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Toxicological aspects of wastewater

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ABSTRACT

'Alea iacta est', the die is cast, said the Roman general Gaius Julius Caesar the moment he and his troops crossed the Rubicon River. This phrase refers to a state where everything has already been decided and this decision cannot be taken back. It is at this borderline that humanity now finds itself; its survival is at stake. The basic biogenic components of the environment, such as water, air, and soil, are coming under the pressure of the modern industrial revolution. The products of this anthropogenic activity significantly affect the environment. We live in a time of rapid climate change, melting of glaciers, devastation of nature, mass extermination, or loss of animal and plant species in order to increase human living standards. Man has caused all this in one stage of human life, a generation. Humanity mismanages natural resources and clings to a lifestyle that is vain. It destroys the natural environment on which it is dependent simultaneously. An environmental disaster is coming. Will our blue planet still be livable for future generations? The study deals with one of the components of the environmental environment, not an insignificant one, that is, water. For the moment, recycled water is a neglected and underappreciated resource from the point of view of the Czech Republic and its state authorities. The cleaning process may be inadequate or unreliable, and residual biological and chemical contaminants may pose a risk to human health. This work focuses on the use of purified wastewater mainly for firefighting unit activities in relation to a possible health risk. The result of the study is a clear possible recommendation for the use of recycled wastewater from a technical, technological, and logistical point of view, but taking into account the precautionary principle.

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1. Introduction

This work deals with one of the components of the environment, water, which is not an insignificant one. From a global perspective, there is plenty of water on earth and still the same amount. The problem lies in the growth of the planet's population, urbanization, industrialization, and the associated higher demand for water. Water scarcity is becoming a problem in many states. The decrease of subsurface and surface water is a real fact, and the consequences of water stress are visible in the drying of rivers, large lakes, and also in the migration of the population [1]. One of the possible ways is the reuse of treated wastewater. From the point of view of the Czech Republic authorities, recycled water is neglected and underappreciated as a possible source of water. Its use offers many advantages, but also possible risks. The cleaning process may be inadequate or unreliable, and residual biological and chemical contaminants can pose a risk to human health [2]. The perception of health risk is very high. However, the safety related to recycled water may change with better quality and relevant information, with evidence of low levels of health risk and increased perception of the benefits of using recycled water in water scarcity in general. The health and safety risks are the most controversial aspects of the use of treated wastewater [3]. The reuse of purified wastewater is not well established in the consciousness of the population of the Czech Republic, probably due to institutional, social, and economic obstacles. The need for the development of this industry and the expansion of other alternative adaptation methods that will be sustainable and environmentally friendly resonates clearly in the society. Economic demands also play an important role here [4,5]. "Progress is not always linear" - the idea of Thomas Samuel Kuhn [6].

Reuse has a number of advantages, but also challenges in terms of public acceptance [7]. The same applies to acceptance among the scientific community. Treatment and reuse of wastewater is nothing new, and knowledge of this topic has progressed significantly throughout human history [8].

Wastewater Treatment Plants (WWTP) are technological facilities that are used for wastewater treatment. Wastewater can be divided into several groups, most often we encounter municipal waste water, industrial wastewater, and mixed water, a mixture of municipal and industrial wastewater [9]. There are several types of wastewater treatment plants. First, they are divided according to the technological process used by the device to treat wastewater. The most common type of wastewater treatment plant in the Czech Republic is a mechanical biological treatment plant. WWTPs can also be divided according to the purpose for which they are designed. There are small-sized treatment plants serving as domestic technology, medium-sized ones where industrial treatment plants and sewage treatment plants in municipalities and small

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towns can be included. The largest are located in large cities and serve to treat mixed wastewater; they are municipal and mixed WWTPs. The principle of wastewater treatment depends on the technological procedure chosen for wastewater treatment. In essence, it is a combination of mechanical, biological, and physical wastewater treatment [10]. The discharge of wastewater from WWTPs is governed by the Water Act and the Act on Water Pipes and Sewers for Public Use. The discharge permit is issued by the Water Authority [11].

The constituents of wastewater, such as potentially harmful pathogens, antibiotic-resistant bacteria, and toxic or biodisturbing chemicals, can adversely affect human health if not properly controlled [12]. Treatment reduces the concentration of microbial pathogens in wastewater, thereby reducing human exposure, and theoretically reduces the risk of adverse health consequences. There is very little epidemiological evidence to demonstrate the specific health benefits of wastewater treatment [13].

Wastewater consists mainly of dissolved particles of organic and inorganic substances, *e.g*., nitrogen (N), phosphorus (P), potassium (K), sodium (Na), calcium (Ca), magnesium (Mg), chlorine (Cl), which also contain microorganisms, including pathogens and bacteria [14]. In addition, toxic or bioaccumulative chemicals are also usually present. Due to this complexity, detailed chemical and biological characterization of treated wastewater is necessary to assess its quality, while it is always difficult to fully predict the effects that may arise from its reuse. Regulatory frameworks require analysis of treated wastewater prior to reuse [15]. The choice of the best methods for wastewater treatment must represent a trade-off between cost effectiveness and water production. Implementation and maintenance costs and environmental impacts cannot be ignored, and it can sometimes be very difficult to reach an ideal compromise. The microbiological characterization of wastewater is mainly focused on the presence of potential human pathogens and parasites and is generally based on the enumeration of indicators of stool and eggs of nematodes [16]. Organic pollutants transported by wastewater, such as phenolic compounds, surfactants, polycyclic aromatic hydrocarbons, or polychlorinated biphenyls. The discussion of the effects of contaminants on the environment is often oversimplified, since a single compound and a target function or parameters are usually evaluated [13].

Pathogens are microorganisms, such as bacteria, viruses, and protozoa (*Salmonella*, *Escherichia coli*, *Legionella*) that cause serious diseases [14]. To protect public health, states adopt regulations and guidelines for the reuse of treated water, *e.g.,* the World Health Organization (WHO) Guidelines for the safe use of wastewater or the more recent European Union regulation (EU No. 2020/741). However, the possibility of exposure to pathogens still exists, especially with secondary treated water or due to noncompliance with regulations. Exposure to the pathogen can occur through direct contact with water or, in the worst case, through ingestion or inhalation, *e.g., E. coli* has the potential to cause diarrhea and extraintestinal disease [17]. Viruses can cause meningitis, encephalitis, hepatitis, and infections of the gastrointestinal tract and respiratory tract [18]. Fecal *coliform* bacteria, on the other hand, are not pathogenic but indicate the presence of disease-causing organisms. Individuals exposed to wastewater containing high coliform bacteria are at increased health risk. The presence of indicator bacteria can indicate the presence of dysentery, typhoid, and bacteria of organisms that cause gastroenteritis. Wastewater can also contain persistent and non-biodegradable pollutants such as heavy metals or microplastics. Heavy metal concentrations are usually very low (depending on the type of wastewater and the level of treatment), but in the long term they pose a risk to both human health and the environment. The effects of heavy metals on human health are well known, *e.g.,* heavy metals can cause cancer or are hazardous noxes for bone, circulatory, enzymatic, endocrine, immune, or nervous systems, or for some organs. Alternatively, there may be a risk of a synergistic effect with other contaminants. In the case of microplastics (particles smaller than 5 mm), ingestion can cause blockage of the digestive system, suffocation or damage organs, or cause death [19]. This bioaccumulation was mainly observed in marine biota. But man is at the top of the food chain. Microplastics can also be leached into groundwater from the soil, which can be considered a potential route of exposure to the human organism [20].

Heavy metals are priority environmental pollutants and are generally toxic and carcinogenic [21]. Most of them are not biodegradable, but up to 90 % can be removed using many conventional methods of treatment processes (precipitation, adsorption, and ion exchange). Regenerated waterborne contaminants are likely to raise various safety and toxicity issues. In many cases, the existing empirical evidence is insufficient to evaluate the potential risks of chronic exposure to most contaminants contained in reclaimed water. Humans may be indirectly or directly exposed to reclaimed water, and the relevant contaminants may cause adverse effects on human health [3].

However, the main source of reclaimed water is municipal wastewater, which contains many types of pollutants. Ideally, all harmful substances should be removed during the cleaning process. However, in reality, not all pollutants can be removed. During the purification process, other by-products with potential risks to human health may be formed. Reclaimed water can be considered a mixture of many types of pollutants whose adverse biological effects are difficult to predict. Classifying water on the basis of chemical analysis alone is insufficient. In addition, toxic substances in reclaimed water usually cause different adverse effects corresponding to the intensity at different biological levels (molecules, cells, organs, individuals, and communities). Some epidemiological studies showed that xenobiotic substances in reclaimed water were related to carcinogenicity, mutagenicity, and teratogenicity [22]. Reclaimed water will become an important alternative source in the future; therefore, the safety of water quality must be ensured to avoid adverse health effects and ecological risks during long-term use [10].

Reclamation and reuse of municipal wastewater provides an effective way to solve water resource problems in arid and semi-arid regions. The benefits and risks associated with the reclaimed water used for irrigation must be analyzed to demonstrate that it is a safe water source when properly applied. The analyzes show that reclaimed water is an economically efficient water resource with potential benefits to improve conditions [23]. Many parts of the world are under increasing pressure to supply freshwater. It is absolutely necessary to take proactive steps to conserve and increase limited water resources to meet the water demands of growing populations and urban development. With advances in treatment technologies, wastewater can be treated to meet the strictest quality requirements. The quality of reclaimed water is inherently different from the quality of drinking water, which contains a large amount of salts [24]. Reclaimed water also contains potentially hazardous compounds such as heavy metals and active pharmaceutical chemicals and pathogens. The production of municipal wastewater remains almost constant, reclaimed water represents a reliable source of water for cities. There are many opportunities to reuse reclaimed water near urban environments where water resources are the most needed and very expensive. Thus, reclaimed water can be a reliable and economical source.

Heavy metals such as arsenic (As), cadmium (Cd), copper (Cu), chrome (Cr), nickel (Ni), plumbum (Pb), zinc (Zn), found in municipal wastewater, are effectively removed by convective wastewater treatment processes from the waterway and are concentrated in the sludge fraction [25]. As a result, their presence in reclaimed water is largely negligible, and their concentrations are comparable to the levels found in fresh water. The biggest health problem in using reclaimed wastewater for irrigation is pathogens [21]. Proper wastewater treatment and disinfection will remove or inactivate most pathogens. An individual can become ill by using regenerated water by direct ingestion or by inhaling the aerosol. The potential for disease transmission through reclaimed water is not completely eliminated. With proper use and proper cleaning, reclaimed water can be safely used [20]. The risk of heavy metals is low and can be essentially neglected, except where there are industrial sources in the wastewater collection system [26]. The so-called tertiary cleaning measures should be taken here. Due to the diversity of pathogens in wastewater collection systems and the low infectious dose of some viruses and parasites, proper management – evaluation is necessary to prevent the possible transmission of the disease to humans when reclaimed water is used. Potential human contamination can be minimized by improving the application methods (*e.g.,* rescue operations - working with the flow line and setting the current in the case of fire brigades) + the correct separation distance and wind direction. Risk can be controlled by proper field practices. The possible negative impacts should not overshadow the huge benefits of using reclaimed water. Reclaimed water use is generally safe and should be encouraged and promoted [27].

The use of purified wastewater presupposes the presence of fecal bacteria. Many of these bacteria are a common part of the digestive tract of warm-blooded animals, including humans [28]. However, its source does not have to be exclusively the intestinal microflora of warm-blooded animals, but also soil, plant remains, *etc*. Some species can reproduce in water. However, the degree of pollution is important. Among the basic indicators of fecal pollution are *coliform* bacteria [29]. This includes most species of bacteria from the *Enterobacteriaceae* family [30]. A subgroup of *coliform* bacteria is a thermotolerant *coliform* bacteria (they are also known by the more appropriate name fecal *coliform* bacteria). Intestinal *enterococci* are also a good indicator of fecal pollution and by their nature complement the determination of thermotolerant (fecal) *coliform* bacteria, or *Escherichia coli* (*E. coli*), which is an ideal indicator of fecal pollution [31]. This species is part of the intestinal microflora, does not reproduce in water, survives only for a limited time depending on the natural conditions, and can be detected very specifically. Pathogenic *E. coli* only has certain serotypes, which are fortunately relatively rare [32]. *Coliform* bacteria cause common intestinal problems but can also cause colic. The most common symptoms include nausea, diarrhea, and vomiting [33]. In addition to bloody diarrhea, *Escherichia coli* can cause hemolytic-uremic syndrome, which can be fatal due to acute kidney failure (especially in children and sensitive people) [10]. The detected occurrence of *coliform* bacteria in the water is a risk factor and the use of this water is not recommended, even for bathing [34,35].

A threat to human health is also the *Pseudomonas* bacteria, which cause dangerous infections that can even cause death. *Pseudomonas* is a type of bacteria (germ) commonly found in the environment, such as in soil and water [36]. The most common cause of human infection is *Pseudomonas aeruginosa*, which can easily adapt to the environment, which is widespread and resistant, even to penicillin-type antibiotics [37]. This bacteria can cause infections in the blood, lungs (pneumonia), or other parts of the body [38]. These bacteria are constantly finding new ways to evade the effects of the antibiotics used to treat the infections they cause. Antibiotic resistance occurs when microbes no longer respond to antibiotics designed to kill them. If they develop resistance to several types of antibiotics, these germs can become multiresistant [39]. Resistant strains of germs can also spread from one person to another through, for example, contaminated hands or surfaces. Infections caused by *Pseudomonas aeruginosa* are generally treated with antibiotics [37]. Due to possible resistance to antibiotics, the best antibiotic to treat a specific infection is determined on the basis of laboratory analysis [37].

Legionella pneumophila can be considered a dangerous bacterium, which is widespread and occurs in almost all waters in harmless amounts [40]. It often settles on the inner sides and corners of the water pipes, the low temperature of the outlet paths (it reproduces best at a temperature of 30 °C), low water pressure, insufficient maintenance, treatment of the distribution system, and many other factors contribute to its occurrence and spread [41]. *Legionella pneumophila* is not harmful when drunk (and since warm water is not intended for drinking, it should not normally be dangerous), but when it enters the lungs, it causes the legionellosis disease [40]. Legionella is most often inhaled while showering. People with reduced immunity are especially at risk. Legionellosis manifests itself as a common respiratory disease caused by the infection of Legionella bacteria in water. It is therefore difficult to identify, and if the correct treatment is not used, the infected person may die (there are several dozen fatal cases in the Czech Republic each year). The defense against Legionella is water chlorination [40]. Of the detergents available, chlorine dioxide is the most effective. This is because, unlike other parasites, it can disrupt the biofilms in which Legionella hides and reproduces [40].

Salmonella is an acute diarrheal disease with a short incubation period (8-10 hours) [40]. Explosive epidemics are typical, in which most people exposed to the disease fall ill in a few hours. It is usually transmitted through contaminated food or contaminated water and also fecal oral in children. It is a common disease in humans who improperly handle food and do not follow hygienic procedures. The term salmonellosis (or salmonella) refers to acute diarrheal bacterial diseases caused by non-typhoid bacteria of the genus Salmonella, which are quite resistant to environmental influences [41]. They are able to survive with and without oxygen, develop the fastest at a temperature of 37 °C, but they also cope well with room climate and tolerate subfreezing temperatures well. The infection typically has a seasonal course and people most often deal with it during the summer months. Anyone can get salmonellosis, which is basically a bacterial gastroenteritis [42]. Children under five years of age, people with weakened immunity, and the elderly are the most at risk [41]. Nausea is typical for salmonellosis, which is accompanied by watery diarrhea that persists for several days. Other characteristic symptoms of salmonella include abdominal pain, convulsions, vomiting, increased temperature, headache, chills, fatigue and restlessness, and malaise [43]. However, it can also have an asymptomatic course. Although in most cases the course of salmonellosis is relatively mild, this disease should not be underestimated. It can be very insidious and can cause very unpleasant complications or even death for patients. The highest risk is salmonellosis in children and elderly patients or people with weakened immunity [44]. Severe diarrhea leads to significant fluid loss, so dehydration is followed by severe convulsions and tachycardia, and in some cases even loss of consciousness and kidney failure can occur [45]. Rarely do sepsis and multiorgan failure develop, which may result in the death of the patient. The treatment of salmonellosis consists in observing a rest regime and introducing a special diet. An important part of the treatment is fluid replenishment (rehydration), which the patient loses due to diarrhea, vomiting, and excessive sweating [41]. In more severe cases, it is necessary to connect the patient to an infusion. If a typhoid course of the disease occurs or if dangerous complications occur, including, for example, organ failure, hospitalization of the patient is necessary [41].

Table 1. Wastewater sampling sites.

Administrative district	Cadastral territory	Population
Přerov	WWTP Přerov - Henčlov	145000
Hranice	WWTP Hranice	30000
Lipník	WWTP Lipník	13733
Kojetín	WWTP Kojetín	5833
Tovačov	WWTP Tovačov - Annín	3375
Dřevohostice	WWTP Dřevohostice	2020
Troubky	WWTP Troubky	2000
Brodek u Př.	WWTP Brodek u Př.	2008

Table 2. Government Regulation No. 401/2015 Coll., Government regulation on indicators and values of permissible pollution of surface water and wastewater, requirements for permits for discharge of wastewater into surface waters and into sewers, and in sensitive areas.

Parameter	NV No. 401/2015 Coll. - Permissible pollution	
	Percentil P95	Maximum
Escherichia coli	900	2500
Intestinal enterococci	1000/330	4000
Thermotolerant coliform bacteria	2000	2000

Table 3. Microbiological analysis of water from pools in artificial swimming pools (swimming, bathing or bathroom pools, pools for babies and toddlers, saunas) according to Decree No.238/2011 Coll.

Parameter	Decree 238/2011 – Swimming in the wild		
	Percentil P95	Percentil P95	Percentil P90
Water quality	**Excellent quality**	**Good quality**	**Acceptable quality**
Escherichia coli	500	1000	900
Intestinal enterococci	200	400	330

Table 4. Decree No. 428/2001 Coll. Decree of the Ministry of Agriculture implementing Act No. 274/2001 Coll., on water pipes and sewers for public use and on the amendment of certain laws (Water Pipes and Sewerage Act).

Qualitative quality of raw water	428/2001 Sb. Raw water quality requirements		
	A1	A2	A3
Escherichia coli	20	1000	10000
Intestinal enterococci	50	5000	50000
Thermotolerant coliform bacteria	20	2000	20000

The main goal of the study was to find new alternative ways to provide fire water and also directions in its use, whether in the use of waste water, rainwater, or the use of small treatment plants as sources of fire water. The secondary goal is an appeal for a change in thinking, but above all, the practical use of alternative resources by the responding fire brigades. This initiative is also aimed at making the necessary changes in legislation and understanding the ecological and economic subtext. The goal of the study was to deepen, to a certain extent, only theoretical knowledge about the properties of purified wastewater, when in our opinion we are only at the beginning of water use in this regard and many potential users are very reserved about using this water, or in the extreme case, they refuse to use this water with reference to the possibility of contamination of the fire brigade member. The study aimed mainly at obtaining data through experimental data collection (samples) followed by microbiological evaluation, which should give us a complete characterization of the possible threat to the firefighter from the point of view of the health threat to his person during the fire brigade intervention. One of the other goals of the study was to determine under what technical or operational conditions it is optimal to use this water while meeting the conditions of work safety.

2. Experimental

The solution of the study was carried out on two levels: laboratory and practical. The originally intended practical testing by swabbing the samples using fire-extinguishing streamers turned out to be an inappropriate method due to the testing possibilities. The captured quantity would not be sufficient to carry out the analysis of the sample, and therefore would not have an indicative value. Therefore, it was necessary to choose another method of sample collection. The capture of moisture, water mist, and aerosol on the inner part of the industrial filter in conjunction with a full face mask type CM5 was evaluated as a possible and realistic method.

2.1. Wastewater sampling

The sampling of individual WWTPs (Table 1) took place in the cadastral territory of the Olomouc region in the administrative districts of ORP Přerov, Lipník, and Hranice. Individual samples were collected in sample boxes, which were always supplied by the State Institute of Health Olomouc prior to collection. The sampling itself was carried out by WWTP workers using the settling tank technology at its outlet. Data were obtained through personal contact with the operator.

Samples were also taken from fire tanks of private companies (after their prior consent) DSA Aviation Company Přerov, and Emos Přerov. These fire tanks are filled with captured rainwater. For comparison, a sample was taken and tested also from the water level of a natural reservoir in the village of Osek nad Bečvou. A control sample of stored waste water taken from an intermediate bulk container (water stored from 2021 at the Central Fire Station Přerov under the conditions of the exit garage) was also tested.

2.2. Microbiological analysis

Laboratory analysis of the collected samples was carried out at the Olomouc State Health Institute. The testing was primarily focused on the presence of *coliform* bacteria, intestinal *enterococci*, thermotolerant bacteria, *Clostridium perfringens*, *Escherichia coli*, *Legionella* spp., *Pseudomonas aeruqinosa* and *Salmonella*. All tested parameters were compared with standards and valid legal regulations that affect microbiological indicators of water, namely: NV No. 401/2015 Coll., Permissible pollution (Table 2) [46], Decree 238/2011, Swimming in the wild (Table 3) [47], NV No. 428/2001 Coll., Raw water quality requirements (Table 4) [48], ČSN 75 7221(2017), Water quality classes (Table 5) [49] and ČSN 75 7143, Water for irrigation (Table 6) [50].

Table 5. ČSN 75 7221 Water quality - Classification of surface water quality.

Water quality classes	ČSN 75 7221 (2017)				
	I	II	III	IV	V
Intestinal enterococci	< 600	< 1300	< 2500	< 4600	≥ 4600
Thermotolerant coliform bacteria	< 2000	< 10000	< 20000	< 40000	≥ 40000

Table 6. ČSN 75 7143 (757143) Water quality - Water quality for irrigation.

Assessment of use	ČSN 75 7143 water for irrigation		
	I / Suitable	II / Conditionally suitable	III / Unsuitable
Intestinal enterococci	1000	10000	> 10000
Coliform Bacterials	10000	100000	> 100000
Salmonella	Negative in 500 mL	Negative in 200 mL	Pozitive in 200 mL
Thermotolerant coliform bacteria	1000	10000	> 10000

Table 7. Wastewater sampling sites and monitored microbiological pollution values.

1	**Hranice na Moravě**	**Value**	**Unit**	**Uncertainty - range (lower and upper limits)**
	Clostridium perfringens	240	KTJ/100 mL	210-270
	Escherichia coli	7700	KTJ/100 mL	7500-7900
	Intestinal enterococci	3300	KTJ/100 mL	3200-3400
	Coliform bacteria	47000	KTJ/100 mL	46600-474000
	Legionella spp.	80	KTJ/100 mL	64-99
	Pseudomonas aeruqinosa	0	KTJ/100 mL	0-0
	Salmonella	Negative	-/100 mL	0-0
	Thermotolerant coliform bacteria	9000	KTJ/100 mL	8800-9190
2	**Lipník nad Bečvou**	**Value**	**Unit**	**Uncertainty – Range (lower and upper limits)**
	Clostridium perfringens	680	KTJ/100 mL	630-730
	Escherichia coli	9300	KTJ/100 mL	9110-9490
	Intestinal enterococci	2200	KTJ/100 mL	2100-2300
	Coliform bacteria	62000	KTJ/100 mL	61500-62500
	Legionella spp.	0	KTJ/100 mL	0-0
	Pseudomonas aeruqinosa	0	KTJ/100 mL	0-0
	Salmonella	Negative	-/100 mL	0-0
	Thermotolerant coliform bacteria	16000	KTJ/100 mL	15800-16300
3	**Kojetín**	**Value**	**Unit**	**Uncertainty – Range (lower and upper limits)**
	Clostridium perfringens	420	KTJ/100 mL	380-460
	Escherichia coli	54000	KTJ/100 mL	53500-54500
	Intestinal enterococci	7700	KTJ/100 mL	7500-7900
	Coliform bacteria	330000	KTJ/100 mL	329000-331000
	Legionella spp.	50	KTJ/100 mL	38-66
	Pseudomonas aeruqinosa	0	KTJ/100 mL	0-0
	Salmonella	Negative	-/100 mL	0-0
	Thermotolerant coliform bacteria	68000	KTJ/100 mL	67500-68500
4	**Přerov**	**Value**	**Unit**	**Uncertainty – Range (lower and upper limits)**
	Clostridium perfringens	400	KTJ/100 mL	360-440
	Escherichia coli	13000	KTJ/100 mL	12800-13200
	Intestinal enterococci	1100	KTJ/100 mL	1000-1200
	Coliform bacteria	47000	KTJ/100 mL	46600-47400
	Legionella spp.	90	KTJ/100 mL	73-110
	Pseudomonas aeruqinosa	0	KTJ/100 mL	0-0
	Salmonella	Negative	-/100 mL	0-0
	Thermotolerant coliform bacteria	23000	KTJ/100 mL	22700-23300
5	**Tovačov**	**Value**	**Unit**	**Uncertainty – Range (lower and upper limits)**
	Clostridium perfringens	500	KTJ/100 mL	460-550
	Escherichia coli	34000	KTJ/100 mL	33600-34400
	Intestinal enterococci	2700	KTJ/100 mL	2600-2800
	Coliform bacteria	100000	KTJ/100 mL	99400-10100
	Legionella spp.	0	KTJ/100 mL	0-0
	Pseudomonas aeruqinosa	0	KTJ/100 mL	0-0
	Salmonella	Negative	-/100 mL	0-0
	Thermotolerant coliform bacteria	37000	KTJ/100 mL	36600-37400
6	**Troubky**	**Value**	**Unit**	**Uncertainty – Range (lower and upper limits)**
	Clostridium perfringens	1500	KTJ/100 mL	1400-1600
	Escherichia coli	25000	KTJ/100 mL	24700-25300
	Intestinal enterococci	6600	KTJ/100 mL	6400-6800
	Coliform bacteria	91000	KTJ/100 mL	90400-91600
	Legionella spp.	0	KTJ/100 mL	0-0
	Pseudomonas aeruqinosa	9	KTJ/100 mL	4-17
	Salmonella	Pozitive	-/100 mL	0-0
	Thermotolerant coliform bacteria	29000	KTJ/100 mL	28700-29300
7	**Brodek**	**Value**	**Unit**	**Uncertainty – Range (lower and upper limits)**
	Clostridium perfringens	600	KTJ/100 mL	550-650
	Escherichia coli	18000	KTJ/100 mL	17900-18100
	Intestinal enterococci	5200	KTJ/100 mL	5100-5300
	Coliform bacteria	180000	KTJ/100 mL	179000-181000
	Legionella spp.	0	KTJ/100 mL	0-0
	Pseudomonas aeruqinosa	0	KTJ/100 mL	0-0
	Salmonella	Pozitive	-/100 mL	0-0
	Thermotolerant coliform bacteria	28000	KTJ/100 mL	27700-28300

Table 7. (Continued).

8	**Dřevohostice**	**Value**	**Unit**	**Uncertainty – Range (lower and upper limits)**
	Clostridium perfringens	100	KTJ/100 mL	82-120
	Escherichia coli	36000	KTJ/100 mL	35600-36400
	Intestinal enterococci	1400	KTJ/100 mL	1300-1500
	Coliform bacteria	100000	KTJ/100 mL	99400-101000
	Legionella spp.	0	KTJ/100 mL	0-0
	Pseudomonas aeruqinosa	0	KTJ/100 mL	0-0
	Salmonella	Pozitive	-/100 mL	0-0
	Thermotolerant coliform bacteria	32000	KTJ/100 mL	31700-32400
9	**Osek nad Bečvou**	**Value**	**Unit**	**Uncertainty – Range (lower and upper limits)**
	Clostridium perfringens	8	KTJ/100 mL	3-16
	Escherichia coli	2	KTJ/100 mL	1-7
	Intestinal enterococci	1	KTJ/100 mL	1-6
	Coliform bacteria	120	KTJ/100 mL	100-140
	Legionella spp.	0	KTJ/100 mL	0-0
	Pseudomonas aeruqinosa	0	KTJ/100 mL	0-0
	Salmonella	negative	/100 mL	0-0
	Thermotolerant coliform bacteria	7	KTJ/100 mL	3-14
10	**EMOS Přerov**	**Value**	**Unit**	**Uncertainty – Range (lower and upper limits)**
	Clostridium perfringens	0	KTJ/100 mL	0-0
	Escherichia coli	0	KTJ/100 mL	0-0
	Intestinal enterococci	3	KTJ/100 mL	1-9
	Coliform bacteria	480	KTJ/100 mL	440-530
	Legionella spp.	0	KTJ/100 mL	0-0
	Pseudomonas aeruqinosa	50	KTJ/100 mL	38-66
	Salmonella	Negative	-/100 mL	0-0
	Thermotolerant coliform bacteria	210	KTJ/100 mL	180-240
11	**DSA Přerov**	**Value**	**Unit**	**Uncertainty – Range (lower and upper limits)**
	Clostridium perfringens	6	KTJ/100 mL	2-13
	Escherichia coli	1	KTJ/100 mL	1-6
	Intestinal enterococci	1	KTJ/100 mL	1-6
	Coliform bacteria	190	KTJ/100 mL	170-220
	Legionella spp.	0	KTJ/100 mL	0-0
	Pseudomonas aeruqinosa	0	KTJ/100 mL	0-0
	Salmonella	Negative	-/100 mL	0-0
	Thermotolerant coliform bacteria	1	KTJ/100 mL	1-6
12	**IBC kontejner**	**Value**	**Unit**	**Uncertainty – Range (lower and upper limits)**
	Clostridium perfringens	170	KTJ/100 mL	150-200
	Escherichia coli	37	KTJ/100 mL	27-51
	Intestinal enterococci	0	KTJ/100 mL	0-0
	Coliform bacteria	95	KTJ/100 mL	78-120
	Legionella spp.	0	KTJ/100 mL	0-0
	Pseudomonas aeruqinosa	0	KTJ/100 mL	0-0
	Salmonella	Negative	-/100 mL	0-0
	Thermotolerant coliform bacteria	41	KTJ/100 mL	30-55

2.3. Verification of the absorption capacity of the filter

The trial test was carried out in a closed room of the washing box during regular cleaning-washing emergency vehicles of the units of the Fire and Rescue Service of the central station Přerov unit for 30 minutes. The goal was to check whether a filter of this type is capable or adapted to trap moisture. The filter itself (1 pc, Industrial filter, MOF-6 filter) was evaluated in terms of weight prior to testing. Weighing took place at the Precheza Přerov Company on certified laboratory scales with an accuracy of thousandths of a gram.

2.4. Method of practical testing

Subsequently, full tests were carried out in both the Přerov fire station and the natural environment with the cooperation of five colleagues. As part of regular professional training, this fact was used to test the mass gradient when working with a flow line. The three different types of nozzles (Nozzle 1**:** Turbo Jet C-52 FLUSH 475, Nozzle 2: Supon B-Stok and Nozzle 3: High pressure water, Protek Style 360) were used for the test. At the same time, it must also be said that five firefighters participated in the testing, but each of them has a different length of service, i.e., other experiences and habits. Testing itself took place according to the following scenario. Ambient temperature, air pressure, ambient humidity, and time were recorded prior to the start of the test. For all filters that were planned for training, the weight was checked in advance at the Precheza company on laboratory scales with accuracy to thousandths of grams. The participants involved in the training (project), equipped with a protective mask with a filter, performed normal activity with moderate body load for 30 minutes (joint exercise in movement and combat development of so-called dry currents). After that, the filters were replaced, and the test continued by working with the flow line against a fixed obstacle at a distance of 2.5 m (imitation of fire fighting, water reflection, or possible contact with the water stream of a colleague) for 30 minutes. After the test, the filters were always sealed in an airtight bag with a zipper and immediately taken to the control weighing. Common currents of type C-52 (Turbo Jet C-52, Flush 475), D-25 (Supon B-Stok), and high-pressure (Protek Style 360) current were used for testing. Flow rate was set on all flow lines at 250 L/min, pressure at 6 bar.

The type of nozzle was chosen to allow the change of current type from full current to atomized current. During work training, the member continuously changes the type of current by spraying into a fixed obstacle, which was a concrete wall. The change was particularly important to register not only particles of possible reflection but also particles in fog or screen-type currents and fine aerosol particles.

3. Results and discussion

3.1. Microbiological analysis

The presence of coliform bacteria, intestinal enterococci, thermotolerant bacteria, *Clostridium perfringens*, and *Escherichia coli* in water is an indication of water pollution by faeces.

Table 8. The working conditions and results with the industrial filter.

Date	Time (h)	Pressure (Hpa)	Humidity (%)	Temperature (°C)	Filter number	User	Initial weight A (g)	Final weight B (g)	B-A (g)
23.05.2022	14:00-14:30	1022	37.0	22.0	12	User 1	358.987	357.507	-1.480
23.05.2022	14:00-14:30	1022	37.0	22.0	14	User 2	362.017	360.187	-1.830
23.05.2022	14:00-14:30	1022	37.0	22.0	18	User 3	363.074	361.760	-1.314
23.05.2022	14:30-15:00	1022	37.0	22.0	19	User 4	362.289	361.049	-1.240
23.05.2022	14:30-15:00	1022	37.0	22.0	20	User 5	361.881	360.716	-1.165
22.09.2022	9:00-9:30	1025	91.2	6.9	1	User 2	360.826	361.436	0.610
22.09.2022	9:00-9:30	1025	91.2	6.9	2	User 6	359.972	360.199	0.227
22.09.2022	9:00-9:30	1025	91.2	6.9	3	User 7	366.784	367.745	0.961
22.09.2022	10:30-11:00	1015	81.0	15.2	4	User 3	361.673	361.646	-0.027
22.09.2022	11:30-12:00	1015	81.0	15.2	5	User 8	363.169	363.113	-0.056
11.10.2022	10:40-11:10	1023	77.0	14.5	5	User 7	368.200	368.368	0.168
11.10.2022	10:40-11:10	1023	77.0	14.5	6	User 9	366.236	366.312	0.076
11.10.2022	10:40-11:10	1023	77.0	14.5	2	User 2	360.957	361.349	0.392
11.10.2022	10:40-11:10	1023	77.0	14.5	9	User 2	364.074	364.455	0.381
11.10.2022	10:40-11:10	1023	77.0	14.5	4	User 3	362.179	362.951	0.772

Table 9. The working conditions and the results with the water stream.

Date	Time (h)	Filter number	Username	Initial weight C (g)	Weight after use D (g)	D-C (g)	The resulting sum (g)	Type of water stream (mm)
23.05.2022	15:00-15:30	11	User 1	363.359	364.892	1.533	3.013	D-Jet (25)
23.05.2022	15:00-15:30	13	User 2	361.790	362.150	0.360	2.190	C-Jet (52)
23.05.2022	15:00-15:30	15	User 3	364.056	366.175	2.119	3.433	C-Jet (52)
23.05.2022	15:30-16:00	16	User 4	361.163	361.746	0.583	1.823	High-pressure jet
23.05.2022	15:30-16:00	17	User 5	361.772	363.249	1.477	2.642	D-Jet (25)
22.09.2022	10:15-10:45	10	User 4	361.464	363.382	1.918	2.528	High-pressure jet
22.09.2022	10:15-10:45	7	User 6	366.501	369.208	2.707	2.934	D-Jet (25)
22.09.2022	10:30-11:00	6	User 7	365.750	365.912	0.162	1.123	C-Jet (52)
22.09.2022	11:20-11:50	8	User 3	362.807	364.713	1.906	1.933	High-pressure jet
22.09.2022	11:30-12:00	9	User 8	362.772	363.745	0.973	1.029	C-Jet (52)
11.10.2022	11:15-11:45	1	User 7	361.839	362.364	0.525	0.693	D-Atomized stream (25)
11.10.2022	11:15-11:45	10	User 9	363.243	363.503	0.260	0.336	C-Atomized stream (52)
11.10.2022	11:15-11:45	8	User 2	365.111	365.575	0.464	0.856	Vysokotlak
11.10.2022	11:15-11:45	7	User 4	369.015	368.745	-0.270	0.651	C-Jet (52)
11.10.2022	11:15-11:45	3	User 3	363.583	363.711	0.128	0.900	C-Jet (52)

Figure 1. Working with a streamline testing documentation.

In humans, these bacteria cause mainly digestive and intestinal problems. The bacteria *Legionella* spp., *Pseudomonas aeruqinosa,* and *Salmonella* cause both digestive and intestinal problems, as well as severe pneumonia, inflammation of the upper respiratory tract, urogenital tract, which can cause long-term health problems or even endanger the life of a person with impaired immunity. We present the results of the testing and analysis of individual samples in Table 7. All tested parameters were compared with standards and valid legal regulations that affect microbiological indicators of water, namely: NV No. 401/2015 Coll., Permissible pollution [46], Decree 238/2011, Swimming in the wild [47], NV No. 428/2001 Coll., Raw water quality requirements [48], ČSN 75 7221(2017), Water quality classes [49] and ČSN 75 7143, Water for irrigation [50].

3.2. Absorption capacity of the filter

The result was completely positive in terms of the ability of the filter to trap moisture. The weight difference was about 5 grams. This confirmed the possibility of testing using an industrial filter; the weight difference is detectable on laboratory scales. This weight difference is a very important aspect in the project, where we determine - we assume - the amount of water aspirated by the firefighter who intervenes into the respiratory tract. When using purified waste water, it is therefore possible to make a qualified estimate of the possible risk of infection from this water.

The test showed very interesting results, which are shown in Tables 8 and 9. The initial decrease in the weight of the filter and its subsequent increase is particularly interesting. Values were influenced by meteorological conditions. When working with a streamer, its operator aspirates a quantity of droplets into the respiratory tract, which depends on the type of current used, the distance from the obstacle, and the skills of the operator. With full current, it is clear that the amount of droplets around the operator is minimal compared to the use of atomized current, Figure 1.

The testing and analysis of the collected water took place mainly in months with an increase in air temperature. Temperature significantly affects the microbiological properties of water. The sampling of surface water from free sources and fire reservoirs is used as a comparative criterion, which is one of the important aspects.

4. Conclusions

Acceptance of the use of reclaimed water also depends on many aspects that are not closely related to technological or technical procedures, such as health, social, economic, and, last but not least, legal aspects. From the point of view of user protection, it is important to introduce new control tools, from which we will obtain a lot of data to carry out an analysis of wastewater reuse. The social aspect should be given greater attention to correctly identify the key objectives in the management of water reuse. The implementation of reuse with inclusion in routine analytical tasks will certainly bring water savings, which may be needed by the population for simple survival in crisis situations. Wastewater, especially that which has undergone treatment, is gaining more and more importance as a water source that regulates water supply and demand, especially in areas regularly affected by hydrological drought. The distribution and use of these waters will definitely be regulated in the future (as with drinking water) at the level of centralized management. In particular, the economic aspect is gaining importance, and wastewater research is gaining importance in recent years. From a technological point of view, wastewater reuse is entering the era of creating continuous "energy water", when large WWTPs will not be considered energy-intensive objects, but are subjected to studies where their equipment could be energy neutral. The reuse of water across society has the potential to be the ultimate solution to structural water shortages [51]. A preliminary agreement on the reuse of urban wastewater was confirmed by the ambassadors of the EU member states after the EU Council meeting in 2020, but this part currently affects agriculture [52]. It will become a more valuable commodity, especially due to the advancing drought and ongoing climate changes. In the Czech Republic, the residents‘ awareness of a constant supply of water resources is deeply rooted [53-55]. But is it really like that? The use of purified wastewater hides a lot of still completely untapped potential, but it also carries certain risks. People have to learn to live and work with this risk. It is absolutely necessary to observe the precautionary system when using or handling such treated water.

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CRediT authorship contribution statement

Conceptualization: Frantisek Ondrasik; Methodology: Frantisek Ondrasik; Software: Frantisek Ondrasik; Validation: Frantisek Ondrasik; Formal Analysis: Frantisek Ondrasik; Investigation: Frantisek Ondrasik; Resources: Frantisek Ondrasik; Data Curation: Frantisek Ondrasik; Writing - Original Draft: Frantisek Ondrasik; Writing - Review and Editing: Frantisek Ondrasik; Visualization: Frantisek Ondrasik; Funding acquisition: Frantisek Ondrasik; Supervision: Sarka Krocova; Project Administration: Frantisek Ondrasik.

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References

[1]. Oteng-Peprah, M.; Acheampong, M. A.; deVries, N. K. Greywater characteristics, treatment systems, reuse strategies and user perception—a review. *Water Air Soil Pollut.* **2018**, *229*, 255.
[2]. Ofori, S.; Puškáčová, A.; Růžičková, I.; Wanner, J. Treated wastewater reuse for irrigation: Pros and cons. *Sci. Total Environ.* **2021**, *760*, 144026.
[3]. Deng, S.; Yan, X.; Zhu, Q.; Liao, C. The utilization of reclaimed water: Possible risks arising from waterborne contaminants. *Environ. Pollut.* **2019**, *254*, 113020.
[4]. Mukherjee, M.; Jensen, O. Making water reuse safe: A comparative analysis of the development of regulation and technology uptake in the US and Australia. *Saf. Sci.* **2020**, *121*, 5–14.
[5]. DeNicola, E.; Aburizaiza, O. S.; Siddique, A.; Siddique, A.; Khwaja, H.; Carpenter, D. O. Climate change and water scarcity: The case of Saudi Arabia. *Ann. Glob. Health* **2015**, *81*, 342–353.
[6]. Sgroi, M.; Vagliasindi, F. G. A.; Roccaro, P. Feasibility, sustainability and circular economy concepts in water reuse. *Curr. Opin. Environ. Sci. Health* **2018**, *2*, 20–25.
[7]. Xu, M.; Bai, X.; Pei, L.; Pan, H. A research on application of water treatment technology for reclaimed water irrigation. *Int. J. Hydrogen Energy* **2016**, *41*, 15930–15937.
[8]. Angelakis, A.; Snyder, S. Wastewater treatment and reuse: Past, present, and future. *Water (Basel)* **2015**, *7*, 4887–4895.
[9]. Xu, J.; Wei, D.; Wang, F.; Bai, C.; Du, Y. Bioassay: A useful tool for evaluating reclaimed water safety. *J. Environ. Sci. (China)* **2020**, *88*, 165–176.
[10]. Hlavínek, P.; Mičín, J.; Prax, P. Příručka stokování a čištění; Brno : NOEL 2000, c2001, 2001, ISBN: 80-86020-30-4.
[11]. Act 254/2001 Sb.: Act on Water and amendment to certain acts (the Water Act), as amended, In:. Year 2001, No. 254. https://eagri.cz/public/web/file/10629/The_Water_Act.pdf (accessed September 3, 2023).
[12]. Becerra-Castro, C.; Lopes, A. R.; Vaz-Moreira, I.; Silva, E. F.; Manaia, C. M.; Nunes, O. C. Wastewater reuse in irrigation: A microbiological perspective on implications in soil fertility and human and environmental health. *Environ. Int.* **2015**, *75*, 117–135.
[13]. Contreras, J. D.; Meza, R.; Siebe, C.; Rodríguez-Dozal, S.; López-Vidal, Y. A.; Castillo-Rojas, G.; Amieva, R. I.; Solano-Gálvez, S. G.; Mazari-Hiriart, M.; Silva-Magaña, M. A.; Vázquez-Salvador, N.; Rosas Pérez, I.; Martínez Romero, L.; Salinas Cortez, E.; Riojas-Rodríguez, H.; Eisenberg, J. N. S. Health risks from exposure to untreated wastewater used for irrigation in the Mezquital Valley, Mexico: A 25-year update. *Water Res.* **2017**, *123*, 834–850.
[14]. Intriago, J. C.; López-Gálvez, F.; Allende, A.; Vivaldi, G. A.; Camposeo, S.; Nicolás Nicolás, E.; Alarcón, J. J.; Pedrero Salcedo, F. Agricultural reuse of municipal wastewater through an integral water reclamation management. *J. Environ. Manage.* **2018**, *213*, 135–141.
[15]. Hanjra, M. A.; Blackwell, J.; Carr, G.; Zhang, F.; Jackson, T. M. Wastewater irrigation and environmental health: Implications for water governance and public policy. *Int. J. Hyg. Environ. Health* **2012**, *215*, 255–269.
[16]. Mizyed, N. R. Challenges to treated wastewater reuse in arid and semi-arid areas. *Environ. Sci. Policy* **2013**, *25*, 186–195.
[17]. Cagno, E.; Garrone, P.; Negri, M.; Rizzuni, A. Adoption of water reuse technologies: An assessment under different regulatory and operational scenarios. *J. Environ. Manage.* **2022**, *317*, 115389.
[18]. Corpuz, M. V. A.; Buonerba, A.; Vigliotta, G.; Zarra, T.; Ballesteros, F., Jr; Campiglia, P.; Belgiorno, V.; Korshin, G.; Naddeo, V. Viruses in wastewater: occurrence, abundance and detection methods. *Sci. Total Environ.* **2020**, *745*, 140910.
[19]. Chen, W.; Lu, S.; Jiao, W.; Wang, M.; Chang, A. C. Reclaimed water: A safe irrigation water source? *Environ. Dev.* **2013**, *8*, 74–83.
[20]. Voulvoulis, N. Water reuse from a circular economy perspective and potential risks from an unregulated approach. *Curr. Opin. Environ. Sci. Health* **2018**, *2*, 32–45.
[21]. Chaoua, S.; Boussaa, S.; El Gharmali, A.; Boumezzough, A. Impact of irrigation with wastewater on accumulation of heavy metals in soil and crops in the region of Marrakech in Morocco. *J. Saudi Soc. Agric. Sci.* **2019**, *18*, 429–436.
[22]. Ren, X.; Kou, Y.-Y.; Kim, T.; Chae, K.-J.; Ng, H. Y. Toxicity study of reclaimed water on human embryonic kidney cells. *Chemosphere* **2017**, *189*, 390–398.
[23]. Adapa, S. Factors influencing consumption and anti-consumption of recycled water: Evidence from Australia. *J. Clean. Prod.* **2018**, *201*, 624–635.
[24]. Deere, D.; Cunliffe, D. A.; Davison, A.; WSAA (Association); Teunis, P.; Donlon, P. *Health risk assessment of fire fighting from recycled water mains*; Water Services Association of Australia, 2004, http://www.wsaa.asn.au (accessed September 3, 2023).
[25]. Zarei, M. Wastewater resources management for energy recovery from circular economy perspective. *Water-energy Nexus* **2020**, *3*, 170–185.

[26]. Shakir, E.; Zahraw, Z.; Al-Obaidy, A. H. M. J. Environmental and health risks associated with reuse of wastewater for irrigation. *Egypt. J. Pet.* **2017**, *26*, 95–102.
[27]. Yadav, G.; Mishra, A.; Ghosh, P.; Sindhu, R.; Vinayak, V.; Pugazhendhi, A. Technical, economic and environmental feasibility of resource recovery technologies from wastewater. *Sci. Total Environ.* **2021**, *796*, 149022.
[28]. Salgot, M.; Folch, M. Wastewater treatment and water reuse. *Curr. Opin. Environ. Sci. Health* **2018**, *2*, 64–74.
[29]. Li, T.; Roy, D. "Choosing not to choose": Preferences for various uses of recycled water. *Ecol. Econ.* **2021**, *184*, 106992.
[30]. Adegoke, A. A.; Amoah, I. D.; Stenström, T. A.; Verbyla, M. E.; Mihelcic, J. R. Epidemiological evidence and health risks associated with agricultural reuse of partially treated and untreated wastewater: A review. *Front. Public Health* **2018**, *6*.
[31]. Ambrožová, J. Ř.; Vejmelková, D.; Čiháková, P. *Technická mikrobiologie a hydrobiologie*; Praha: Vysoká Škola Chemicko-Technologická Praze, 2017.
[32]. Rizzo, L.; Gernjak, W.; Krzeminski, P.; Malato, S.; McArdell, C. S.; Perez, J. A. S.; Schaar, H.; Fatta-Kassinos, D. Best available technologies and treatment trains to address current challenges in urban wastewater reuse for irrigation of crops in EU countries. *Sci. Total Environ.* **2020**, *710*, 136312.
[33]. Ongerth, H. J.; Ongerth, J. E. Health consequences of wastewater reuse. *Annu. Rev. Public Health* **1982**, *3*, 419–444.
[34]. Baudišová, D.; Mlejnková, H. Microbial pollution of surface waters. Water management technical and economic information, TGM Water Research Institute, 2017.
[35]. LeChevallier, M. W.; Welch, N. J.; Smith, D. B. Full-scale studies of factors related to coliform regrowth in drinking water. *Appl. Environ. Microbiol.* ***1996***, *62*, 2201–2211.
[36]. U.S. Department of Health & Human Services: Centers for Disease Control and Prevention Pseudomonas aeruginosa infection. https://www.cdc.gov/hai/organisms/pseudomonas.html (accessed September 3, 2023).
[37]. Crone, S.; Vives-Flórez, M.; Kvich, L.; Saunders, A. M.; Malone, M.; Nicolaisen, M. H.; Martínez-García, E.; Rojas-Acosta, C.; Catalina Gomez-Puerto, M.; Calum, H.; Whiteley, M.; Kolter, R.; Bjarnsholt, T. The environmental occurrence of Pseudomonas aeruginosa. *APMIS* **2020**, *128*, 220–231.
[38]. Iglewski, B. H. *Pseudomonas*; University of Texas Medical Branch at Galveston, 1996. https://www.ncbi.nlm.nih.gov/books/NBK8326/ (accessed September 3, 2023).
[39]. Mobarki, N.; Almerabi, B.; Hattan, A. Antibiotic Resistance Crisis. *Int. J. Med. Dev. Ctries.* **2019**, 561–564.
[40]. Tison, D. L.; Seidler, R. J. Legionella incidence and density in potable drinking water supplies. *Appl. Environ. Microbiol.* **1983**, *45*, 337–339.
[41]. Coburn, B.; Grassl, G. A.; Finlay, B. B. Salmonella, the host and disease: a brief review. *Immunol. Cell Biol.* **2007**, *85*, 112–118.
[42]. Hanna, E.; Tait, P. Limitations to thermoregulation and acclimatization challenge human adaptation to global warming. *Int. J. Environ. Res. Public Health* **2015**, *12*, 8034–8074.
[43]. Giannella, R. A. *Salmonella*; University of Texas Medical Branch at Galveston, 1996.
[44]. Vanmetre, D. Infectious diseases of the gastrointestinal tract. In *Rebhun's Diseases of Dairy Cattle*; Elsevier, 2008; pp. 200–294.
[45]. Vega, R. M.; Avva, U. *Pediatric Dehydration*; StatPearls Publishing, 2023. https://www.ncbi.nlm.nih.gov/books/NBK436022/ (accessed September 3, 2023).
[46]. NV No. 401/2015 Coll: Permissible pollution. Prague: *Collection of Laws of the Czech Republic*, 2015.
[47]. Decree 238/2011: Swimming in the wild. Prague: *Collection of Laws of the Czech Republic*, 2011.
[48]. NV No. 428/2001 Coll.: Raw water quality requirements. Prague: *Collection of Laws of the Czech Republic*, 2001.
[49]. ČSN 75 7221: Water quality classes. Prague: *Czech Standardization Institute*, 1998.
[50]. ČSN 75 7143: Water quality. Water quality for irrigation; Prague: *Czech Standardization Institute*, 1992.
[51]. Adamec, V. *Ochrana před povodněmi a ochrana obyvatelstva*; Sdružení požárního a bezpečnostního inženýrství, ISBN: 8073851180, 9788073851187, 2012.
[52]. Kurrer, C.; Lipcaneanu, N. Water protection and management. https://www.europarl.europa.eu/factsheets/en/sheet/74/water-protection-and-management (accessed May 11, 2023).
[53]. Kavan, S. Selected social impacts and measures resulting from the Covid-19 epidemic in the Czech Republic on the specific example of the South Bohemian Region. *Health Soc Care Community*. **2021**, 29, e224–e231.
[54]. Kavan, S. Traffic Safety as an Element of Children. In Proceedings of 26th International Scientific Conference; Education in the Czech Republic: Kaunas, Litva, 2022; pp. 699–703.
[55]. Malerova, L.; Pokorny, J. Transport of Dangerous Substance in Territory. In *Proceedings of the 21th International Scientific Conference Transport Means*; Lithuania: Kaunas Univ Technology Press, 2017; pp. 607–610.