Written evidence from Dr Andrew C Singer

I am a Senior Scientist at the UK Centre for Ecology & Hydrology, where for the past 20 years, I have lead research into the intersection of antimicrobial resistance, pollution, and wastewater with a focus on the implications on the environment and human health. The following is offered as a personal evidence submission to inform the EAC Inquiry into Water Quality in Rivers and the particular risk that antimicrobial resistance found within wastewater poses to the environment and human health.

Antimicrobial resistance (AMR) refers to the capacity of microorganisms to resist the effects of otherwise inhibitory chemicals - an attribute that can be intrinsic or acquired. Acquired AMR is at the core of the global increase in drug-resistant infections, representing a healthcare emergency, costing the NHS an estimated £30 billion per year to treat infections and infectious diseases in England [1]. Mobile genetic elements (MGEs) facilitate the exchange of antimicrobial resistance genes (ARGs) within and between microorganisms, enabling rapid and global dissemination. The mobility of ARGs between microbes is key to driving the spread of existing and novel ARGs globally.

Antimicrobials (antivirals, antibacterials, antifungals, antiprotozoals, anthelmintics) represent a fraction of all chemicals known to select for or aid in maintaining ARGs in the environment. The chemicals that drive AMR, i.e., antimicrobial resistance-driving chemicals (ARDCs), include metals, biocides, pesticides and many other environmental pollutants [2]. Areas of significant anthropogenic impact can be areas of elevated AMR, including manufacturing and industry discharge, agriculture, municipal wastewater (wastewater treatment plants [WWTPs], combined-sewer outfalls, sewage sludge) and meat animal, egg, sport animal and dairy production activities (feed, chemotherapy, biosecurity, manure, slurry).

Concentrations of ARDCs that do not kill bacteria (i.e. sub-lethal concentrations) are sufficient to drive the selection and mobilisation of ARGs in many environmental compartments, e.g., freshwater and soils [3,4]. Source reduction of ARDCs and ARGs is likely the most important mitigating measure to reduce the hazard from AMR in freshwater environments in the UK, which can be achieved by reducing the need for their use in the community and industry, as well as eliminating the need for combined sewer overflows and storm overflows which represent a short-circuit in the treatment pathway for ARDC-rich wastewater[5]. It remains unclear the extent to which eliminating CSOs will address the entirety of the problem posed by ARDCs, and ARGs found in the environment. Despite a decline of 2 to 3 orders of magnitude (i.e., 99 to 99.9%), treated wastewater still contains many tens to hundreds of thousands of ARGs per litre, of which 11 billion are released into UK waters per day. Moreover, agricultural sources of ARDCs and ARGs can be substantial in some catchments, introducing animal waste directly or indirectly into freshwaters. Given the abundance of wastewater treatment plants in the UK (nearly 9,000) and the low degree of dilution that this effluent receives in many UK rivers, there will likely be a need to improve wastewater treatment to minimise the impact of ARDCs and ARGs in freshwaters and the transmission risks it poses to animals and humans.

The challenge of CSOs in the UK stems from numerous concurrent factors:

A) underinvestment in the sewerage network [6,7];
B) network capacity not expanding with the population [8–11];
C) continued use of combined sewers [11,12];
D) insufficient implementation of sustainable urban drainage schemes [13];
E) climate change generating heavier storms [11,14];
F) leaking pipes allowing groundwater ingress [7,9]; and
G) under-capacity storm tanks at WWTPs [7,15].

These factors conspire to fill sewer networks with water even during light rain. All of these factors need to be addressed to eliminate the need for CSOs [11,16]. Regular reporting on the frequency and volume of CSO discharge will facilitate tracking progress over time and improve our understanding of the risks to the receiving environment and reduce ARG dissemination and transmission risks.

A decrease in ARDC and ARG discharge from CSOs and wastewater treatment plants will have the co-benefits of reducing the toxic effects from antimicrobials [17] and the thousands of other chemicals present in municipal sewage on freshwater aquatic organisms[18]. The elimination of CSOs has the potential to improve the quality of impacted river water quality and habitat. The risks to human health may also be alleviated, particularly wild swimmers exposed to sewage-impacted rivers [19–21]. Increasing interest from the public to transform stretches of river into designated bathing waters will increase pressure on the water industry to eliminate CSO discharges and reduce the discharge of coliforms and other pathogens in treated WWTP effluent—a hazard AMR further exacerbates. Dogs and other animals that live in/by or use rivers would also benefit from a reduction in ARG and pathogen exposure. It remains unclear as to the extent of the risk to human health from companion animals exposed to sewage-impacted freshwaters.

In summary, antimicrobial resistance is a global challenge that is being tackled nationally through the *UK 5-year action plan for antimicrobial resistance 2019 to 2024*[22]. There is increasing recognition of the need to address the environmental component of AMR. There is a growing consensus that source reduction and improving the level of treated sewage will likely be needed for a sustainable long-term reduction in the environmental burden of AMR—a solution that has many co-befits. However, eliminating the discharge of untreated sewage will substantially and immediately reduce the AMR burden on the environment and translate to reduced pathogen and ARG exposure risks to humans and animals that come into direct or indirect contact with freshwaters.

Kind regards,

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