007** **Altekruse et al., 1999**
2	Is the illness self-limiting within 72 hours (without requiring	Duration 2-5 days, usually self-limiting. Several days to more than 1	Heymann, 2005

Score[2]	Data Element	Scoring Data	Reference[3]
	medical intervention)?	week, self-limiting, relapse in 5-10% cases.	Fitzgerald in MCM, 2007 CDC, 2019
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?	Asymptomatic to acute diarrhea, abdominal pain, malaise, and fever.	Fitzgerald in MCM, 2007

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC NORS reports from 1971 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Altekruse, S.F., N.J. Stern, P.I. Fields, and D.L. Swerdlow. 1999. *Campylobacter jejuni* – An Emerging Foodborne Pathogen. Emerging Infectious Diseases. 5(1): 28-35.

Carter, A.M., R.E. Pacha, G.W. Colark, and E.A. Williams. 1987. Seasonal occurrence of *Campylobacter* spp. in surface waters and their correlation with standard indicator bacteria. Applied and Environmental. Microbiology. 53(3): 523-526.

Centers for Disease Control and Prevention (CDC), 2019. *Campylobacter* home page. Available online at: https://www.cdc.gov/campylobacter/index.html.

CDC, 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Heymann, D. (ed.). 2005. *Control of Communicable Diseases Manual*, 18th Edition. American Public Health Association, Washington, DC.

Kuusi, M., J.P. Nuorti, M.L. Hanninen, M. Koskela, V. Jussila, E. Kela, I. Miettinen, and P. Ruutu. 2005. A large outbreak of campylobacteriosis associated with a municipal water supply in Finland. Epidemiology & Infection. 133(4): 593-601.

Fitzgerald, C. and I. Nachamkin. 2007. *Campylobacter* and *Arcobacter*. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry, and M.A. Pfaller (ed.) *Manual of Clinical Microbiology*, 9th Edition, Volume 1, pp. 933-935. American Society for Microbiology Press, Washington, DC.

Nachamkin, I. 2019. *Campylobacter* and *Arcobacter*. In Carroll, K.C., M.A. Pfaller, M.L. Landry, A.J. McAdam, R. Patel, S.S. Richter, and D.W. Warnock (ed). *Manual of Clinical Microbiology*, 12th Edition. American Society of Microbiology, Washington, DC.

O'Reilly, C.E., A.B. Bowen, N.E. Perez, J.P. Sarisky, C.A. Shepherd, M.D. Miller, B.C. Hubbard, M. Herring, S.D. Buchanan, C.C. Fitzgerald, V. Hill, M.J. Arrowood, L.X. Xiao, R.M. Hoekstra, E.D. Mintz, F. Lynch, and Outbreak Working Group. 2007. A Waterborne Outbreak of Gastroenteritis with Multiple Etiologies among Resort Island Visitors and Residents: Ohio, 2004. Clinical Infectious Diseases. 44(4): 506-512.

Sacks, J.J., S. Lieb, L.M. Baldy, S. Berta, C.M. Patton, M.C. White, W.J. Bigler, and J.J. Witte. 1986. Epidemic campylobacteriosis associated with a community water supply. American Journal of Public Health. 76(4): 424-429.

Water Quality and Health Council. 2017 Update: New Zealand's Largest Drinking Water Outbreak. Available online at: https://waterandhealth.org/safe-drinking-water/update-new-zealands-largest-drinking-water-outbreak-2.

Comamonas testosteroni Scoring Data

Scoring Summary[1,2]	
Occurrence	**2**
Health Risk	
General population	**1**
Sensitive subpopulation(s) [CD]	**6**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (2 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
3	Has caused documented WBDOs at any time in the U.S.?		
2	Has caused WBDOs in countries other than the U.S.?		
1	**Has never caused WBDOs in any country, but has been epidemiologically**		

Score[2]	Data Element	Scoring Data	Reference[3]
	associated with water related disease?		
	Occurrence		
3	Detected in drinking water in the U.S.?		
2	**Detected in source water in the U.S.?**	***Comamonas testosteroni* is often found in freshwater, soil, plants, and in hospital devices such as intravenous lines and the reservoir water in the humidifiers of respiratory therapy equipment.**	**Tiwari and Nanda, 2019**
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?		
6 [CD, G]	**Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?**	***Comamonas testosteroni* has been shown to cause pneumonia in patients with AIDS. (Franzetti et al., 1992). It has also been documented causing meningitis in a patient that had recurrent cholesteatoma (Arda et al., 2008). It also been shown to infect those who were**	**Franzetti et al., 1992** **Arda et al., 2003** **LaPuma et al. in MCM, 2019**

Score[2]	Data Element	Scoring Data	Reference[3]
		previously healthy.	
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?		
4	Does the illness require short term hospitalization (< week)?		
3	Does the illness require physician intervention?		
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?		
1 [G]	**Does the illness result in mild symptoms with minimal or no impact on daily activities?**	**Infrequently cause human infections on healthy individuals**	**LaPuma et al. in MCM, 2019**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Arda, B., S. Aydemir, T. Yamazhan, A. Hassan, A. Tünger, and D. Serter. 2003. *Comamonas testosteroni* meningitis in a patient with recurrent cholesteatoma: Case report. Apmis. 111(4): 474-476.

Franzetti, F., M. Cernuschi, R. Esposito, and M. Moroni. 1992. *Pseudomonas* infections in patients with AIDS and AIDS-related complex. Journal of internal medicine. 231(4): 437-443.

Centers for Disease Control and Prevention (CDC). 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

LaPuma, J.J., B.J. Currie, S.J. Peacock, and P.A.R. Vandamme. 2019. *Burkholderia, Stenotrophomonas, Ralstonia, Cupriavidus, Pandoraea, Brevundimonas, Comamonas, Delftia,* and *Acidovorax*. In Carroll, K.C., M.A. Pfaller, M.L., Landry, A.J. McAdam, R. Patel, S.S. Richter, and D.W. Warnock (ed). 2019. *Manual of Clinical Microbiology*, 12th Edition. American Society for Microbiology, Washington, DC.

Tiwari, S. and M. Nanda. 2019. Bacteremia caused by *Comamonas testosteroni* an unusual pathogen. Journal of laboratory physicians. 11(1): 87.

Cyclospora cayetanensis Scoring Data

Scoring Summary[1, 2]	
Waterborne Disease Outbreak	**3**
Health Risk	
General population	**3**
Sensitive subpopulation(s) [C]	**4**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (1 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
3	**Has caused documented WBDOs at any time in the U.S.?**	**Yes** **1971-2008: 2 Community**	**CDC-NORS, 2020**
2	Has caused WBDOs in countries other than the U.S.?		

Score[2]	Data Element	Scoring Data	Reference[3]
1	Has never caused WBDOs in any country, but has been epidemiologically associated with water related disease?	Yes	Huang et al., 1995
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes**	**CDC, 2019**
2	Detected in source water in the U.S.?	No	
1	Not detected in the U.S.?	Detected in drinking water in Guatemala.	Dowd et al., 2003
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?	No	
6	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?	No	
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?	Guillain-Barré and Reiter's syndromes have been reported.	Connor et al., 2001

Score[2]	Data Element	Scoring Data	Reference[3]
4 [C]	**Does the illness require short term hospitalization (< week)?**	**[C] Most cases do not required hospitalization, infants may require hospitalization for rehydration therapy.**	**Fisk et al., 2005**
3 [G, P, E, C, CD]	**Does the illness require physician intervention?**	**[All populations] Can cause diarrhea and biliary disease.** **In patients not treated, illness can be protracted with relapsing symptoms.**	**Lindsay in MCM, 2010** **Heymann, 2005** **CDC, 2019**
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?	.	
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Centers for Disease Control and Prevention (CDC). 2019. *Cyclospora* homepage. Available online at: https://www.cdc.gov/parasites/cyclosporiasis/index.html.

CDC. 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Connor, B.A., E. Johnson, and R. Soave. 2001. Reiter syndrome following protracted symptoms of *Cyclospora* infection. Emerging infectious diseases. 7: 453-454.

Dowd, E.S., D. John, J. Eliopolus, C.P. Gerba, J. Naranjo, R. Klein, B. Lopez, M. de Mejia, C.E. Mendoza, and I. Pepper. 2003. Confirmed detection of *Cyclospora cayetanesis, Encepalitozoon intestinalis* and *Cryptosporidium parvum* in water used for drinking. Journal of Water and Health. 1(3): 117-123.

Fisk, T.L., J.S. Keystone, and P. Kozarsky. 2005. In Mandell, G.L., J.E. Bennett, and R. Dolin (eds.). *Mandell, Douglas and Bennett's Principles and Practice of Infectious Diseases*, 6th Edition. Elsevier, Philadelphia, PA.

Heymann, D.(ed.). 2005. *Control of Communicable Diseases Manual,* 18th Edition. American Public Health Association, Washington, DC.

Huang, P., J.T. Weber, D.M. Sosin, P.M. Griffin, E.G. Long, J.J. Murphy, F. Kocka, C. Peters, and C. Kallick. 1995. The first reported outbreak of diarrheal illness associated with *Cyclospora* in the United States. Annals of Internal Medicine.123: 409-414.

Lindsay, D., S. Upton, and L. Weiss. 2010. *Isospora*, *Cyclospora* and *Sarcocystis*. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.A. Pfaller, and R.H. Yolken (ed.) *Manual of Clinical Microbiology*, 10th Edition, Volume 2, p. 2172. American Society for Microbiology Press, Washington, DC.

Entamoeba histolytica Scoring Data

Scoring Summary[1, 2]	
Waterborne Disease Outbreak	**3**
Health Risk	
General population	**3**
Sensitive subpopulation(s) [C, P, E, CD]	**3**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (1 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
3	**Has caused documented WBDOs at any time in the U.S.?**	**1971-2008: 3 Community (one is "Entamoeba unknown')** **1 Noncommunity**	**CDC-NORS, 2020**
2	Has caused WBDOs in countries other than the U.S.?		

Score[2]	Data Element	Scoring Data	Reference[3]
1	Has never caused WBDOs in any country, but has been epidemiologically associated with water related disease?		
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Found during WBDO.**	**CDC, 2006**
2	Detected in source water in the U.S.?		
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?	500 million infected (*E. dispar* and *E. histolytica*) each year with approximately 50 million cases of colitis and liver abscess and 100,000 deaths worldwide.	Leber in MCM, 2010
6	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?	Infections in the U.S. rarely progress to complications, amoebic colitis may result in perforation of the intestinal wall, resulting in peritonitis; dissemination to extraintestinal sites may involve the liver, lungs, or brain. Liver abscess is the most common complication.	Heymann, 2005
5	Does the illness result in long term or permanent	Abdominal perforations and peritonitis are rare	Leber in MCM, 2010

Score[2]	Data Element	Scoring Data	Reference[3]
	dysfunction or disability, i.e. sequelae?	complications. Up to 5% develop liver abscess.	
4	Does the illness require short term hospitalization (< week)?	Intestinal invasion can lead to lesions, ulcers.	Leber in MCM, 2010
3 [G, C, P, E, CD]	**Does the illness require physician intervention?**	**[All populations]** **Clinical symptoms are dysentery, colitis or rarely amoeboma).** **Fulminant colitis occurs most often in children who present with diffuse abdominal pain, profuse bloody diarrhea and fever.**	**Leber in MCM, 2010** **Marshall, 1997**
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?	Most human infections (90%) are asymptomatic, symptomatic non-invasive strains cause gastrointestinal symptoms such as cramping and increased frequency of bowel movements, constipation may alternate with diarrhea, invasive strains may cause amoebic dysentery.	Heymann, 2005
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation.

These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Centers for Disease Control and Prevention (CDC). 2020. National Outbreak Reporting System (NORS). Available online at:https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Heymann, D. (ed.). 2005. Control of Communicable Diseases Manual, 18th Edition. American Public Health Association, Washington, DC.

Leber, A. and S. Novak-Weekley. 2010. Intestinal and Urogenital Amebae, Flagellates, and Ciliates. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry, and M.A. Pfaller (ed.) *Manual of Clinical Microbiology*, 10th Edition, Volume 2, p. 2149. American Society for Microbiology Press, Washington, DC.

Marshall, M., D. Naumovitz, Y. Ortega, and C. Sterling. 1997. Waterborne protozoan pathogens. Clinical Microbiology Reviews. 10(1): 67–85.

Enterovirus Scoring Data

Scoring Summary[1,2]	
Occurrence	**3**
Health Risk	
General population	**4**
Sensitive subpopulation(s) [C]	**6**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (2 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 1990-2009	No	CDC-NORS, 2020
3	Has caused documented WBDOs at any time in the U.S.?	No	
2	**Has caused WBDOs in countries other than the U.S.?**	**Yes** **Switzerland and others.**	**Hafliger et al., 2000**
1	Has never caused WBDOs in any country, but has		

Score[2]	Data Element	Scoring Data	Reference[3]
	been epidemiologically associated with water related disease?		
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes**	**Mack et al., 1972 Lieberman et al., 2003** **Keswick et al., 1984**
2	Detected in source water in the U.S.?	Yes	Borchardt et al., 2003
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?		
6 [C]	**Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?**	**[C] Aseptic meningitis and neonatal sepsis are the most common complications.** **EVs are the most common cause of meningitis in the U.S., over 80% of all viral meningitides (estimated 30,000 to 50,000 hospitalizations for non-polio EV each year (principally echo and coxsackie)).** **Enterovirus causes myocarditis, viral**	**Heymann, 2005** **Romero in MCM, 2007** **Khetsuriani et al.,**

Score[2]	Data Element	Scoring Data	Reference[3]
		meningitis, encephalitis and meningioencephalitis. **Widespread illness in children with asthma.**	**2002** **Kim et al., 2001** **Khetsuriani, 2003** **Midgely at al, 2015**
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?	Diabetes has been associated with enterovirus infection.	Heymann, 2005
4 [G]	**Does the illness require short term hospitalization (< week)?**	**[G] Hospitalization may be required for severe manifestations of disease. Approximately 20-30% of meningitis outbreak cases in young adults require hospitalization.** **During the summer and fall, responsible for 50 – 60% of hospital admissions for evaluation of febrile illnesses for infants and children.**	**Sawyer, 2002** **Romero in MCM, 2007**

Score[2]	Data Element	Scoring Data	Reference[3]
3	Does the illness require physician intervention?	Children with acute pharyngitis may be taken to a physician to differentiate between streptococcal and viral sore throat. Upper respiratory illness lasts 4-6 days, lower respiratory illness lasts 5-7 days, and meningitis lasts 7-10 days.	Romero in MCM, 2007 Heymann, 2005
2 [E, P, CD]	Is the illness self-limiting within 72 hours (without requiring medical intervention)?	[E, P, CD] Most cases are asymptomatic. Most common symptoms are acute nonspecific febrile illness.	Romero in MCM, 2007
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Borchardt, M.A., P.D. Bertz, S.K. Spencer, and D.A. Battigelli. 2003. Incidence of enteric viruses in groundwater from household wells in Wisconsin. Applied and Environmental Microbiology. 69(2): 1172-1180.

Centers for Disease Control and Prevention (CDC). 2020. National Outbreak Reporting System (NORS). Available online at:https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Hafliger D., P. Hubner, and J. Luthy. 2000. Outbreak of viral gastroenteritis due to sewage-contaminated drinking water. International Journal of Food Microbiology. 54(1-2): 123-126.

Heymann, D. (ed.). 2005. *Control of Communicable Diseases Manual*, 18th Edition. American Public Health Association, Washington, DC.

Keswick, B., C. Gerba, H. DuPont, and J. Rose. 1984. Detection of Enteric Viruses in Treated Drinking Water. Applied and Environmental Microbiology. 47(6): 1290-1294.

Khetsuriani N., R. Holman, and L. Anderson. 2002. Burden of Encephalitis-Associated Hospitalizations in the United States, 1988–1997. Clinical Infectious Diseases. 35(2): 175-182.

Khetsuriani, N., E.S. Quiroz, R.C. Holman, and L.J. Anderson. 2003. Viral meningitis-associated hospitalizations in the United States, 1988-1999. Neuroepidemiology. 22(6): 345-352.

Kim, K-S., G. Hufnagel, N.M. Chapman, and S. Tracy. 2001. The group B coxsackieviruses and myocarditis. Reviews in Medical Virology. 11(6): 355-368.

Lieberman, R.J., L.C. Shadix, B.S. Newport, C.P. Frebis, M.W.N. Moyer, R.S. Safferman, R.E. Stetler, D. Lye, G.S. Fout, and D. Dahling. 2002. Microbial monitoring of vulnerable public ground water supplies, p. 142. American Water Works Association, Dever, CO.

Mack, W.N., L. Yue-Shoung, and D.B. Coohon. 1972. Isolation of poliomyelitis virus from a contaminated well. Health Services Report. 87(3): 271-274.

Midgley, C.M., J.T. Watson, W.A. Nix, A.T. Curns, S.L. Rogers, B.A., Brown, C. Conover, S.R. Dominguez, D.R. Feikin, S. Gray, and F. Hassan. 2015. Severe respiratory illness associated with a nationwide outbreak of enterovirus D68 in the USA (2014): a descriptive epidemiological investigation. The Lancet Respiratory medicine. 3(11): 879-887.

Romero, J. 2007. Enteroviruses and Parechoviruses. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry, and M.A. Pfaller (ed.) *Manual of Clinical Microbiology*, 9th Edition, Volume 2, p. 1394. American Society for Microbiology Press, Washington, DC.

Sawyer, M.H. 2002. Enterovirus infections: diagnosis and treatment. Seminars in Pediatric Infectious Diseases.13(1): 40-47.

Escherichia coli (O157)† Scoring Data

Scoring Summary[1,2]	
Waterborne Disease Outbreak	**5**
Health Risk	
General population	**3**
Sensitive subpopulation(s) [C, E]	**6**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (2 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	**Yes** **2010: 1 Community** **2011: 1 Transient Noncommunity** **2013: 1 Transient Noncommunity** **2014: 1 Nontransient Noncommunity** **2016: 1 Community**	**CDC-NORS, 2020**
4	Has caused at least one documented WBDOs in U.S. reported by CDC		

Score[2]	Data Element	Scoring Data	Reference[3]
	between 2009-2017		
3	Has caused documented WBDOs at any time in the U.S.?	1971-2008: 5 Community 5 Noncommunity	CDC-NORS, 2020
2	Has caused WBDOs in countries other than the U.S.?		
1	Has never caused WBDOs in any country, but has been epidemiologically associated with water related disease?		
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes**	**Bopp et al., 2003**
2	Detected in source water in the U.S.?	Yes As a result of animal fecal contamination.	Kramer et al., 1996
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?	No Approximately 60 deaths per 73,000 cases per year (nearly >1/1,000) are reported due to *E. coli* (O157). A case fatality rate of 0.5 has been reported for outbreak-related cases caused by *E. coli* O157:H7	Nataro in MCM, 2007 Rangel et al., 2005 Buchan in MCM, 2019

Score[2]	Data Element	Scoring Data	Reference[3]
6 [C, E]	**Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?**	**[C, E] Patients at extremes of age have an increased risk for infection and associated complications.** **Children under 5 are most frequently diagnosed with infection and are at greatest risk of developing HUS. The elderly also appear to be an increased risk of complications.** **HUS develops in 10% of patients under the age of 10.**	**Chinyu, 1995** **Nataro and Kaper, 1998** **Heymann, 2005** **CDC, 2019**
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?	25% of HUS survivors develop long term renal sequelae. 3.2% of children with diarrhea plus HUS develop diabetes. Adults have a greater likelihood of hypertension and reduced renal function.	Garg et al., 2003 Suri et al., 2005 Garg et al., 2005
4	Does the illness require short term hospitalization (< week)?		

Score[2]	Data Element	Scoring Data	Reference[3]
3 [G, P, CD]	**Does the illness require physician intervention?**	**[G, P, CD] Fluid replacement is the cornerstone of treatment for EHEC diarrhea; some clinicians choose to hospitalize all patients with *E. coli* O157:H7 for hydration to prevent HUS.**	**Heymann, 2005**
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?		
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?	Can present as mild nonbloody diarrhea.	Nataro in MCM, 2007

[†]The names *E. coli* O157 and *E. coli* O157:H7 are used interchangeably for CCL 5 due to ongoing taxonomical debate in the scientific literature.

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Bopp, D.J., B.D. Sauders, A.L. Waring, J. Ackelsberg, N. Dumas, E. Braun-Howland, D. Dziewulski, B.J. Wallace, M. Kelly, T. Halse, K. Aruda Musser, P.F. Smith, D.L. Morse, and Limberger, R.J. 2003. Detection, Isolation, and Molecular Subtyping of *Escherichia coli* O157:H7 and *Campylobacter jejuni* Associated with a Large Waterborne Outbreak. Journal of Clinical Microbiology. 41(1): 174-180.

Buchan, B., M.L. Faron, R. Humphries, J. Dekker, and N.A. Ledeboer. 2019. *Escherichia*, *Shigella* and *Salmonella*. In Carroll, K.C., M.A Pfaller, M.L. Landry, A.J. McAdam, R. Patel, S.S. Richter, and D.W. Warnock (ed). *Manual of Clinical Microbiology*, 12th Edition. American Society of Microbiology Press, Washington DC.

Chinyu S., and L.J. Brandt. *Escherichia coli*: H7 Infection in Humans. 1995. Annals of Internal Medicine. 123(9): 698-707.

Centers for Disease Control and Prevention (CDC). 2019. *E. coli (Escherichia coli)* homepage. Available online at: https://www.cdc.gov/ecoli/index.html.

CDC, 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Garg, A.X., L. Moist, D. Matsel, H.R. Thiessen-Philbrook, R.B. Haynes, R.S. Suri, M. Salvadori, J. Ray, and W.F. Clark. 2005. Risk of hypertension and reduced kidney function after acute gastroenteritis from bacteria-contaminated drinking water. CMAJ. 173(3): 261–268.

Garg, A.X., R.S. Suri, N. Barrowman, F. Rehman, D. Matsell, M.P. Rosas-Arellano, M. Salvadori, R.B. Haynes, and W.F. Clark. 2003. Long-term Renal Prognosis of Diarrhea-Associated Hemolytic Uremic Syndrome. Journal of the American Medical Association. 290(10): 1360-1370.

Heymann, D. (ed.). 2005. Control of Communicable Diseases Manual, 18th Edition. American Public Health Association, Washington, DC.

Karch, H., P.I. Tarr, and M. Bielaszewska. 2005. Enterohaemorrhagic *Eschericia coli* in human medicine. International Journal of Medical Microbiology. 295: 405-418.

Kramer, M.H., B.L. Herwaldt, G.F. Craun, R.L. Calderon, and D.D. Juranek. 1996. Surveillance for waterborne-disease outbreaks – United States, 1993-1994. MMWR Surveillance Summaries. 45(SS-1): 1-33.

Nataro, J., C. Bopp, P. Fields, J. Kaper, and N. Strockbine. 2007. *Escherichia*, *Shigella* and *Salmonella*. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry, and M.A. Pfaller (ed.) *Manual of Clinical Microbiology*, 9th Edition, Volume 1, pp. 670 - 672. American Society for Microbiology Press, Washington, DC.

Nataro, J.P. and J.B. Kaper. 1998. Diarrheagenic *Escherichia coli*. Clinical microbiology reviews.11(1): 142-201.

Rangel, J.M., P.H. Sparling, C. Crowe, P.M. Griffin, and D.L. Swerdlow. 2005. Epidemiology of *Escherichia coli* O157:H7 outbreaks, United States, 1982-2002. Emerging infectious diseases. 11(4): 603-609.

Suri, R.S., W.F. Clark, N. Barrowman, J.L. Mahon, H.R. Thiessen-Philbrook, M.P. Rosas-Arellano, K. Zarnke, J.S. Garland, and A.X. Garg. 2005. Diabetes during diarrhea-associated hemolytic uremic syndrome: a systematic review and meta-analysis. Diabetes Care. 28(10): 2556-2562.

Exophiala jeanselmei Scoring Data

Scoring Summary[1]	
Occurrence	**3**
Health Risk	
General population	**3**
Sensitive subpopulation(s) [C, P, E, CD]	**3**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (1 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
3	Has caused documented WBDOs at any time in the U.S.?	No	
2	Has caused WBDOs in countries other than the U.S.?	No	

Score[2]	Data Element	Scoring Data	Reference[3]
1	**Has never caused WBDOs in any country, but has been epidemiologically associated with water related disease?**	**Yes**	**Nucci et al., 2002**
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes**	**West, 1986**
2	Detected in source water in the U.S.?	Yes	Nucci et al., 2001
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?	No	
6	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?	Infections increase in severity in patients with impaired immunity and metabolic diseases such as diabetes.	De Hoog and Vitale in MCM, 2007
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?	No	
4	Does the illness require short term hospitalization (< week)?	No	
3 [G, C, P,	**Does the illness require**	**[All populations] A chronic spreading**	**Heymann, 2005**

Score[2]	Data Element	Scoring Data	Reference[3]
E, CD]	**physician intervention?**	**mycosis.** **The frequency of infection is low, yet potential severe outcome and high degrees of resistance to antifungal drugs requires medical attention.**	**De Hoog and Vitale in MCM, 2007**
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?		
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Centers for Disease Control and Prevention (CDC). 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Heymann, D. (ed.). 2005. *Control of Communicable Diseases Manual*, 18th Edition. American Public Health Association, Washington, DC.

Nucci, M., T. Akiti, G. Barreiros, F. Silveira, S.G. Revankar, D.A. Sutton, and T.F. Patterson. 2001. Nosocomial fungemia due to *Exophiala jeanselmei* var. *jeanselmei* and a *Rhinocladiella* species: newly described causes of bloodstream infection. Journal of Clinical. Microbiology. 39(2): 514-518.

Marcio, N., A. Tiyomi, B. Gloria, S. Fernanda, S.G. Revankar, L.W. Brian, D.A. Sutton, and T.F. Patterson. 2002. Nosocomial outbreak of *Exophiala jeanselmei* fungemia associated with contamination of hospital water. Clinical infectious diseases. 34: 1475-1480.

De Hoog, G. and R. Vitale. 2007. Bipolaris, Exophiala, Scedosporium, Sporothrix, and Other Dematiaceous Fungi. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry, and M.A. Pfaller (ed.) *Manual of Clinical Microbiology*, 9th Edition, Volume 2, pp.1908 and 1918. American Society for Microbiology Press, Washington, DC.

West, P.R. 1986. Isolation rates and characterization of fungi in drinking water distribution systems. Proceedings of the Water Quality Technology Conference. American Water Works Association, Denver, CO.

Fusarium solani Scoring Data

Scoring Summary[1, 2]	
Occurrence	**3**
Health Risk	
General population	**4**
Sensitive subpopulation(s) [C, P, E, CD]	**4**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (1 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
3	Has caused documented WBDOs at any time in the U.S.?	No	
2	Has caused WBDOs in countries other than the U.S.?	No	
1	**Has never caused WBDOs in any country, but has been epidemiologically associated with water related disease?**	**Yes** **Houston TX**	**Annaissie et al., 2001**

Score[2]	Data Element	Scoring Data	Reference[3]
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes**	**Nagy and Olson, 1982** **Annaissie et al., 2001**
2	Detected in source water in the U.S.?	Yes	
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?	Mortality associated with cutaneous *Fusarium* infection is high in immunocompromised patients but low for immunocompetent hosts.	Nucci and Annaissie, 2002
6	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?	Most severe disease occurs in severely immunocompromised. *Fusarium* has been associated with pneumonia and disseminated infections	Fridkin and Jarvis, 1996; Annaissie et al., 2001 Sutton and Brandt, in MCM, 2010
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?		

Score[2]	Data Element	Scoring Data	Reference[3]
4 **[G, C, P, E, CD]**	Does the illness require short term hospitalization (< week)?	**[All populations] Can cause infections that may require hospitalization, particularly in immunocompromised patients (endophthalmitis, central nervous system infections, endocarditis)**	**Dignani and Anaissie, 2004**
3	Does the illness require physician intervention?	Treatment and/or removal of the foreign body is usually required as well as antifungal therapy. In immunocompetent patients manifestations include keratitis, localized skin lesions, onychomycosis, and occasionally cellulitis and peritonitis.	Dignani and Anaissie, 2004
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?		
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Anaissie, E.J., R.T. Kuchar, J.H. Rex, A. Francesconi, M. Kasai, F-M.C. Muller, M. Lozano-Chiu, R.C. Summerbell, M.C. Dignani, S.J. Chanock, and T.J. Walsh. 2001. Fusariosis Associated with Pathogenic Fusarium Species Colonization of a Hospital Water System: A New Paradigm for the Epidemiology of Opportunistic Mold Infections. Clinical Infectious diseases. 33: 1871-1878.

Centers for Disease Control and Prevention (CDC). 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Dignani, M. and E. Anaissie. 2004. Human Fusariosis. Clinical and Infection Microbiology.1: 67-75.

Fridkin, S. and W. Jarvis. 1996. Epidemiology of Nosocomial Fungal Infections. Clinical microbiology reviews. 9(4): 499-511.

Nagy L. and B. Olson. 1982. The occurrence of filamentous fungi in drinking water distribution systems. Canadian Journal of Microbiology. 28(6): 667-71.

Nucci, M. and E. Anaissie. 2002. Cutaneous infection by *Fusarium* species in health and immunocompromised hosts: implications for diagnosis and management. Clinical Infectious diseases. 35: 909-920.

Sutton, D. and M. Brandt. 2007. *Fusarium,* and Other Opportunistic Hyaline Fungi. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry and M.A. Pfaller (ed.) *Manual of Clinical Microbiology*, 10th. Edition, Volume 2, p. 1853. American Society for Microbiology Press, Washington, DC.

Helicobacter pylori Scoring Data

Scoring Summary[1,2]	
Occurrence	**2**
Health Risk	
General population	**7**
Sensitive subpopulation(s) [E]	**7**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (2 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017.	No	CDC, 1991 – CDC, 2017
3	Has caused documented WBDOs at any time in the U.S.?	No	
2	Has caused WBDOs in countries other than the U.S.?	No	
1	**Has never caused WBDOs in any country, but has been epidemiologically**	**Yes**	**Klein and Graham, 1991**

Score[2]	Data Element	Scoring Data	Reference[3]
	associated with water related disease?		**Hulten et al., 1996** **Rolle-Kampczyk, 2004** **Aziz et al., 2015**
	Occurrence		
3	Detected in drinking water in the U.S.?	Yes	Hegarty and Baker, 1999
2	**Detected in source water in the U.S.?**	**Yes**	**Richards et al., 2018**
1	Not detected in the U.S.?		
	Health Risk		
7 [G, E]	**Does the organism cause significant mortality (> 1/1,000 cases)?**	**[G, E] 6500 deaths per year.** **1.2 Million acute cases per year (>1/1,000 deaths).** **46% of deaths occur before age of 64.**	**CDC, 1997** **Stratton et al., 2000**
6	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?	40 – 50% infection rates in the elderly. More likely to suffer from gastric ulcer, gastric adenocarcinomas and MALT.	Fox in MCM, 2007 Couturier in MCM, 2019
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?	Main cause for peptic ulcers and a major risk factor for gastric cancer.	Fox in MCM, 2007

Score[2]	Data Element	Scoring Data	Reference[3]
4	Does the illness require short term hospitalization (< week)?		
3 [C, P, CD]	Does the illness require physician intervention?	[C, P, CD] Many patients have recurrent abdominal symptoms; 16% develop duodenal ulcers. NIH (1994) recommends diagnosis and antimicrobial treatment for anyone with peptic ulcers.	Fox in MCM, 2007
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?	No Infection persists lifelong without treatment.	Fox in MCM, 2007
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Aziz, R.K., M.M. Khalifa, and R.R. Sharaf. 2013. Contaminated water as a source of *Helicobacter pylori* infection: A review. Journal of Advanced Research. 6(4): 539–547. doi:10.1016/j.jare.2013.07.007.

CDC. 1991. Surveillance for Waterborne-Disease Outbreaks Associated with Drinking Water --- United States, 1989—1990. MMWR Surveillance Summaries. 40(SS-3): 1-21.

CDC. 1993. Surveillance for Waterborne-Disease Outbreaks Associated with Drinking Water --- United States, 1991—1992. MMWR Surveillance Summaries. 42(SS-5): 1-22.

CDC. 1996. Surveillance for Waterborne-Disease Outbreaks Associated with Drinking Water --- United States, 1993—1994. MMWR Surveillance Summaries. 45(SS-1): 1-33.

CDC.1997. Knowledge About Causes of Peptic Ulcer Disease -- United States, March-April 1997, October 24, 1997. 46(42):985-987

CDC. 1998. Surveillance for Waterborne-Disease Outbreaks Associated with Drinking Water --- United States, 1995—1996. MMWR Surveillance Summaries. 47(SS-5): 1-33.

CDC. 2000. Surveillance for Waterborne-Disease Outbreaks Associated with Drinking Water --- United States, 1997—1998. MMWR Surveillance Summaries. 49(SS-4): 1-35.

CDC. 2002. Surveillance for Waterborne-Disease Outbreaks Associated with Drinking Water --- United States, 1999—2000. MMWR Surveillance Summaries. 51(SS-8): 1-36.

CDC. 2004. Surveillance for Waterborne-Disease Outbreaks Associated with Drinking Water --- United States, 2001—2002. MMWR Surveillance Summaries. 53(SS08): 23-45.

CDC. 2006. Surveillance for Waterborne-Disease Outbreaks Associated with Drinking Water --- United States, 2003—2004. MMWR Surveillance Summaries. 55(SS12): 31-58.

CDC. 2008. Surveillance for Waterborne Disease and Outbreaks Associated with Drinking Water and Water not Intended for Drinking — United States, 2005–2006. MMWR. 60(SS12): 38-68.

CDC. 2011. Surveillance for Waterborne Disease Outbreaks Associated with Drinking Water — United States, 2007–2008. MMWR. 60(SS12): 38–68

CDC. 2013. Surveillance for waterborne disease outbreaks associated with drinking water and other nonrecreational water — United States, 2009–2010. MMWR. 62(35): 714-20.

CDC. 2015. Surveillance for waterborne disease outbreaks associated with drinking water — United States, 2011–2012. MMWR. 64(31): 842-848.

CDC. 2017. Surveillance for waterborne disease outbreaks associated with drinking water — United States, 2013–2014. MMWR. 66 (44): 1216-21.

CDC. 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Roger-Couturier, M. *Helicobacter*. 2019. In Carroll, K.C., M.A Pfaller, M.L. Landry, A.J. McAdam, R. Patel, S.S. Richter, and D.W. Warnock (ed). *Manual of Clinical Microbiology*, 12th Edition. American Society for Microbiology Press, Washington, DC.

Fox, G. and F. Megraud. 2007. *Helicobacter*. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry, and M.A. Pfaller (ed.) *Manual of Clinical Microbiology*, 9th Edition, Volume 1, p. 950. American Society for Microbiology Press, Washington, DC.

Hegarty, J.P. and K.H. Baker. 1999. Occurrence of *Helicobacter pylori* in surface water in the United States. Journal of Applied Microbiology. 87: 697-701.

Hulten, K., S.W. Han, H. Enroth, P.D. Klein, A.R. Opekun, R.H. Gilman D.G. Evans, L. Engstrand, D.Y. Graham, and F.A.K. El-Zaatari. 1996. *Helicobacter pylori* in the drinking water in Peru. Gastroenterology. 110: 1031-1035.

Klein, P.D, A.R. Opekun, E.O. Smith, D.Y. Graham, A. Gaillour, and Gastrointestinal Physiology Working Group.1991. Water source as risk factor for *Helicobacter pylori* infection in Peruvian children. The Lancet. 337(8756): 1503-1506.

Richards C.L., S.C. Broadaway, M.J. Eggers, J. Doyle, B.H. Pyle, A.K. Camper, and T.E. Ford. 2018. Detection of Pathogenic and Non-pathogenic Bacteria in Drinking Water and Associated Biofilms on the Crow Reservation, Montana, USA. Microbial Ecology. 76(1): 52-63. doi: 10.1007/s00248-015-0595-6.

Rolle-Kampczyk, U.E., G.J. Fritz, U. Diez, I. Lehman, M. Richter, and O. Herbarth. 2004. Well water – one source for *Helicobacter pylori* colonization. International Journal of Hygiene and Environmental Health. 207: 363-368.

Stratton, K.R., J.S. Durch, and R.S. Lawrence (eds.). 2000. Committee to Study Priorities for Vaccine Development. Institute of Medicine. Vaccines for the 21st century: a tool for decision making. National Academies Press, Washington, DC.

Hepatitis A Virus Scoring Data

Scoring Summary[1,2]	
Waterborne Disease Outbreak	**3**
Health Risk	
General population	**3**
Sensitive subpopulation(s) [E]	**6**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (2 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	No	
3	**Has caused documented WBDOs at any time in the U.S.?**	**Yes** **1 Community** **1 Noncommunity (Previously unreported)/A** **1971-2008: 10**	**CDC-NORS, 2020**

Score[2]	Data Element	Scoring Data	Reference[3]
		Community **9 Noncommunity**	
2	Has caused WBDOs in countries other than the U.S.?		
1	Has never caused WBDOs in any country, but has been epidemiologically associated with water related disease?		
	Occurrence		
3	Detected in drinking water in the U.S.?		
2	**Detected in source water in the U.S.?**	**Yes**	**Abbaszadegan et al., 2003** **Borchardt et al., 2004**
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?	Reported case fatality is normally low, 0.1% – 0.3%; it can reach 1.8% for adults over 50.	Heymann, 2005
6 [E]	**Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of**	**[E] Fulminant hepatitis may develop. Disease severity shows a general increase with age.**	**Anderson in MCM, 2007** **CDC, 2019**

Score[2]	Data Element	Scoring Data	Reference[3]
	illness necessitating long term hospitalization (> week)?		
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?		
4	Does the illness require short term hospitalization (< week)?		
3 [G, C, P, CD]	**Does the illness require physician intervention?**	**[G, C, P, CD] Commonly begins with "flu-like" symptoms. May develop jaundice. Physician office visit is common for diagnosis and/or vaccination.**	**Anderson in MCM, 2007**
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?		
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Abbaszadegan, M., M. LeChevallier, and C. P. Gerba. 2003. Occurrence of viruses in U. S. groundwaters. Journal American Water Works. A95: 107-120.

Anderson, D. 2007. Hepatitis A and E Viruses. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry, and M.A. Pfaller (ed.) *Manual of Clinical Microbiology,* 9th Edition, Volume 2, pp. 1428-1429. American Society for Microbiology Press, Washington, DC.

Borchardt, M.A., N.L. Haas, and R.L. Hunt. 2004. Vulnerability of drinking-water wells in La Crosse, Wisconsin to enteric-virus contamination from surface water contributions. Applied and Environmental Microbiology. 10: 5937-5946.

Centers for Disease Control and Prevention (CDC). 2019. Viral Hepatitis-Hepatitis A home page. Available online at: https://www.cdc.gov/hepatitis/hav/index.htm.

CDC. 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Heymann, D. (ed.). 2005. Control of Communicable Diseases Manual18th Editon. American Public Health Association, Washington, DC.

Hepatitis E Virus Scoring Data

Scoring Summary[1, 2]	
Waterborne Disease Outbreak	**2**
Health Risk	
General population	**3**
Sensitive subpopulation(s) [P]	**7**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (1 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
3	Has caused documented WBDOs at any time in the U.S.?	No	
2	**Has caused WBDOs in countries other than the U.S.?**	**Yes** **Waterborne outbreaks have occurred in Asia and Africa.**	**Guthmann et al., 2006** **Panda et al., 2006**

Score[2]	Data Element	Scoring Data	Reference[3]
1	Has never caused WBDOs in any country, but has been epidemiologically associated with water related disease?	Yes California camping.	Tsang et al., 2000
	Occurrence		
3	Detected in drinking water in the U.S.?	No	
2	Detected in source water in the U.S.?	No	
1	**Not detected in the U.S.?**	**Yes** **India**	**Jothikumar et al., 2000**
	Health Risk		
7 [P]	**Does the organism cause significant mortality (> 1/1,000 cases)?**	**[P] May progress to fulminant disease in pregnant women when infection occurs during the third trimester. High mortality (for fetus) when infection occurs during pregnancy.** **The case-fatality rate is similar to that of hepatitis A except in pregnant women, where it may reach 20% among those infected during the third trimester of pregnancy.**	**Anderson in MCM, 2010; Isopet and Kamar in MCM 2019** **Heymann, 2005**
6 [E]	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other	[E] Fulminant hepatitis may develop. Disease severity shows a general increase with	Anderson in MCM, 2010

Score[2]	Data Element	Scoring Data	Reference[3]
	severe manifestations of illness necessitating long term hospitalization (> week)?	age.	
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?		
4	Does the illness require short term hospitalization (< week)?		
3 [G, C]	**Does the illness require physician intervention?**	**[G, C] Commonly begins with "flu-like" symptoms. May develop jaundice. Physician office visit is common for diagnosis and/or vaccination.**	**Anderson in MCM, 2010**
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?		
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Anderson, D., and N. Counahan. 2010. Hepatitis A and E Viruses. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry, and M.A. Pfaller (ed.) *Manual of Clinical Microbiology*, 10th Edition, Volume 2, p.1423. American Society for Microbiology Press, Washington, DC.

Centers for Disease Control and Prevention (CDC). 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Guthmann, J.P., H. Klovstad, D. Boccia, N. Hamid, L. Pinoges, J.Y. Nizou, M. Tatay, F. Diaz, A. Moren, R.F. Grais, I. Ciglenecki. 2006. A large outbreak of hepatitis E among a displaced population in Darfur, Sudan, 2004: the role of water treatment methods. Clinical Infectious Diseases. 42: 1685-1691.

Heymann, D. (ed.). 2005. Control of Communicable Diseases Manual, 18th Edition. American Public Health Association, Washington, DC.

Isopet, J. and N. Kamar. 2019. Hepatitis A and E Viruses. In Carroll, K.C., M.A. Pfaller, M.L. Landry, A.J. McAdam, R. Patel, S.S. Richter, and D.W. Warnock, *Manual of Clinical Microbiology,* 12th Edition, American Society of Microbiology Press, Washingon, DC.

Jothikumar N., R. Paulmurugan, P. Padmanabhan, R.B. Sundari, S. Kamatchiammal, and K.S. Rao. 2000. Duplex RT-PCR for simultaneous detection of hepatitis A and hepatitis E virus isolated from drinking water samples. Journal of Environmental Monitoring. 2(6): 587-90.

Panda, S.K., D. Thakral, and S. Rehman. 2007. Hepatitis E virus. Reviews in Medical Virology. 17(3): 151-180.

Tsang, T.H., E.K. Denison, H.V. Williams, L.V. Venczel, M.M. Ginsberg, and D.J. Vugia. Acute Hepatitis E Infection Acquired in California. Clinical Infectious Diseases. 30: 618–9.

Isospora belli Scoring Data

Scoring Summary[1, 2]	
Waterborne Disease Outbreak	**2**
Health Risk	
General population	**1**
Sensitive subpopulation(s) [C]	**2**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (1 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
3	Has caused documented WBDOs at any time in the U.S.?	No	
2	**Has caused WBDOs in countries other than the U.S.?**	**Yes**	**Karanis, 2006**
1	Has never caused WBDOs in any country, but has	Yes	

Score[2]	Data Element	Scoring Data	Reference[3]
	been epidemiologically associated with water related disease?		
	Occurrence		
3	Detected in drinking water in the U.S.?	No	
2	Detected in source water in the U.S.?	No	
1	Not detected in the U.S.?	No	
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?		
6	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?		
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?		
4	Does the illness require short term hospitalization (< week)?		
3	Does the illness require physician intervention?	Can cause serious and sometimes fatal disease in immunocompetent humans, more severe in	Lindsay in MCM, 2010

Score[2]	Data Element	Scoring Data	Reference[3]
		immunocompromised patients.	
2 [C]	**Is the illness self-limiting within 72 hours (without requiring medical intervention)?**	**[C] Symptoms are more severe in infants and children.**	**Lindsay in MCM, 2010**
1 [G]	**Does the illness result in mild symptoms with minimal or no impact on daily activities?**	**[G] Symptoms include diarrhea, steatorrhea, headache, fever, malaise, abdominal pain, vomiting, dehydration, and weight loss.**	**Lindsay in MCM, 2010**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Centers for Disease Control and Prevention (CDC). 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Karanis P. 2006. A review of an emerging waterborne medical important parasitic protozoan. Japanese Journal of Protozoology. 39(1): 5-19.

Lindsay, D., S. Upton, and L. Weiss. 2010. *Isospora*, *Cyclospora* and *Sarcocystis*. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.A. Pfaller, and R.H. Yolken (ed.) *Manual of Clinical Microbiology*, 10th Edition, Volume 2, p. 2172. American Society for Microbiology Press, Washington, DC.

Legionella pneumophila Scoring Data

Scoring Summary[1,2]	
Waterborne Disease Outbreak	**5**
Health Risk	
General population	**4**
Sensitive subpopulation(s) [E, CD]	**6**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (1 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	**Yes** **9 Community (2009)** **12 Community (2010)** **11 Community (2011)** **12 Community (2012)** **6 Community (2013)** **17 Community (2014)** **13 Community (2015)**	**CDC-NORS, 2020**

Score[2]	Data Element	Scoring Data	Reference[3]
		24 Community (2016) **21 Community (2017)**	
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017		
3	Has caused documented WBDOs at any time in the U.S.?	**1971-2008: 30 Community** **25 Noncommunity**	**CDC-NORS, 2020**
2	Has caused WBDOs in countries other than the U.S.?		
1	Has never caused WBDOs in any country, but has been epidemiologically associated with water related disease?		
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes**	**AWWARF, 2004** **Lin et al., 1998** **Maier et al., 2000**
2	Detected in source water in the U.S.?	Yes	Maier et al., 2000
1	Not detected in the U.S.?		

Score[2]	Data Element	Scoring Data	Reference[3]
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?	Avg. 12% fatality rate; death rates of 15% (general pop.) up to 75% (immunocompromised) if untreated. Avg. 25% death rate (between 20-40% during an outbreak. 10 – 15% death rate. Fatality rate has been as high as 39% in hospitalized cases; it is generally higher in those with compromised immunity.	Edelstein in Murray, 2007 AWWARF, 2004 CDC, 2005 Heymann, 2005
6 [E, CD]	**Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?**	**[E, CD] Acute pneumonia may progress to respiratory collapse and death if diagnosis and effective antibiotic therapy are delayed. The elderly and individuals with chronic diseases are at higher risk.**	**Edelstein in MCM, 2007; MCM, 2019** **CDC, 2005**
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?	No	
4 [G, C, P]	**Does the illness require short term hospitalization (< week)?**	**[G, C, P] Hospitalization is required for treatment of acute pneumonia.**	**Edelstein in MCM, 2007**

Score[2]	Data Element	Scoring Data	Reference[3]
3	Does the illness require physician intervention?		
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?	Pontiac fever resolves without treatment and has flu-like symptoms.	Edelstein in MCM, 2007 Heymann, 2005
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Centers for Disease Control and Prevention (CDC). 2005. Legionellosis: Legionnaires' Disease (LD) and Pontiac Fever. Disease Listing. October 12, 2005. http://www.cdc.gov/ncidod/dbmd/diseaseinfo/legionellosis_t.htm

CDC. 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Edelstein, P. 2007. *Legionella*. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry, and M.A. Pfaller (ed.) *Manual of Clinical Microbiology*, 9th Edition, Volume 1, p. 837. American Society for Microbiology Press, Washington, DC.

Edelstein, P. 2019. *Legionella*. In Carroll, K.C., M.A. Pfaller, M.L. Landry, A.J. McAdam, R. Patel, S.S. Richter, and D.W. Warnock (ed.) *Manual of Clinical Microbiology*, 12th Edition. American Society for Microbiology Press, Washington, DC.

Heymann, D.(ed.). 2005. *Control of Communicable Diseases Manual*, 18th Edition. American Public Health Association, Washington, DC.

Lin, Y.S., J.E. Stout, V.L. Yu, and R.D. Vidic. 1998. Disinfection of water distribution systems for *Legionella*. Seminars in Respiratory lnfections. 13: 147-159.

Maier, R.M., I.L. Pepper, and C.P. Gerba (eds.) 2000. *Environmental Microbiology*, pp. 454-455, 539. Academic Press.

Riffard, S., S. Springthorpe, L. Filion, and S. Sattar. 2002. Occurrence of *Legionella* in Groundwater. AWWA Research Foundation Reports, American Water Works Association, Dever, CO.

Microsporidia Scoring Data

Scoring Summary[1, 2]	
Occurrence	**2**
Health Risk	
General population	**2**
Sensitive subpopulation(s) [CD, C, P, E]	**2**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (1 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
3	Has caused documented WBDOs at any time in the U.S.?	No	
2	Has caused WBDOs in countries other than the U.S.?	No	
1	**Has never caused WBDOs in any country,**	**Yes**	**Cotte et al., 1999**

Score[2]	Data Element	Scoring Data	Reference[3]
	but has been epidemiologically associated with water related disease?		**Enriquez et al., 1998** **Hutin et al., 1998**
	Occurrence		
3	Detected in drinking water in the U.S.?	No	
2	**Detected in source water in the U.S.?**	**Yes**	**Didier et al., 2004** **Dowd et al., 1998**
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?		
6	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?		
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?		
4	Does the illness require short term hospitalization (< week)?		

Score[2]	Data Element	Scoring Data	Reference[3]
3	Does the illness require physician intervention?	Antimicrobial therapy available for immunodeficient patients.	Weber in MCM, 2010
2 [G, C, P, E, CD]	**Is the illness self-limiting within 72 hours (without requiring medical intervention)?**	**[All populations] Diarrhea and weight loss lasting in up to 2 – 3 weeks in immunocompetent hosts. Has been identified among elderly persons with acute or chronic diarrhea.**	**Weber in MCM, 2010**
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Centers for Disease Control and Prevention (CDC). 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Cotte, L., M. Rabondonira, F. Chapuis, F. Bailly, F. Bissuel, and C. Raynal. 1999. Waterborne outbreak of intestinal microsporidiosis in persons with and without human immunodeficiency virus infection. Journal of Infectious Diseases. 180: 2003-2008.

Didier, E.S., M.E. Stovall, L.C. Green, P.J. Brindley, K. Sestak, and P.J. Didier. 2004. Veterinary parasitology,.126: 145-166.

Dowd, S.E., C.P. Gerba, and I.L. Pepper. 1998. Confirmation of the human-pathogenic microsporidia *Enterocytozoon bieneusi, Encephalitozoon intestinalis*, and *Vittaforma corneae* in water. Applied and Environmental Microbiology. 64(9): 3332-3335.

Enriquez, F.J., D. Taren, A. Cruz-Lopez, M. Muramoto, J.D. Palting, and P. Cruz. 1998. Prevalence of intestinal encephalitozoonosis in Mexico. Clinical Infectious Diseases. 26: 1227-1229.

Hutin, Y.J.F., M.N. Sombardier, O. Ligoury, C. Sarfati, F. Derouin, J. Modai, and J.M. Molina. 1998. Risk factors for intestinal micorspooridiosis in patients with human immunodeficiency virus infection: a case control study. Journal of Infectious Diseases. 178: 904-907.

Weber R., A. Mathis, and P. Deplazes. 2010. Microsporidia. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.A. Pfaller, and R.H. Yolken (ed.) *Manual of Clinical Microbiology*, 10th Edition, Volume 2, p. 2190. American Society for Microbiology Press, Washington, DC.

Mycobacterium abscessus Scoring Data

Scoring Summary[1,2]	
Waterborne Disease Outbreak	**4**
Health Risk	
General population	**4**
Sensitive subpopulation(s) [CD]	**5**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (2 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017		CDC-NORS, 2020
4	**Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017**	**2014: 1 Hospital**	**CDC-NORS, 2020**
3	Has caused documented WBDOs at any time in the U.S.?		
2	Has caused WBDOs in countries other than the U.S.?		
1	Has never caused WBDOs in any country, but has been epidemiologically associated		

Score[2]	Data Element	Scoring Data	Reference[3]
	with water related disease?		
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes. Idaho public health officials and pediatric infectious disease physicians investigated a US documented outbreak of *Mycobacterium abscessus* skin infections in children whose only common exposure was an indoor wading pool (Carter et al., 2019). Another outbreak occurred in the Duke University Hospital linked to the hospital tap water (Baker et al., 2017).**	**Baker et al., 2017** **Carter et al., 2019**
2	Detected in source water in the U.S.?		
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?		
6	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (>	.	

Score[2]	Data Element	Scoring Data	Reference[3]
	week)?		
5 [CD]	**Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?**	**[CD] *M. abscessus* complex can cause pulmonary disease, especially in vulnerable hosts with underlying structural lung disease, such as cystic fibrosis, bronchiectasis, and prior tuberculosis.**	**Griffith, 2007**
4 [G]	**Does the illness require short term hospitalization (< week)?**	**Yes. Prolonged intravenous (IV) therapy and side effects are often necessary to treat *Mycobacterium abscessus* infections.**	**Novosad, 2016**
3	Does the illness require physician intervention?		
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?		
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Baker, A.W., S.S. Lewis, B.D. Alexander, L.F. Chen, R.J. Wallace Jr., B.A. Brown-Elliott, and J.M. Reynolds. 2017. Two-phase hospital-associated outbreak of *Mycobacterium abscessus*: investigation and mitigation. Clinical Infectious Diseases. 64(7): 902-911.

Carter, K.K., I. Lundgren, S. Correll, T. Schmalz, T. McCarter, J. Stroud, and C.G. Hahn. 2018. First United States outbreak of *Mycobacterium abscessus* hand and foot disease among children associated with a wading pool. Journal of the Pediatric Infectious Diseases Society. 8(4): 291-296.

Centers for Disease Control and Prevention (CDC). 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Griffith, D.E., T. Aksamit, B.A. Brown-Elliott, A. Catanzaro, C. Daley, F. Gordin, and M. Iseman. 2007. An official ATS/IDSA statement: diagnosis, treatment, and prevention of nontuberculous mycobacterial diseases. American journal of respiratory and critical care medicine. 175(4): 367-416.

Novosad, S.A., S.E. Beekmann, P.M. Polgreen, K. Mackey, and K.L. Winthrop. 2016. Treatment of *Mycobacterium abscessus* infection. Emerging Infectious Diseases. 22(3): 511.

Mycobacterium avium Scoring Data

Scoring Summary[1,2]	
Waterborne Disease Outbreak	**4**
Health Risk	
General population	**3**
Sensitive subpopulation(s) [E]	**5**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (2 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	**Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017**	**Yes** **2016: 1 Community (*Mycobacterium* "other")**	**CDC-NORS, 2020**
3	Has caused documented WBDOs at any time in the U.S.?	Yes Not listed in CDC's NORS however, data linking patient, outbreak and drinking water.	Tobin-D'Angelo et al., 2004
2	Has caused WBDOs in	No	

Score[2]	Data Element	Scoring Data	Reference[3]
	countries other than the U.S.?		
1	Has never caused WBDOs in any country, but has been epidemiologically associated with water related disease?	Yes	Glover et al., 1994 Aronson et al., 1999 von Reyn et al., 1994
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes**	**Glover et al., 1994** **Covert et al., 1999** **Falkinham et al., 2001**
2	Detected in source water in the U.S.?	Yes	Covert et al., 1999 Falkinham et al., 2004
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?		
6	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?	Disseminated MAC infections are a major problem in HIV-Infected individuals.	Heymann, 2005
5 [E]	**Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?**	**[E] Most commonly immunocompetent patients develop a slowly evolving cavitary disease that resembles**	**Murray et al., 2005** **Carroll et al., 2019**

Score[2]	Data Element	Scoring Data	Reference[3]
		tuberculosis. Elderly non-smoking females, can develop "Lady Windermere's syndrome" which has been associated with significant morbidity and mortality.	
4 [CD]	Does the illness require short term hospitalization (< week)?	[CD] Tuberculosis-like upper lobe fibrocavitary disease occurs typically in men 45 – 60 who have preexisiting lung disease.	Pfyffer in MCM, 2007
3 [G]	**Does the illness require physician intervention?**	**[G] Symptoms of infection include pulmonary disease, lymphadenitis, post-traumatic wound infection. Diagnosis of disease and treatment requires physician intervention.**	**Pfyffer in MCM, 2007** **Heymann, 2005**
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?		
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Aronson, T., A. Holtzman, N. Glover, M. Boian, S. Froman, O.G.W. Berlin, H. Hill, and G. Stelma Jr. 1999. Comparison of large restriction fragments of *Mycobacterium avium* isolates recovered from AIDS and non-AIDS patients with those of isolates from potable water. Journal of Clinical Microbiology. 37: 1008-1012.

Carroll, K.C., M.A. Pfaller, M.L. Landry, A.J. McAdam, R. Patel, S.S. Richter, and D.W. Warnock (ed). 2019. Manual of Clinical Microbiology, 12th Edition. American Society of Microbiology Press, Washington, DC.

Centers for Disease Control and Prevention (CDC). 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Covert, T.C., M.R. Rodgers, A.L., Reyes, and G.N. Stelma Jr. 1999. Occurrence of nontuberculous mycobacteria in environmental samples. Applied and environmental microbiology. 65(6): 2492-2496.

Falkinham III, J.O., C.D. Norton, and M.W. LeChevallier. 2001. Factors influencing numbers of *Mycobacterium avium, Mycobacterium intracellulare*, and other mycobacteria in drinking water distribution systems. Applied and Environmental Microbiology. 67: 1225-1231.

Falkinham III, J.O., G. Nichols, J. Bartram, A. Dufour, and F. Portaels. 2004. Natural ecology and survival in water of mycobacteria of potential public health importance. In Pedley, S., J. Bartram, G. Rees, A. Dufour, and J.A. Cotruvo (eds.) Pathogenic mycobacteria in water: a guide to public health consequences, monitoring and management. IWA Publishing, London, UK.

Glover, N., A. Holtzman, T. Aronson, S. Froman, O.G.W. Berlin, P. Dominguez, K.A. Kunkel, G. Overturf, G. Stelma, Jr., C. Smith, and M. Yakrus. 1994. The isolation and identification of *Mycobacterium avium* complex (MAC) recovered from Los Angeles potable water, a possible source of infection in AIDS patients. International Journal of Environmental Health Research. 4: 63-72.

Heymann, D. (ed.). 2005. *Control of Communicable Diseases Manual*, 18th Edition. American Public Health Association, Washington, DC.

Murray, P.R., K.S. Rosenthal, and M.A. Pfaller. 2005. *Medical Microbiology*, 5th Edition. Elsevier Inc., Mosby, New York.

Pfyffer, G. 2007. *Mycobacterium*: General Characterisitis, Laboratory Detection, and Staining Procedures. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry, and M.A. Pfaller (ed.) *Manual of Clinical Microbiology*, 9th Edition, Volume 1, pp. 547-548. American Society for Microbiology Press, Washington, DC.

Tobin-D'Angelo, M.J., M. A. Blass, C. del Rio, J.S. Halvosa, H.M. Blumberg, and C.R. Horsburg, Jr., 2004. Hospital water as a source of *Mycobacterium avium* complex isolates in respiratory specimens. Journal of Infectious Diseases. 189: 98-104.

von Reyn, C.F., J.N. Maslow, T.W. Barber, J.O. Falkinham III, and R.D. Arbeit. 1994. Persistent colonization of potable water as a source of *Mycobacterium avium* infection in AIDS. Lancet. 343: 1137-1141.

Naegleria fowleri Scoring Data

Scoring Summary[1,2]	
Waterborne Disease Outbreak	5
Health Risk	
General population	**7**
Sensitive subpopulation(s) [C, P, E, CD]	**7**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	**Has caused multiple (2 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017**	**Yes, 1 Community (note an outbreak is only one case for *Naegleria*)**	**CDC, 2017**
4	Has caused at least one documented WBDOs in the U.S. as reported by CDC surveillance between 1990 and 2014?		
3	Has caused documented WBDOs at any time in the U.S.?	1971-2008: 1 Community	CDC-NORS, 2020
2	Has caused WBDOs in countries other than the U.S.?		
1	Has never caused WBDOs in		

Score[2]	Data Element	Scoring Data	Reference[3]
	any country, but has been epidemiologically associated with water related disease?		
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes** **Arizona storage -** **Sampled pre-treatment multiple-well study in Arizona.** **Louisiana**	**Gerba et al., 2007** **Marciano-Cabral et al., 2003** **LA, 2013**
2	Detected in source water in the U.S.?	Yes	Schuster and Visvesvara, 2004
1	Not detected in the U.S.?		
	Health Risk		
7 [G, C, P, E, CD]	**Does the organism cause significant mortality (> 1/1,000 cases)?**	**[All populations] Recovery from primary amoebic meningoencephalitis is rare.**	**Heymann, 2005** **Cope and Ali, 2016.**
6	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?	Acute fulminating disease. Only a few patients have survived.	Visvesvara in MCM, 2010 Cope et al, in MCM, 2019
5	Does the illness result in	No	

Score[2]	Data Element	Scoring Data	Reference[3]
	long term or permanent dysfunction or disability, i.e. sequelae?		
4	Does the illness require short term hospitalization (< week)?	All cases are hospitalized for diagnosis and treatment.	Visvesvara in MCM, 2010
3	Does the illness require physician intervention?		
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?		
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Centers for Disease Control and Prevention (CDC). 2017. *Naegleria fowleri* in Louisiana Public Water Systems. Available online at: https://www.cdc.gov/parasites/naegleria/public-water-systems-louisiana.html.

Centers for Disease Control and Prevention (CDC). 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Cope, J.R. and I.K. Ali. 2016. Primary Amebic Meningoencephalitis: What Have We Learned in the Last 5 Years?. Current Infectious Disease Reports. 18(10): 31. https://doi.org/10.1007/s11908-016-0539-4

Cope J.R., I.K. Ali, and G. Visvesvara. 2019. Pathogenic and Opportunistic Free-Living Amebae. In Carroll, K.C., M.A. Pfaller, M.L. Landry, A.J. McAdam, R. Patel, S.S. Richter, and D. W. Warnock (ed). *Manual of Clinical Microbiology*,12th Edition. American Society of Microbiology Press, Washington, DC.

Gerba, C., B. Blair, P. Sarkar, and K. Bright. 2007. Occurrence and Control of *Naegleria fowleri* in Well Water and Chlorine Resistance. Proceedings, Water Quality Technology Conference, American Water Works Association, November 5-8, 2007.

Heymann, D. (ed.). 2005. *Control of Communicable Diseases Manual*, 18th Edition, pp. 417-419. American Public Health Association, Washington, DC.

Louisiana Department of Health, 2013. DHH Issues Emergency Rule Requiring Drinking Water Systems in Louisiana to Raise the Level of Disinfectant in their Water, Increase Monitoring by 25 Percent. Available online at: http://ldh.la.gov/index.cfm/newsroom/detail/2906

Marciano-Cabral, F., R. MacLean, A. Mensah, and L. LaPat-Polasko. 2003. Identification of *Naegleria fowleri* in domestic water source by nested PCR. Applied and Environmental Microbiology. 69(10): 5864-5869.

Schuster, F.L. and G.S. Visvesvara. 2004. Free-living amoebae as opportunistic and non-opportunistic pathogens of humans and animals. International Journal for Parasitology. 34: 1001-1027.

Visvesvara, G. 2007. Pathogenic and Opportunistic Free-Living Amebae. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.A. Pfaller, and R.H. Yolken (ed.) *Manual of Clinical Microbiology*, 10th Edition, Volume 2, p. 3129. American Society for Microbiology Press, Washington, DC.

Nontuberculous Mycobacteria (NTM) Scoring Data

Scoring Summary[1,2]	
Occurrence	**3**
Health Risk	
General population	**3**
Sensitive subpopulation(s) [E]	**5**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (2 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
3	Has caused documented WBDOs at any time in the U.S.?	No	
2	Has caused WBDOs in countries other than the U.S.?	No	
1	**Has never caused WBDOs in any country, but has been epidemiologically associated with water**	**Yes**	**Johnson and Odell, 1994**

Score[2]	Data Element	Scoring Data	Reference[3]
	related disease?		
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes**	**Falkinham et al., 2011**
2	Detected in source water in the U.S.?	Yes	Covert et al., 1999 Falkinham et al., 2004
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?		
6	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?	Disseminated MAC infections are a major problem in HIV-Infected individuals.	Heymann, 2005
5 [E]	**Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?**	**[E] Most commonly immunocompetent patients develop a slowly evolving pulmonary disease.**	**Murray et al., 2005**
4	Does the illness require short term hospitalization (< week)?		

Score[2]	Data Element	Scoring Data	Reference[3]
3 [G]	**Does the illness require physician intervention?**	**[G] Symptoms of infection include pulmonary disease; diagnosis of disease and treatment requires physician intervention.**	**Pfyffer in MCM, 2007**
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?		
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Centers for Disease Control and Prevention (CDC). 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Covert, T.C., M.R. Rodgers, A.L., Reyes, and G.N. Stelma Jr. 1999. Occurrence of nontuberculous mycobacteria in environmental samples. Applied and environmental microbiology. 65(6): 2492-2496.

Falkinham III, J.O. 2011. Nontuberculous mycobacteria from household plumbing of patients with nontuberculous mycobacteria disease. Emerging Infectious Diseases. 17: 419–424

Hernández-Garduño, E. and K. Elwood. 2012. Nontuberculous mycobacteria in tap water. Emerging Infectious Disease. 18(2): 353.

Heymann, D. (ed.). 2005. *Control of Communicable Diseases Manual*, 18th Edition, pp. 417-419. American Public Health Association, Washington, DC.

Johnson, M.M. and J.A. Odell. 2014. Nontuberculous mycobacterial pulmonary infections. Journal of Thoracic Disease. 6(3): 210–220.

Murray, P.R., K.S. Rosenthal, and M.A. Pfaller. 2005. *Medical Microbiology*, 5th Edition, p.304. Elsevier Mosby

Pfyffer, G. 2007. *Mycobacterium*: General Characterisitis, Laboratory Detection, and Staining Procedures. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry, and M.A. Pfaller (ed.) *Manual of Clinical Microbiology*, 9th Edition, Volume 1, pp. 547- 548. American Society for Microbiology Press, Washington, DC.

Pantoea agglomerans Scoring Data

Scoring Summary[1,2]	
Waterborne Disease Outbreak	**4**
Health Risk	
General population	**1**
Sensitive subpopulation(s) [C, CD]	**6**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (2 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	**Yes.** **2012: 1 Community Outbreak of *Pantoea agglomerans* bloodstream infection occurred in a health care facility linked to the drinking water system.**	**CDC-NORS, 2020**
3	Has caused documented WBDOs at any time in the U.S.?		

Score[2]	Data Element	Scoring Data	Reference[3]
2	Has caused WBDOs in countries other than the U.S.?		
1	Has never caused WBDOs in any country, but has been epidemiologically associated with water related disease?		
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes. Outbreak of *Pantoea agglomerans* bloodstream infection occurred in a health care facility linked to the drinking water system.**	**Yablon et al., 2017**
2	Detected in source water in the U.S.?		
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?		
6 [C, CD]	**Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?**	**[C, CD] Yes. There are documented cases of long-term hospitalization and death in children with pneumonia (Büyükcam, 2018).** **It can also cause infections in cuts and in immunocompromised individuals in health**	**Büyükcam, 2018** **Dutkiewicz et al., 2016** **Forsythe et al. in MCM, 2019**

Score[2]	Data Element	Scoring Data	Reference[3]
		care settings. **Septic arthritis or synovitis appears as a common clinical outcome of exogenous infection with *P. agglomerans*, others include endophthalmitis, periostitis, endocarditis and osteomyelitis (Dutkiewicz et al., 2016).**	
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?		
4	Does the illness require short term hospitalization (< week)?		
3	Does the illness require physician intervention?		
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?		
1 [G]	**Does the illness result in mild symptoms with minimal or no impact on daily activities?**	***Pantoea agglomerans* is not generally an infectious agent in healthy humans (Dutkiewicz, et al. 2016).**	**Dutkiewicz et al., 2016**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Büyükcam, A., Ö. Tuncer, D. Gür, B. Sancak, M .Ceyhan, A.B. Cengiz, and A. Kara. 2018. Clinical and microbiological characteristics of *Pantoea agglomerans* infection in children. Journal of Infection and Public Health. 11(3): 304-309.

Dutkiewicz, J., B. Mackiewicz, M.K. Lemieszek, M. Golecand, and J. Milanowski. 2016. *Pantoea agglomerans*: a mysterious bacterium of evil and good. Part III. Deleterious effects: infections of humans, animals, and plants. Annals of Agricultural and Environmental Medicine. 23(2).

Centers for Disease Control and Prevention (CDC). 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Forsythe, S., J. Pitout, A. Charnot-Katsidkas, K. Alby, and K. Frank. 2019. *Klebsiella* and Selected *Enterobacterales*. In Carroll, K.C., M.A. Pfaller, M.L. Landry, A.J. McAdam, R. Patel, S.S. Richter, and D.W. Warnock (ed). *Manual of Clinical Microbiology*, 12th Edition. American Society of Microbiology Press, Washington, DC.

Yablon, B.R., R. Dantes, V. Tsai, R. Lim, H. Moulton-Meissner, M. Arduino, B. Jensen, M.T. Patel, M.O. Vernon, Y. Grant-Greene, and D. Christiansen. 2017. Outbreak of *Pantoea agglomerans* Bloodstream Infections at an Oncology Clinic—Illinois, 2012-2013. Infection Control & Hospital Epidemiology. 38(3): 314-319.

Plesiomonas shigelloides Scoring Data

Scoring Summary[1,2]	
Waterborne Disease Outbreak	**3**
Health Risk	
General population	**2**
Sensitive subpopulation(s) [C, E]	**3**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (1 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
3	**Has caused documented WBDOs at any time in the U.S.?**	**1971-2008: 2 Noncommunity**	**CDC-NORS, 2020**
2	Has caused WBDOs in countries other than the U.S.?		
1	Has never caused WBDOs in any country,		

Score[2]	Data Element	Scoring Data	Reference[3]
	but has been epidemiologically associated with water related disease?		
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes**	**CDC, 1998**
2	Detected in source water in the U.S.?	Yes	Abbott in MCM, 2010 Holmberg and Farmer, 1984 Holmberg et al., 1986
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?	No	
6	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?	No	
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?	No	

Score[2]	Data Element	Scoring Data	Reference[3]
4	Does the illness require short term hospitalization (< week)?	Hospitalization may be required for severe infections and/or underlying diseases.	Abbott in MCM, 2010
3 [C, E]	**Does the illness require physician intervention?**	**[C, E] Physician office visit may be required for diagnosis and treatment of dysenteric form of the disease in children or the elderly. Bacteremia more common with advanced age.**	**Abbott in MCM, 2010**
2 [G]	**Is the illness self-limiting within 72 hours (without requiring medical intervention)?**	**[G] Diarrhea may persist up to two weeks.**	**Abbott in MCM, 2010; Forsythe in MCM, 2019**
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?	*Plesiomonas* is associated with travelers' diarrhea or a history of seafood consumption, most infections are self-limiting.	Abbott in MCM, 2010

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Abbott, S.L. 2007. *Klebsiella, Enterobacter, Citrobacter, Serratia, Plesiomonas*, and other *Enterobacteriaceae*. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.A. Pfaller, and R.H. Yolken (ed.) *Manual of Clinical Microbiology*, 10th Edition, Volume 1, p. 639. American Society for Microbiology Press, Washington, DC.

Centers for Disease Control and Prevention (CDC). 1998. *Plesiomonas shigelloides* and *Salmonella* serotype Hartford infections associated with a contaminated water supply – Livingston County, New York, 1996. MMWR. 47(19): 394-396.

CDC, 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Forsythe, S., J. Pitout, A. Charnot-Katsidkas, K. Alby, and K. Frank. 2019. *Klebsiella* and Selected *Enterobacterales*. In Carroll, K.C., M.A. Pfaller, M.L. Landry, A.J. McAdam, R. Patel, S.S. Richter, and D.W. Warnock (ed). *Manual of Clinical Microbiology*, 12th Edition. American Society of Microbiology Press, Washington, DC.

Holmberg, S.D. and J.J. Farmer. 1984. *Aeromonas hydrophila* and *Plesiomonas shigelloides* as causes of intestinal infections. Reviews of Infectious Diseases. 6(5):633-639.

Holmberg, S.D., K. Wachsmith, F.W. Hickman-Brenner, P.A. Blake, and J.J. Farmer. 1986. *Plesiomonas* enteric infections in the United States. Annals of Internal Medicine. 105(5): 690-694.

Pseudomonas aeruginosa Scoring Data

Scoring Summary[1,2]	
Waterborne Disease Outbreak	**5**
Health Risk	
General population	**3**
Sensitive subpopulation(s) [C, CD]	**6**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	**Has caused multiple (2 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017**	**Yes** **2013: 1 Community** **2016: 1 Community**	**CDC-NORS, 2020**
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
3	Has caused documented WBDOs at any time in the U.S.?	Yes; tap water in NICU	Kinsey et al., 2017
2	Has caused WBDOs in countries other than the U.S.?	NA	
1	Has never caused WBDOs in	NA	

Score[2]	Data Element	Scoring Data	Reference[3]
	any country, but has been epidemiologically associated with water related disease?		
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes**	**Kinsey et al., 2017**
2	Detected in source water in the U.S.?		
1	Not detected in the U.S.?		
	Health Risk		
7 [C]	Does the organism cause significant mortality (> 1/1,000 cases)?	Nosocomial pneumonia.	Henry and Speert in MCM, 2010
6 [C, CD]	**Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?**	**Septicemia and meningitis occur rarely in immunocompetent hosts but can occur in neonates and cystic fibrosis patients.**	**Henry and Speert in MCM, 2010** **CDC, 2019** **Hoiby et al. in MCM, 2019**
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?		
4	Does the illness require short term hospitalization (< week)?		
3 [G]	**Does the illness require physician intervention?**	**Antibiotics**	**Henry and Speert in MCM, 2010**

Score[2]	Data Element	Scoring Data	Reference[3]
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?		
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Centers for Disease Control and Prevention (CDC). 2019. *Pseudomonas aeruginosa*. Available online at: https://www.cdc.gov/hai/organisms/pseudomonas.html.

CDC. 2020. National Outbreak Reporting System (NORS). Available online at https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Henry, D. and D. Speert. 2010. *Pseudomonas*. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.A. Pfaller, and R.H. Yolken (ed.) *Manual of Clinical Microbiology*, 8th Edition, p. 666. American Society for Microbiology Press, Washington, DC.

Hoiby, N., O. Ciofu, and T. Bjarnsholt. 2019. *Pseudomonas*. In Carroll, K.C., M.A. Pfaller, M.L. Landry, A.J. McAdam, R. Patel, S.S. Richter, and D.W. Warnock (ed). 2019. *Manual of Clinical Microbiology*, 12th Edition. American Society of Microbiology Press, Washington, DC.

Kinsey, C.B., S. Koirala, B. Solomon, J. Rosenberg, B.F Robinson, A. Neri, A.L. Halpin, M.J. Arduino, H. Moulton-Meissner, J. Noble-Wang, and N. Chea. 2017. *Pseudomonas aeruginosa* outbreak in NICU linked to contaminated tap water. Infection Control & Hospital Epidemiology. 38(7): 801-808.

Rotavirus Scoring Data

Scoring Summary[1,2]	
Occurrence	**3**
Health Risk	
General population	**1**
Sensitive subpopulation(s) [C]	**6**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (1 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
3	**Has caused documented WBDOs at any time in the U.S.?**	**Yes** **1971-2008: 1 Community**	**CDC-NORS, 2020**
2	Has caused WBDOs in countries other than the U.S.?	Yes China and Sweden.	Hardy, 1987 Gerba et al., 1996
1	Has never caused WBDOs in any		

Score[2]	Data Element	Scoring Data	Reference[3]
	country, but has been epidemiologically associated with water related disease?		
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes**	**Banks, 2001** **Gerba et al., 1996**
2	Detected in source water in the U.S.?	Yes	Abbaszadegan et al., 2003 Gerba et al., 1996
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?	No For children under 5 years of age: Estimated 37 deaths in 60,000 hospitalized cases per year in U.S. (1/1621 hospitalizations).	Fischer et al., 2007
6 [C]	**Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?**	**[C] Rotavirus infects all children; causes severe gastroenteritis in infants. Significant numbers of physician visits and hospitalizations and high medical and societal costs.** **A sporadic, seasonal, often severe gastroenteritis of infants and young children,**	**Pang in MCM, 2010; MCM, 2019** **CDC, 2019**

Score[2]	Data Element	Scoring Data	Reference[3]
		characterized by vomiting, fever and watery diarrhea. **Rotaviral enteritis is occasionally associated with severe dehydration and death in young children. In developing countries, an estimated 600,000-870,000 diarrheal deaths each year.**	**Heymann, 2005**
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?		
4	Does the illness require short term hospitalization (< week)?		
3	Does the illness require physician intervention?		
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?		
1 [G, P, E, CD]	**Does the illness result in mild symptoms with minimal or no impact on daily activities?**	**[G, E, P, CD]** **Self-limiting acute watery diarrhea, vomiting, fever.**	**Heymann, 2005**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Abbaszadegan, M., M. LeChevallier, and C.P. Gerba. 2003. Occurrence of viruses in U. S. groundwaters. Journal of American Water Works Association. 95(9): 107-120.

Centers for Disease Control and Prevention (CDC). 2019. Rotavirus home page. Available online at: https://www.cdc.gov/rotavirus/index.html.

CDC. 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Fischer, T.K., C. Viboud, U. Parashar, M. Malek, C. Steiner, R. Glass, and L. Simonsen. 2007. Hospitalizations and deaths from diarrhea and rotavirus among children < 5 years of age in the United States, 1993-2003. Journal of Infectious Diseases. 195: 1117.

Gerba, C.P., J.B. Rose, C.N. Haas, and K.D. Crabtree. 1996. Waterborne rotavirus: a risk assessment. Water Research. 30: 2929.

Heymann, D. (ed.). 2005. *Control of Communicable Diseases Manual*, 18th Edition, pp. 417-419. American Public Health Association, Washington, DC.

Pang, X. and X. Jiang. 2010. Gastroenteritis Viruses. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.A. Pfaller, and R.H. Yolken (ed.) *Manual of Clinical Microbiology*, 10th Edition, Volume 2, pp. 1454-1457. American Society for Microbiology Press, Washington, DC.

Pang, X. and M. Smieja. 2019. Gastroenteritis Viruses. In Carroll, K.C., M.A. Pfaller, M.L Landry, A.J. McAdam, R. Patel, S.S. Richter, and D.W. Warnock (ed) *Manual of Clinical Microbiology,* 12th Edition. American Society of Microbiology Press, Washington, DC.

Banks, W.S, C.A. Klohe, and D.A. Battigelli. 2001. Occurrence and Distribution of Enteric Viruses in Shallow Ground Water and Factors Affecting Well Vulnerability to Microbiological Contamination in Worcester and Wicomico Counties, Maryland. Water Resources Investigations Report. 01-4147: 14, 21.

Salmonella enterica Scoring Data

Scoring Summary[1,2]	
Waterborne Disease Outbreak	**3**
Health Risk	
General population	**3**
Sensitive subpopulation(s) [C, E]	**4**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (2 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	No	
3	**Has caused documented WBDOs at any time in the U.S.?**	**Yes** **1971-2008: 13 Community** **7 Noncommunity**	**CDC-NORS, 2020 (some are "Salmonella unknown")**
2	Has caused WBDOs in countries other than the U.S.?		
1	Has never caused WBDOs		

Score[2]	Data Element	Scoring Data	Reference[3]
	in any country, but has been epidemiologically associated with water related disease?		
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes**	**Angulo et al., 1997** **CDC, 1998**
2	Detected in source water in the U.S.?		
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?	Each year, 1.4 M cases of illness and 600 deaths are caused by non-typhoidal salmonellosis in the U.S. Estimated 800 cases per year of typhoid fever in the U.S., with fewer than 5 deaths/yr.; >70% of U.S. cases related to foreign travel.	Nataro et al. in MCM, 2007 Buchan in MCM, 2019
6	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?	Nontyphoidal salmonellosis usually causes intestinal infection; can cause extraintestinal infections in rare cases (bacteremia, urinary tract infection, osteomyelitis), especially in immunocompromised	Nataro et al. in MCM, 2007

Score[2]	Data Element	Scoring Data	Reference[3]
		persons.	
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?	None reported.	
4 [C, E]	**Does the illness require short term hospitalization (< week)?**	**[C] Extra-intestinal infections highest in infants and young children.** **[E] Dehydration, especially among infants or in the elderly, may be severe. Deaths are uncommon, except in the young and old, the debilitated and immunosuppressed.**	**Nataro et al. in MCM, 2007** **Heymann, 2005** **CDC, 2019**
3 [G, P, CD]	**Does the illness require physician intervention?**	**[G, P, CD] Antibiotic and rehydration may be necessary.**	**Heymann, 2005**
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?	Non-typhoidal Salmonella usually cause intestinal infection that often lasts 1 week or longer.	Nataro et al. in MCM, 2007
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Angulo, F.J., S. Tippen, D. J. Sharp, B.J. Payne, C. Collier, J.E. Hill, T.J. Barrett, R.H. Clark, E.E. Geldreich, H.D. Donnell Jr., and D.L. Swerdlow. 1997. A community waterborne outbreak of salmonellosis and the effectiveness of a boil water order. American Journal of Public Health. 87(4): 580-584.

Buchan, B., M. Faron, R. Humphries, J. Dekker, and N. Ledeboer. 2019. *Escherichia*, *Shigella* and *Salmonella.* In Carroll, K.C., M.A. Pfaller, M.L., Landry, A.J. McAdam, R. Patel, S.S. Richter, and D.W. Warnock (ed). *Manual of Clinical Microbiology*, 12th Edition. American Society of Microbiology Press, Washington, DC.

Centers for Disease Control and Prevention (CDC). 1998. *Plesiomonas shigelloides* and *Salmonella* serotype Hartford infections associated with a contaminated water supply – Livingston County, New York, 1996. MMWR. 47(19): 394-396.

CDC, 2019. Salmonella home page. https://www.cdc.gov/salmonella/index.html

CDC, 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Heyman, D. (ed.). 2005. *Control of Communicable Diseases Manual*, 18th Edition. American Public Health Association, Washington, DC.

Nataro, J.P., C.A. Bopp, P.I. Fields, J.B. Kaper, and N.A. Strockbine. 2007. *Escherichia, Shigella*, and *Salmonella*. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry, and M.A. Pfaller (ed.) *Manual of Clinical Microbiology*, 9th Edition, Volume 1, pp. 680-687. American Society for Microbiology Press, Washington, DC.

Shigella sonnei Scoring Data

Scoring Summary[1,2]	
Waterborne Disease Outbreak	**4**
Health Risk	
General population	**3**
Sensitive subpopulation(s) [C, E]	**6**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (2 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	**Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017**	**Yes** **2015: 1 Community (suspected, not confirmed)**	**CDC-NORS, 2020**
3	Has caused documented WBDOs at any time in the U.S.?	1971-2008: 15 Community 23 Noncommunity (some unknown)	CDC-NORS, 2020
2	Has caused WBDOs in countries other than the U.S.?		
1	Has never caused WBDOs in any country, but has been epidemiologically associated		

Score[2]	Data Element	Scoring Data	Reference[3]
	with water related disease?		
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes**	**Craun, 2003**
2	Detected in source water in the U.S.?	Yes	Black et al., 1978
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?	In U.S. approximately 450,000 cases occur each year with 70 deaths.	Nataro et al. in MCM, 2007 Buchan in MCM, 2019
6 [C, E]	**Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?**	**[C, E] *S. dysentariae* is associated with more serious symptoms than other species with complications such as toxic megacolon, hemolytic uremic syndrome and intestinal perforation. Cases may be severe in infants and the elderly and convulsions may occur in young children.**	**Heymann, 2005**
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?	Reiter's syndrome.	Heymann, 2005

Score[2]	Data Element	Scoring Data	Reference[3]
4	Does the illness require short term hospitalization (< week)?	Hospitalization is usually required for intravenous antibiotic therapy due to bacteremia, which is uncommon.	Heymann, 2005
3 [G]	**Does the illness require physician intervention?**	**[G] Most cases occur in children under 10 years, infants under 6 months rarely infected, increased severity in children and elderly, high secondary case rate in outbreaks, outbreaks occur in daycare centers, institutions, refugee camps, among homosexual men, 20% of U.S. cases result from international travel, specific antibiotic therapy available for prolonged or severe cases, multi-antibiotic resistance occurs.**	**Heymann, 2005**
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?	Acute diarrhea, fever, nausea, vomiting, cramps and tenesmus, stools contain blood and mucus (dysentery), usually self-limiting in 4-7 days without treatment.	Heymann, 2005 CDC, 2019
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?	*S. sonnei* causes most of the shigellosis cases in the U.S., cases may be asymptomatic or mildly symptomatic, but they are frequently acute.	Heymann, 2005

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation.

These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Black, R.E., G.F. Craun, and P.A. Blake. 1978. Epidemiology of common-source outbreaks of shigellosis in the United States, 1961-1975. American Journal of Epidemiology. 108: 47-52.

Buchan, B., M. Faron, R. Humphries, J. Dekker, and N. Ledeboer. 2019. *Escherichia*, *Shigella* and *Salmonella.* In Carroll, K.C., M.A. Pfaller, M.L. Landry, A.J. McAdam, R. Patel, S.S. Richter, and D.W. Warnock (ed.). *Manual of Clinical Microbiology*, 12th Edition. American Society of Microbiology, Washington, DC.

Centers for Disease Control and Prevention (CDC). 2019. *Shigella* home page. Available online at: https://www.cdc.gov/shigella/index.html.

CDC. 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Craun, G., R. Calderon, and M. Craun. 2003. Waterborne Outbreaks in the United States, 1971-2000, pp. 45-60. In Pontius, F. (ed.) *Drinking Water Regulation and Health*. John Wiley & Sons.

Heymann, D. (ed.). 2005. *Control of communicable diseases manual*, 18th edition. American Public Health Association, Washington, DC.

Nataro, J., C. Bopp, P. Fields, J. Kaper, and N. Strockbine. 2007. *Escherichia, Shigella, and Salmonella*. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.A. Pfaller, and R.H. Yolken (ed.) *Manual of Clinical Microbiology*, 9th Edition, Volume 1, pp. 670, 677-678. American Society for Microbiology Press, Washington, DC.

Toxoplasma gondii Scoring Data

Scoring Summary[1]	
Waterborne Disease Outbreak	**2**
Health Risk	
General population	**2**
Sensitive subpopulation(s) [P]	**7**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (1 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
3	Has caused documented WBDOs at any time in the U.S.?	No	
2	**Has caused WBDOs in countries other than the U.S.?**	**Yes** **Canada and Brazil.**	**Bowie et al., 1997** **de Moura, 2006**
1	Has never caused		

Score[2]	Data Element	Scoring Data	Reference[3]
	WBDOs in any country, but has been epidemiologically associated with water related disease?		
	Occurrence		
3	Detected in drinking water in the U.S.?	No	
2	Detected in source water in the U.S.?	No	
1	**Not detected in the U.S.?**	**Yes** **Groundwater in Poland and Canada.**	**Sroka et al., 2006** **Isaac-Renton et al., 1998**
	Health Risk		
7 [P]	**Does the organism cause significant mortality (> 1/1,000 cases)?**	**[P] Congenital infection of neonates severe.** **Infection during early pregnancy may lead to fetal infection with death of the fetus or other severe manifestations. Later in pregnancy, maternal infection results in mild or subclinical fetal disease.**	**Wilson in MCM, 2007; McAuley and Singh in MCM, 2019** **Heymann, 2005**
6	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of	Immunocompromised hosts may experience CNS, pneumonitis, and myocarditis.	Wilson in MCM, 2007

Score[2]	Data Element	Scoring Data	Reference[3]
	illness necessitating long term hospitalization (> week)?		
5	Does the illness result in long term or permanent dysfunction or disability, i.e. sequelae?		
4	Does the illness require short term hospitalization (< week)?		
3	Does the illness require physician intervention?	Treatment is indicated only for pregnant women, infants and immunocompromised hosts.	Wilson in MCM, 2007
2 [G, C, E, CD]	**Is the illness self-limiting within 72 hours (without requiring medical intervention)?**	**[G, C, E, CD] Infection is generally asymptomatic; however, 10 – 20% of patients with acute infection may develop cervical lymphadenopathy and/or flu-like symptoms.**	**Wilson in MCM, 2007**
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Bowie, W.R., S.A. King, D.H. Werker, J.L. Isaac-Renton, A. Bell, S.B. Eng, and S.A. Marion. 1997. Outbreak of toxoplasmosis associated with municipal drinking water. Lancet. 350: 173-177.

Centers for Disease Control and Prevention (CDC). 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

de Moura L., L.M. Bahia-Oliveira, M.Y. Wada, J.L. Jones, S.H. Tuboi, E.H. Carmo, W.M. Ramalho, N.J. Camargo, R. Trevisan, R.M. Graca, A.J. da Silva, I. Moura, J.P. Dubey, and D.O. Garrett. 2006. Waterborne toxoplasmosis, Brazil, from field to gene. Emerging Infectious Diseases. 12(2): 326-329.

Heymann, D. (ed.). 2005. *Control of Communicable Diseases Manual,* 18th Edition. American Public Health Association, Washington, DC.

Isaac-Renton, J., W.R. Bowie, A. King, G.S. Irwin, C.S. Ong, C.P. Fung, M.O. Shokeir, and J.P. Dubey. 1998. Detection of *Toxoplasma gondii* Oocysts in Drinking Water. Applied and Environmental Microbiology. 64(6): 2278-2280.

McAuley, J. and K. Singh. 2019. *Toxoplasma*. In Carroll, K.C., M.A. Pfaller, M.L. Landry, A.J. McAdam, R. Patel, S.S. Richter, and D.W. Warnock (ed). *Manual of Clinical Microbiology*, 12th Edition. American Society of Microbiology Press, Washington, DC.

Sroka J., A. Wojcik-Fatla, and J. Dutkiewicz. 2006. Occurrence of *Toxoplasma Gondii* in Water from Wells Located on Farms. Annals of Agricultural and Environmental Medicine. 13:169-175.

Wilson, M., J. Jones, and J. McAuley. 2007. *Toxoplasma*. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry, and M.A. Pfaller (ed.) *Manual of Clinical Microbiology*, 9th Edition, Volume 2, p. 2070. American Society for Microbiology Press, Washington, DC.

Vibrio cholerae Scoring Data

Scoring Summary[1,2]	
Waterborne Disease Outbreak	**3**
Health Risk	
General population	**3**
Sensitive subpopulation(s) [C, E, P, CD]	**3**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (2 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
3	**Has caused documented WBDOs at any time in the U.S.?**	**1971-2008: 1 Bulk Water Purchase**	**CDC-NORS, 2020**
2	Has caused WBDOs in countries other than the U.S.?		
1	Has never caused WBDOs in any country, but has been epidemiologically associated with water related disease?		

Score[2]	Data Element	Scoring Data	Reference[3]
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes (outbreak data)**	**CDC, 1996**
2	Detected in source water in the U.S.?	Yes	Rhodes et al., 1986 Kaper et al., 1982
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?	*V. cholerae* Non-O1: third most commonly isolated in U.S. - Septicemia case fatality rate from 47-65%.	Abbott in MCM, 2010; Tarr et al. in MCM, 2019
6	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?	*V. cholerae* O1: Extremely rare cases cause severe extraintestinal infection. If untreated, *V. cholerae* O1 infection causes severe dehydration which leads to hypovolemic shock, acidosis, circulatory collapse, and death. Unlike O1 strains, non-O1 isolates are commonly associated with extrainstestinal infections such as septicemia.	Abbott in MCM, 2010
5	Does the illness result in long term or permanent		

Score[2]	Data Element	Scoring Data	Reference[3]
	dysfunction or disability, i.e. sequelae?		
4	Does the illness require short term hospitalization (< week)?	In severely dehydrated cases (cholera gravis), death may occur within a few hours, and the case-fatality rate may exceed 50%. With proper and timely rehydration, this can be less than 1%.	Heymann, 2005
3 [G, C, P, E, CD]	**Does the illness require physician intervention?**	**[All populations] In most cases infection is asymptomatic or causes self-limiting diarrhea.** **Treatment consists of fluid replacement by oral rehydration therapy and/or intravenous fluids.**	**Abbott in MCM, 2010**
2	Is the illness self-limiting within 72 hours (without requiring medical intervention)?		
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Abbott, S.L., J.M. Janda, and J.J. Farmer. 2010. *Vibrio* and Related Organisms. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.A. Pfaller, and R.H. Yolken (ed.) *Manual of Clinical Microbiology*, 8th Edition, Volume 1, p. 666. American Society for Microbiology Press, Washington, DC.

Centers for Disease Control and Prevention (CDC). 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Heymann, D. (ed.). 2005. *Control of Communicable Diseases Manual*, 18th Edition, pp. 113-127. American Public Health Association, Washington, DC.

Kaper, J.B., H.B. Bradford, N.C. Roberts, and S. Falkow. 1982. Molecular epidemiology of Vibrio cholerae in the U.S. Gulf Coast. Journal of Clinical Microbiology. 16(1): 129-134.

Rhodes, J.B., H.L. Smith Jr., and J.E. Ogg. 1986. Isolation of Non-O1 Vibrio cholerae Serovars from Surface Waters in Western Colorado. Applied and Environmental Microbiology. 51(6): 1216-1219.

Tarr, C., W. Glover II, Y. Boucher, and J.J. Farmer III. 2019., *Vibrio* and Related Organisms. In Carroll, K.C., M.A. Pfaller, M.L. Landry, A.J. McAdam, R. Patel, S.S. Richter, and D.W. Warnock (ed). *Manual of Clinical Microbiology*, 12th Edition. American Society of Microbiology Press, Washington, DC.

Yersinia enterocolitica Scoring Data

Scoring Summary[1,2]	
Waterborne Disease Outbreak	**3**
Health Risk	
General population	**2**
Sensitive subpopulation(s) [C]	**2**

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease

Score[2]	Data Element	Scoring Data	Reference[3]
	Waterborne Disease Outbreaks		
5	Has caused multiple (2 or more) documented WBDOs in the U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
4	Has caused at least one documented WBDOs in U.S. reported by CDC between 2009-2017	No	CDC-NORS, 2020
3	**Has caused documented WBDOs at any time in the U.S.?**	**1971-2008: 1 Noncommunity**	**CDC-NORS, 2020**
2	Has caused WBDOs in countries other than the U.S.?		
1	Has never caused WBDOs in any country,		

Score[2]	Data Element	Scoring Data	Reference[3]
	but has been epidemiologically associated with water related disease?		
	Occurrence		
3	**Detected in drinking water in the U.S.?**	**Yes**	**Highsmith et al., 1977** **Eden et al., 1977**
2	Detected in source water in the U.S.?	Yes	Meadows and Snudden, 1982
1	Not detected in the U.S.?		
	Health Risk		
7	Does the organism cause significant mortality (> 1/1,000 cases)?	No	
6	Does the organism cause pneumonia, meningitis, hepatitis, encephalitis, endocarditis, cancer, or other severe manifestations of illness necessitating long term hospitalization (> week)?	An uncommon complication of gastroenteritis is septicemia for which the elderly and immunocompromised are at higher risk, particularly those with metabolic diseases associated with iron overload (hemochromatosis), cancer, liver disease and steroid therapy.	Wanger in MCM, 2010; Kingry et al. in MCM, 2019
5	Does the illness result in long term or permanent dysfunction or disability, i.e.	Uncommon sequelae include: reactive arthritis, inflammatory bowel disease, autoimmune	Wanger in MCM, 2010

Score[2]	Data Element	Scoring Data	Reference[3]
	sequelae?	thyroid disorders.	
4	Does the illness require short term hospitalization (< week)?		
3	Does the illness require physician intervention?	The elderly are at greater risk for septicemia.	Wanger in MCM, 2010
2 [G, C]	**Is the illness self-limiting within 72 hours (without requiring medical intervention)?**	**[G, C] (No information available for other populations) Young children most commonly develop gastroenteritis and present with fever, diarrhea, and abdominal pain. Symptoms typically resolve within 7 days.** **Infection typically manifested by acute febrile diarrhea with abdominal pain (especially in young children). Diarrhea may be absent in up to a third of *Y. enterocolitica* infections.**	**Wanger in MCM, 2010** **Heymann, 2005**
1	Does the illness result in mild symptoms with minimal or no impact on daily activities?		

[1] Bolded text indicates the highest score for that particular protocol. For the health risk protocol two scores were selected: the general population [G] and the highest score for a sensitive subpopulation. These 2 scores were added and normalized by multiplying by 5/14 for a final health risk score. The higher score between the WBDO and Occurrence protocols was used for total pathogen score calculation. Health Risk protocol: G - General, C - Child, E - Elderly, P - Pregnant Women, CD - Chronic Disease.

[2]See *Final Contaminant Candidate List 3 Microbes: PCCL to CCL Process*. EPA 815-R-09-009. Final. August 2009 for a detailed description on how to calculate the total pathogen score.

[3]EPA based the WBDO scores on the CDC MMWR reports from 1991 – 2017 and then collected occurrence citations if there were no CDC WBDOs.

References

Centers for Disease Control and Prevention (CDC). 2020. National Outbreak Reporting System (NORS). Available online at: https://wwwn.cdc.gov/norsdashboard/. Accessed August 31, 2020.

Eden, K.V., M.L. Rosenberg, M. Stoopler, B.T. Wood, A.K. Highsmith, P. Skaliy, J.G. Wells, and J.C. Feeley. 1977. Waterborne gastrointestinal illness at a ski resort-Isolation of *Yersinia enterocolitica* from drinking water. Public Health Reports. 92(3): 245-50.

Heymann, D. (ed.). 2005. *Control of Communicable Diseases Manual*, 18th Edition. American Public Health Association, Washington, DC.

Highsmith, A.K., J.C. Feeley, P. Skaliy, J.G. Wells, and B.T. Wood. 1977. Isolation of *Yersinia enterocolitica* from well water and growth in distilled water. Applied and Environmental Microbiology. 34: 745-750.

Kingry, L., C. Tarr, and J. Petersen. 2019. *Yersinia*. In Carroll, K.C., M.A. Pfaller, M.L. Landry, A.J. McAdam, R. Patel, S.S. Richter, and D.W. Warnock (ed). *Manual of Clinical Microbiology*, 12th Edition. American Society of Microbiology Press, Washington, DC.

Meadows, C.A. and B.H. Snudden. 1982. Prevalence of *Yersinia enterocolitica* in waters of the lower Chippewa river basin, Wisconsin. Applied and Environmental Microbiology. 43: 953-954.

Wanger, A. 2007. *Yersinia*. In Murray, P.R., E.J. Baron, J.H. Jorgensen, M.L. Landry, and M.A. Pfaller (ed.) *Manual of Clinical Microbiology*, 9th Edition, Volume 1, p. 689-690. American Society for Microbiology Press, Washington, DC.

Appendix G. CCL 5 Data Source Descriptions

Data Sources for Microbial Contaminants

Data Source Name	**The National Outbreak Reporting System (NORS)**
Data Source Description	Launched in 2009 for Health Departments to report to CDC cases of enteric disease outbreaks caused by bacterial, viral, parasitic, chemical, toxin, and unknown agents, as well as foodborne and waterborne outbreaks of non-enteric disease. NORS was designed to integrate data on waterborne as well as foodborne outbreaks, but for CCL only the waterborne data were used.
Proprietor	CDC
Contact Information	CDC, 1600 Clifton Road, N.E., MS C-9, Atlanta, GA 30333. Telephone: 404-639-1700; E-mail: healthywater@cdc.gov
Type of Data Elements	Waterborne outbreak data
Relevance Explanation	This source is considered relevant for the CCL process because it contains information on drinking water outbreaks caused by microbial contaminants which is a major component of the scoring process.
Completeness Explanation	It meets considerations because it is peer reviewed.
Redundancy Explanation	This source is not redundant.
Retrievability Explanation	This source meets retrievability criteria because it is in tabular format.
Source URL	https://www.cdc.gov/nors/index.html
Data Source Name	**Center for Disease Control and Prevention's Morbidity and Mortality Weekly Reports (MMWR)**
Data Source Description	Since 1971, CDC, EPA and the Council of State and Territorial Epidemiologists (CSTE) have maintained a collaborative surveillance system for collecting and periodically reporting data related to occurrences and causes of Waterborne Disease Outbreaks (WBDOs). These reports from the CDC are published

	periodically in the MMWR. For CCL EPA used CDC's MMWR summaries as the source for the WBDO scoring protocol. The summaries include data on outbreaks associated with drinking water, recreational water, water not intended for drinking (excluding recreational water) and water use of unknown intent. Public health agencies are responsible for investigating outbreaks and reporting them voluntarily to CDC using a standard form. Only data on outbreaks associated with drinking water, water not intended for drinking (excluding recreational water) and water use of unknown intent are summarized in this report. CDC and EPA acknowledge that the WBDOs reported in the surveillance system represent only a portion of the burden of illness associated with drinking water exposure. The surveillance information does not include endemic waterborne disease risks. (Description adapted from website.)
Proprietor	CDC
Contact Information	Division of Foodborne, Waterborne, and Environmental Diseases, National Center for Emerging and Zoonotic Infectious Diseases, CDC, 1600 Clifton Road, N.E., MS C-9, Atlanta, GA 30333. Telephone: 404-639-1700; E-mail: healthywater@cdc.gov
Type of Data Elements	Waterborne outbreak data
Relevance Explanation	This source is considered relevant for the CCL process because it contains information on drinking water outbreaks caused by microbial contaminants which is a major component of the scoring process.
Completeness Explanation	It meets considerations because it is peer reviewed.
Redundancy Explanation	This source is not redundant.
Retrievability Explanation	This source meets retrievability criteria because it is in tabular format.
Source URL	http://www.cdc.gov/mmwr/indss_2011.html

Data Source Name	**EPA Literature Search for Supplemental Data for Microbial Contaminants**
Data Source Description	As part of its ongoing assessment of microbes in drinking water, EPA conducted a literature review of peer-reviewed, published journal literature for health risks and occurrence data for nominated microbes from 2016-2019. EPA reviewed all relevant research reports found to identify papers that might present data for the nominated microbes that might help inform CCL 5. EPA also reviewed studies submitted and referenced by nominators.
Proprietor	U.S. EPA
Contact Information	Nicole Tucker Email: Tucker.Nicole@epa.gov
Type of Data Elements	Health risks, drinking water occurrence data elements
Relevance Explanation	This source is considered relevant for the CCL process because it contains information on health risks and occurrence in water.
Completeness Explanation	It meets considerations because the studies were peer-reviewed.
Redundancy Explanation	This source is not redundant (though some, but not all, data may overlap among papers by the same authors).
Retrievability Explanation	Data not retrievable. This source contains written and tabulated data that can be copied and formatted.
Source URL	Not applicable

Data Source Name	**Manual of Clinical Microbiology (MCM), 12th Edition**
Data Source Description	The 12th edition of the MCM is the result of collaborative efforts of 22 editors and more than 267 authors from around the world, all experienced researchers and practitioners in medical and diagnostic microbiology. The manual has been brought fully up to date, resulting in 149 chapters containing the latest research findings, infectious agents, methods, practices and safety guidelines. Now entering its fifth decade the Manual strives to continue to be the leading, most authoritative reference for the "real-world" practice of clinical microbiology. This publication builds on the content of past editions. The process requires about 3 years of careful planning, design, writing and review of chapters before the final phases of copyediting, composition, printing and binding. (Description adapted from website.)
Proprietor	American Society for Microbiology Press, Washington, DC
Contact Information	James Versalovic

	Microbiology Laboratories Texas Children's Hospital Houston, Texas
Type of Data Elements	Production Volume
Relevance Explanation	This source is considered relevant for the CCL Universe because it contains health risks and occurrence information on microbial pathogens.
Completeness Explanation	It meets considerations because it is peer reviewed.
Redundancy Explanation	This source is not redundant.
Retrievability Explanation	This source is not automatically retrievable. It is a book available for purchase.
Source URL	Not applicable