

Emerging Contaminants

What are they?

An emerging contaminant is a substance that has not historically been considered a contaminant, but for which there is increasing evidence that it is present in the environment and may cause adverse human and environmental health effects. Some emerging contaminants have been present in the environment for a long time but could not be detected until the development of new testing methods. Others are of concern due to recent changes in synthesis, use, or disposal practices. Research on the occurrence and health effects of these contaminants is important to characterize the nature of the risk and decide what actions may be required to protect human and environmental health.



Pharmaceuticals, including antibiotics, birth control pills and other prescription medicines are one class of contaminants of emerging concern. *Photo: US Department of Defense*

Emerging contaminants often enter the groundwater from wastewater from municipal, industrial, or agricultural sources, although some come from naturally occurring sources. Pharmaceuticals, such as antibiotics, birth control pills, or other prescription medicines, are a large group of emerging contaminants from human-generated waste streams. Another is personal care products (PCPs), which include shampoos, detergents, and “over-the-counter” non-prescription medicines. Other broad classes of emerging contaminants include viruses and agricultural pesticides and their metabolites.

Health effects vary and are not always well understood. Some emerging contaminants, including some pesticides, pharmaceuticals and PCPs, act as endocrine disrupting compounds (EDCs), which adversely affect the behavior of natural hormones in animals and humans. EDCs include both anthropogenic chemicals, such as pesticides and plasticizers, and naturally occurring compounds like steroids and plant-produced estrogens. Scientific studies suggest these compounds may cause developmental, reproductive, neurologic, and immune problems as well as cancer (NIH, 2010), but more research is needed on many of them.

Occurrence in Wisconsin

The occurrence of emerging contaminants in Wisconsin is not easily generalized, but several studies supported by the GCC have investigated the potential for certain emerging contaminants to enter groundwater from specific sources.

Wastewater effluent. Antibiotics have been detected in treated wastewater effluent from facilities across the state, with very low concentrations of tetracycline and sulfamethoxazole detected in one groundwater monitoring well directly adjacent to a groundwater discharge site (Karthikeyan and Bleam,

2003). In treated effluent from private on-site wastewater treatment systems (POWTS), acetaminophen (Tylenol), paraxanthine (a caffeine metabolite) and the hormones estrone and β -estradiol have been detected in Dane County (Bradbury and Bahr, 2005) and estrogenic EDCs have detected in southeast



Pete Chase and Jacob Krause, WGNHS, install well casing during a WGRMP-funded experiment designed to improve understanding of virus transport from wastewater to drinking water wells. *Photo: Blake Russo-Nixon.*

Wisconsin (Sonzogni et al., 2006). Neither study detected compounds in groundwater monitoring well samples. However, a follow up study at the Dane County site ten years after development of a subdivision found a number of contaminants that may have moved from POWTS into groundwater: artificial sweeteners were found in seven of ten monitoring wells and two domestic wells, human enteric virus indicators were found in three monitoring wells, and pathogenic bacteria indicators were found in one monitoring well (Bradbury et al., 2015). Other studies also suggest human enteric viruses from wastewater may be present in private and public drinking water wells across the state (Borchardt et al., 2003a, 2003b, 2004, 2007; Bradbury et al. 2013).

Agricultural sources. Due to the expense of testing and the limited analytical methods available, only a fraction of the pesticides applied to agricultural fields and their metabolites have been tested for in groundwater. However, DATCP's most recent statewide statistical survey of agricultural chemicals in groundwater found that approximately 33% of

private wells in Wisconsin contained at least one of the 31 pesticides and pesticide metabolites analyzed (DATCP, 2008). The most commonly detected compounds do have health-based groundwater standards, but the potential health effects of others are less well understood. Hormones from livestock operations were detected in runoff and tile drain water from one agricultural field in a study funded by the Wisconsin Groundwater Research and Monitoring Program (WGRMP), but they were not found in nearby groundwater monitoring wells (Hemming et al., 2013). A different study evaluated wells in northeastern Wisconsin that were suspected of being impacted by agricultural activities due to nearby land use and contamination with bacteria and/or nitrate (Bauer-Dantoin, 2009). These researchers identified estrogenic activity in some groundwater samples from these wells.

Industrial sources. Municipal and industrial landfills and hazardous waste clean-up sites are always sources of concern for both known and emerging contaminants. One example of emerging contaminants suspected to originate at these sites are perfluoroalkyl substances (PFASs), organic molecules that have a number of industrial applications including use in firefighting foams and as a carpet, upholstery, and fabric protector. These compounds were detected in three public water supply

wells during monitoring for unregulated contaminants required by the US EPA from 2013-2015. It is suspected they may be present in groundwater at other locations near firefighting training sites and facilities that manufacture products containing PFASs.

Natural geologic formations. The susceptibility of groundwater to contamination by natural trace elements depends on the geochemical environment, which can be highly variable spatially and temporally and is not always well described. Strontium is emerging as a trace element of concern in eastern Wisconsin, particularly in the Brown and Outagamie county areas. A recent study detected strontium above the US EPA's health advisory limit in about 63% of well samples from this area (Luczaj et al., 2013) but the full extent of groundwater with high strontium levels is not well documented, nor are the potential health effects.

GCC Agency Actions

By definition, much is unknown about emerging contaminants, so an important role of the GCC is supporting research studies that further scientific understanding of these substances. In addition to the many studies mentioned above that tested for occurrence of emerging contaminants, other WGRMP-funded projects have explored pathways of contaminant transport. One group of these studies investigated factors that affect the mobility and fate of antibiotics in the subsurface (Gao and Pedersen, 2005 and 2010; Gu and Karthikian, 2005a, 2005b, 2008; Gu et al., 2007; Sibley and Pedersen, 2008; Pedersen et al., 2009). This body of work has helped describe under what conditions specific antibiotic compounds bind to soil, which is important for assessing the risk to groundwater from antibiotics in wastewater sources.



Nested piezometers installed for monitoring groundwater levels and sampling for groundwater contaminants near Spring Green.
Photo: Blake Russo-Nixon.

Ongoing groundwater monitoring in areas known to be vulnerable to emerging contaminants is another way in which GCC agencies coordinate efforts to understand emerging contaminants. DATCP's regular statistical survey of agricultural chemicals and DATCP's targeted monitoring programs in agricultural areas are good examples of this. The DNR also regularly reviews groundwater data from near active and closed landfills, mining operations, and hazardous waste remediation sites.

Future Work

In Wisconsin law, there is an established process that facilitates regular review of groundwater monitoring data and identification of contaminants of emerging concern ([WI 160.27](#)). A fundamental component of this process is the long-term groundwater monitoring data itself, so maintenance and expansion of current networks is an ongoing priority for the GCC.

The US Environmental Protection Agency (EPA) also has a process for regularly gathering data on emerging contaminants and assessing potential risks nationwide. The Unregulated Contaminant Monitoring Rule (UCMR) provides for monitoring of no more than 30 unregulated contaminants every five years in all large (serving >10,000 people) public water systems and a representative sample of small (serving <10,000 people) public water systems. The Third UCMR (UCMR3) monitoring period was completed in 2015 and monitoring for the Fourth UCMR (UCMR4) will occur from 2018-2020. Data collected at Wisconsin public water supply systems during UCMR monitoring supplements data from other GCC-supported monitoring and occurrence studies.

The US EPA also maintains a Contaminant Candidate List (CCL) of physical, chemical, biological and radiological substances that might potentially be found in drinking water. Potential contaminants listed on the CCL are substances not currently subject to federal Safe Drinking Water Act (SDWA) regulation but are known, or anticipated to be, present in public water supply systems. The US EPA evaluates occurrence data on these unregulated contaminants and this information assists with identification of potential emerging contaminants in Wisconsin groundwater.

Further Reading

DNR overview of pharmaceuticals and PCPs in the environment [[link](#)]

Wisconsin Contaminated Lands Environmental Action Network [[link](#)]

DATCP Water Quality report [[link](#)]

NIH factsheet on endocrine disruptors [[link](#)]

US EPA Third Unregulated Contaminant Monitoring Rule (2012-2016) fact sheets [[link](#)]

US EPA Third Unregulated Contaminant Monitoring Rule (2012-2016) data summary [[link](#)]

US EPA Fourth Unregulated Contaminant Monitoring Rule (2017-2021) information [[link](#)]

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