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CHEMICALS OF EMERGING CONCERN IN THE GREAT LAKES REGION

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Cover images (top to bottom):
Pharmaceuticals (Pixabay), A farmer sprays pesticides on a rice field (Pixabay), A glass of water (EPA), Firefighters use firefighting foam in training (FEMA)

Lake Superior Bark Bay. (Karen Rodriguez/ USEPA)

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EXECUTIVE SUMMARY

The Great Lakes play a critical role in providing drinking water, transportation, recreation, and livelihoods for the millions of people in the Great Lakes basin. Yet, the health of the Great Lakes is in great danger, as unregulated chemicals of emerging concern (CECs) are being detected more and more frequently in Great Lakes water. As of 2017, findings from the Environmental Protection Agency and U.S. Fish and Wildlife Service suggest that CECs are ubiquitous in the Great Lakes Basin. CECs refer to a long list of compounds, which include pharmaceuticals, personal care products, pesticides and herbicides, water disinfection byproducts, household and industrial chemicals, nanomaterials, and metals. CECs are not defined by their chemical composition or use. Rather, CECs are defined as anthropogenic or naturally occurring chemicals that are not regularly included in monitoring programs or widely regulated, but that are found to occur in the environment and may pose health threats to humans, fish and wildlife, and/or the environment.

A number of CECs have proven to be persistent, bioaccumulative, and toxic, raising significant environmental and health concerns. These characteristics not only allow these chemicals to persist in the environment and in human bodies, but also allow some CECs to withstand wastewater and drinking water treatments, People are exposed to CECs nearly every day through a variety of sources, including drinking water, direct product use, and food consumption. While few studies have investigated CEC occurrence in Great Lakes communities, preliminary evidence and general trends following other environmental pollutants suggest that CECs may disproportionally affect communities of color and low-income communities

Although the U.S. has expanded its efforts to address CECs through research and monitoring programs, regulatory programs, and voluntary initiatives, these efforts remain incohesive and incapable of keeping up with the pace of chemical development and CEC contamination occurrence. It is imperative that stakeholders, led by strong federal leadership, collaborate to curb CEC contamination.

This report includes multiple recommendations in regards to improving the scientific understanding and management of CECs, with a focus on the Great Lakes region. These recommendations include the following:

- Federal and state agencies should expand the range of involved stakeholders in the chemicals management process, including citizens, industry, universities, and nonprofits
- Chemicals management should adopt a proactive product lifecycle approach, which would be more effective and less costly than managing chemicals after their production
- The U.S. should establish a national multi-agency research program to coordinate CEC studies among agencies
- The federal government should provide more funding for external research through academic institutions and non-profits
- Researchers should focus on...
  - Measuring the breakdown products of CECs and how they impact fish, wildlife, and human health
  - Investigating how mixtures of CECs with other chemicals or non-chemical agents affect humans and wildlife
  - Investigating how CECs cycle through a wider range of environmental media
- The U.S. and Canada should increase communication and coordination to implement binational CEC monitoring and management programs in the Great Lakes
- Researchers and decision-makers should assess and manage chemicals in classes, rather than individually, to accelerate the decision-making process
- Industries with high usage of chemicals, such as the automotive industries, should provide more transparency in sustainability goals

INTRODUCTION

Over 40,000 chemicals are currently being manufactured, processed, or imported in the US (USEPA, 2019), Yet, a number of these chemicals are not well understood in terms of their impact on humans, wildlife, and the environment. While many of these lesser-studied chemicals have been detected in the environment, research and regulatory efforts have traditionally focused on legacy pollutants, such as PCBs, lead, and mercury. In the absence of regulation, thousands of chemicals are entering the environment and likely exposing humans every day.

Scientists have begun to use the term "chemicals of emerging concern" or "CECs" to describe such chemicals that may have adverse health and/or ecological effects but lack health-based standards. CECs encompass a long list of pharmaceuticals, pesticides, personal care products, and industrial chemicals, among other compounds. The danger of chemicals of emerging concern lies in the fact that not much is known about them. By definition, chemicals are only considered "emerging" while there is a lack of scientific literature or knowledge regarding their potential effects on human health, wildlife, and the environment (Sauvé and Desrosiers, 2014). This uncertainty is due to the fact that many of these compounds have not been studied, cannot be tested for in municipal water systems (Rosenfeld and Feng, 2011), or have not been measured in multiple environmental media. Without this knowledge, regulators and decision-makers often struggle in determining how to manage CECs. Differing opinions have led to the creation of inconsistent standards and regulatory actions across state lines, and have deterred the establishment of federal regulations. The regulatory process under most laws is also too slow to catch up with the creation of new chemicals. As a result, only a very small fraction of the chemicals in commerce are formally regulated.

While heightened concern has spurred action among scientists and regulatory decision-makers in recent years, an enormous amount of work still lies ahead to identify and prioritize chemicals of emerging concern, understand their risks, and create tools to adequately address them in an urgent manner.

Sleeping Bear Dunes. (Robert De Jonge/ Michigan Travel Bureau)

As the largest freshwater system in the world, the Great Lakes are especially susceptible to chemicals of emerging concern. The Great Lakes provide drinking water for more than 48 million people in the US and Canada in addition to providing a home for more than 3,500 plant and animal species. Additionally, the lakes are imperative to the economy and culture of the Great Lakes region, supporting a $6 trillion regional economy (https://www.glc.org/lakes/). The Great Lakes have been exposed to environmental contaminants for decades, and are still recovering from legacy pollutants that have not been manufactured in years, including PCBs and DDT. The Great Lakes region has provided numerous case studies and acted as a leader in environmental contaminant research for years, and continues to do so for chemicals of emerging concern. It is critically important that policymakers at all levels, as well as researchers, NGOs, and industry work to protect the valuable resource that is the Great Lakes.

This report will highlight what is known about chemicals of emerging concern in terms of their usage, risks to fish and wildlife, risks to people, and effects on communities. Additionally, this report will summarize existing tools in place to address CECs, including research and monitoring programs, regulatory programs, and non-regulatory programs. Finally, a number of recommendations will be suggested for a more effective approach to CEC management in the Great Lakes region and beyond.

OVERVIEW OF SCIENTIFIC UNDERSTANDING

DEFINING CECS

There is no universal definition for chemicals of emerging concern. However, chemicals of emerging concern are broadly defined as synthetic or naturally occurring chemicals that are...

1. Not commonly included in monitoring programs, or only relatively recently included in monitoring programs
2. Not widely regulated by the government
3. Found to occur in the environment
4. Potentially a risk to human health, fish, and wildlife (Rosenfeld and Feng, 2011)

CECs are not new chemicals per se - many CECs have been used for decades and are well-established pollutants. As their name implies, CECs are chemicals that only relatively recently have come to the attention of the scientific community as a potential concern. Legacy contaminants that have newly discovered concerns would also be considered CECs. In theory, not all CECs may actually prove to be dangerous (Sauve and Desrosiers, 2014). However, the lack of toxicological data and knowledge regarding their environmental fate is a cause for concern at the time.

Chemicals of emerging concern have many synonyms in the scientific community, including but not limited to contaminants of emerging concern (CECs), emerging contaminants (ECs), emerging contaminants of concern, emerging chemicals (ECs), and emerging chemicals of concern.

There is no formal, universal list of CECs, and different organizations may consider different chemicals as CECs. CECs include a wide range of other classes of chemicals, such as endocrine-disrupting chemicals (EDCs), PFAS, and PBDEs. Because the list of CECs is so extensive and diverse, CECs are often placed in categories that describe their use or nature (See Table 1.) There is no standardized set of categories used among agencies, and there can be overlap between categories, which can lead to confusion.

For the purposes of this report, CECs will be grouped into the following categories:

- **Pharmaceuticals and personal care products (PPCPs)**
- **Pesticides**
- **Water disinfection byproducts (DBPs)**
- **Industrial and household chemicals**
- **Microplastics and nanomaterials**
- **Metals**

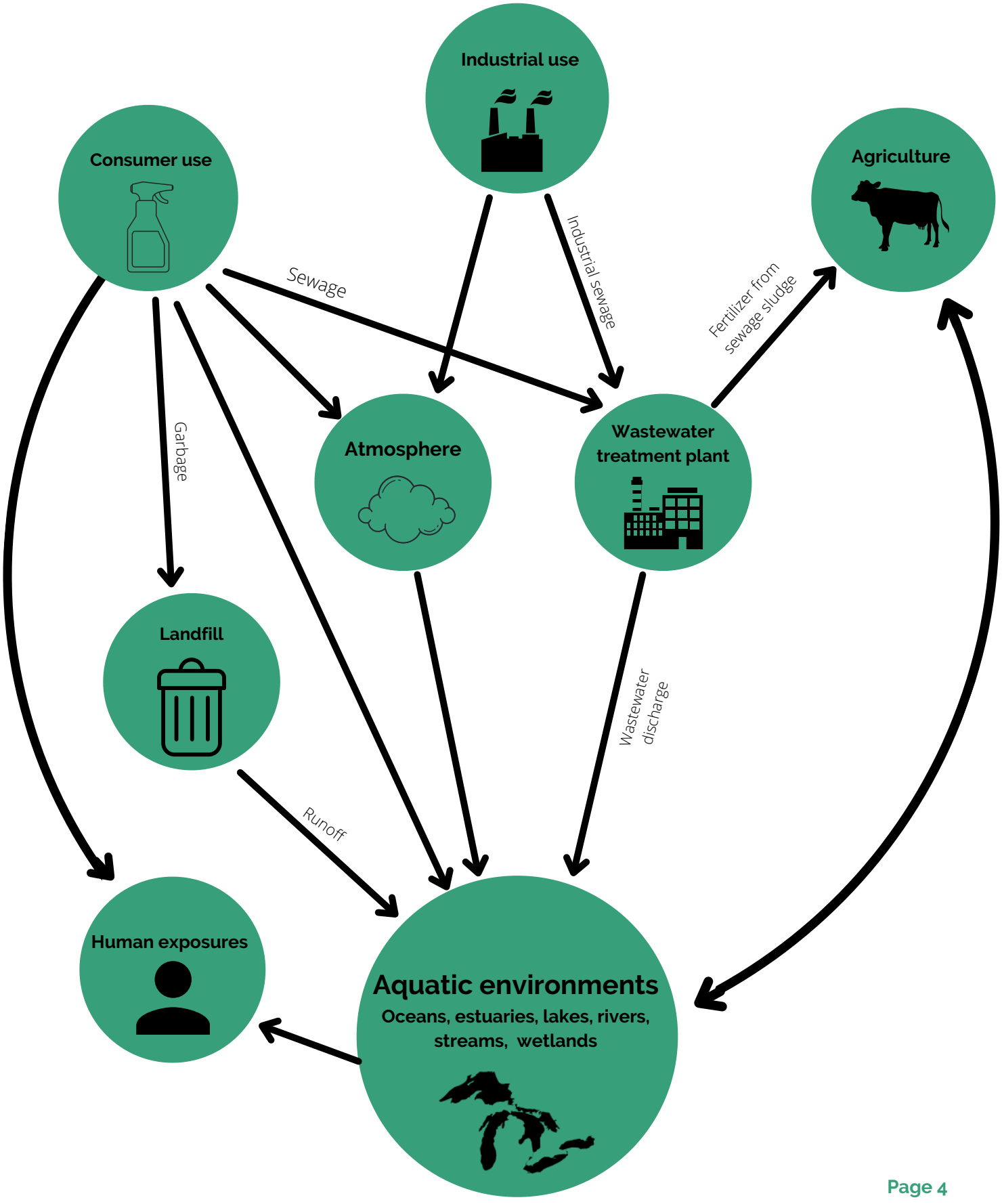
Microplastics are unlike other CECs because they are not defined by their chemical structure or use. Rather they are defined as plastic fragments that are smaller than 5 mm (Schmidt et al., 2017). However, for the purposes of this report, we are including microplastics as a class of CECs because of their prevalence in the Great Lakes and the threat they pose to aquatic life.

Table 1. Examples of CECs

Category	Examples
Pharmaceuticals and Personal Care Products (PPCPs)	Hormones, antibiotics, antiseptics, cosmetics, synthetic musks, sunscreens
Pesticides	Neonicotinoids
Water disinfection byproducts (DBPs)	Trihalomethanes, haloacetic acids
Industrial & household chemicals	Flame retardants, plasticizers, antioxidants, preservatives , perfluorinated compounds
Nanomaterials and microplastics	Nanosilver (nAg), carbon nanotubes; microbeads, plastic pellets
Metals	Tungsten, strontium, rare earth elements

Sources: (Richardson and Kimura, 2020; Sauvé and Desrosiers, 2014)

Figure 1. CEC Pollution Cycle



SOURCES OF CECS

CECs are virtually found everywhere, including in food products, drinking water, cosmetics, cleaning products, and electronics (Rosenfeld and Feng, 2011). They are used in household, commercial, medical, manufacturing, and agricultural environments. There are numerous pathways for CECs to enter the Great Lakes, including point and nonpoint sources. However, these sources can be difficult to identify and quantify because they are so widespread and ubiquitous. Additionally, not much is known about how CECs move through the environment and whether they transform or break down throughout this process. It is known, however, that many CECs are resistant to natural degradation processes and capable of accumulating and persisting in the environment (Raghav et al., 2013).

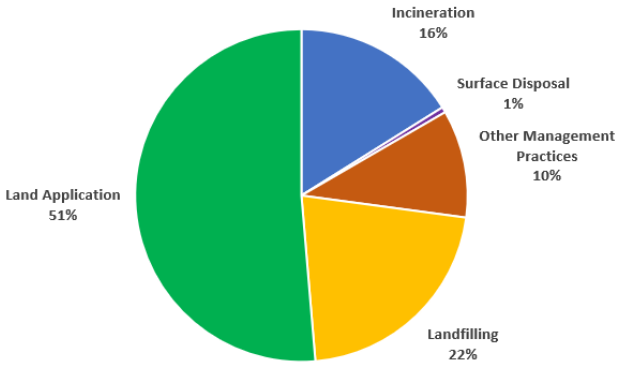
Most CECs have a lifecycle that includes a production phase, a use phase, and a disposal phase. CECs can be released into the environment or expose humans in any of these phases. During the production phase, manufacturing facilities will discharge CECs directly into bodies of water, into the atmosphere, or to wastewater treatment plants (WWTPs). CECs that are emitted into the atmosphere can be transported to water or land surfaces by atmospheric deposition (See Figure 1.)

CEC-containing products that are used or applied outdoors, such as pesticides or sunscreen, are directly introduced to the environment in the use phase. Once exposed to the outdoors, CECs can travel via wind, runoff, and leaching. Humans can be exposed to CECs in low levels while using CEC-containing products, such as cosmetics, food packaging, and other household goods. A study by the Silent Spring Institute in 2017, for example, suggested that per- and polyfluoroalkyl substances (PFAS) in food packaging can leach into food and increase dietary exposure (Schaider, 2017).

After being used or applied as products, CECs have a number of pathways to enter the environment. Pharmaceuticals, for example, can be excreted by humans and animals when not fully metabolized by the body. Human waste will enter the municipal wastewater system, while animal waste that is not properly contained can leach into surrounding soil and water (Glassmeyer, 2007). Pharmaceuticals, household chemicals, and personal care products often end up in the municipal wastewater stream or in landfills after being disposed of down drains or in the trash. Disposed plastic objects can degrade in the environment through natural weather processes and become secondary microplastics.

Many CECs will go through WWTPs after being disposed of. However, conventional wastewater treatment is not designed to remove CECs. Some CECs may persist even after advanced wastewater treatments. As a result, treated wastewater effluent can contain trace amounts of CECs when discharged into surface or ground waters. Certain CECs, known as water disinfection byproducts, are actually formed during the disinfection steps in WWTPs and drinking water treatment plants. While some water disinfection byproducts, such as trihalomethanes (THMs) and haloacetic acids (HAAs), are under strict regulation at drinking water treatment plants, their byproducts are lesser-known (Glassmeyer, 2007.) Even those CECs that are removed from effluent may remain in sewage sludge, which is generated as a byproduct during the wastewater treatment process. Sewage sludge, also referred to as "biosolids," often ends up in landfills, incinerators, or used as fertilizer (Glassmeyer, 2007). In 2019, about 4.72 million dry metric tons of sewage sludge were produced in the US by major publicly-owned treatment works. Figure 2 displays how these biosolids were used or disposed of. (https://www.epa.gov/biosolids/basic-information-about-biosolids#basics.)

Figure 2. Biosolids Use and Disposal from Major POTWs in 2019.



HUMAN AND WILDLIFE EXPOSURE & EFFECTS

Chemicals of emerging concern enter waterways through a myriad of ways including through agricultural runoff, manufacturing and industrial waste, biological waste products, and direct human pollution. Once they are in the waterways, people and wildlife are exposed through inhalation, ingestion, drinking water, and skin absorption. Letcher et al. found in 2015 that there are PFAS all throughout the Great Lakes, with the highest concentrations being in Lake Michigan. The researchers discovered an interesting concentration gradient in which PFAS concentrations in herring gull eggs passed on from the mother are at their lowest levels in the northwest in Lake Superior, and increase in abundance as you move south and east through the Great Lakes. Once these contaminants are in the water they are ingested and absorbed by wildlife organisms that live in and depend on these freshwater sources. Once taken in by an organism lower in trophic level, some contaminants can be concentrated as they move up the food chain in a process known as biomagnification.

Bioaccumulation is the process by which organisms accumulate harmful substances in their body. (USEPA, n.d.) The more an organism is exposed to through ingestion or otherwise, the more of the substance is stored, the more potential to harm it has. Organisms exposed at higher magnitudes or exposed for prolonged periods of time suffer more build-up. An organism with a long life span can end up with more toxicant in their tissue than a short-lived organism. Biomagnification is the process by which the abundance of harmful substances increases as it travels up the food chain. Organisms at the base of the food web can absorb toxicants in the dissolved state, and then primary consumers can consume those organisms, which are then consumed by secondary consumers and so on and so forth. This is concerning because organisms higher up on the food chain (including salmon and walleye), tend to be the same organisms that humans consume. This biomagnification process can lead to increased risks of toxicant effects to organisms such as top predator fish, fish-eating birds, aquatic mammals, and humans.

Many CECs are fat soluble, potentially making them more harmful to wildlife and humans. After being taken up by the organism, they are stored in fatty tissue. Then when the body goes to use the stored fat, the toxicants are released and cause harmful effects. Examples of CECs that are fat-soluble or hydrophobic include PCBs, DDT and other pesticides, and some PFAS. As the vast majority of polluted sites in the Great Lakes are affected by more than one contaminant, an overarching conclusion of research done in the region is that more time needs to be spent distinguishing the physiological effects of individual pollutants, and determining which pose the greatest threat, along with the intricacies of multisource/multiple exposure effects. Though there are a myriad of exposure effects, endocrine pathways seemed to be the most affected by the largest amount of CECs, with the thyroid gland being a particular target. (Baker et. al, 2014; Brouwer et. al, 1998; Leatherland 1998)

As with countless other environmental issues, we find that Black/Indigenous People of Color (BIPOC) communities and low income communities can be hit hardest by the effects of CEC contamination. Fitzgerald et al. conducted a study on the Mohawk indigenous peoples living in areas of New York, Ontario, and Quebec. Indigenous peoples value and require clean environments, including waterways, in order to continue to allow for sustenance fishing practices in the Great Lakes Region. The study found that in fish-eating populations of Mohawk peoples, men had higher concentrations of PCBs and DDEs than women or children (Fitzgerald et al., 1996).

Another study published in 2009 by McGraw et. al looked at concentrations of PCBs and DDEs in low income pregnant African-American women in the city of Chicago, Illinois. The study found elevated levels of PCBs in 80% of the cohort of women, and correlated different levels of PCBs and DDEs to a myriad of different cofactors including age, weight, race, and smoking. The study concluded that while the consumption of Great Lakes fish was one factor, a likely secondary factor was exposure through inhalation of Chicago air (McGraw et al., 2009), suggesting that remediation efforts should include other exposure pathways besides water alone.

COMMUNITY CONCERNS

The sociological effects CECs have on the communities they disrupt are as significant as the physical health effects that occur after contact. It is also important to note where CEC contamination is generally concentrated. While CECs affect everyone, they seem to follow trends inherent to other pollutants and disproportionately affect rural and lower socio-economic status (SES) communities the most. When these chemicals contaminate local waterways, they become complicit in undermining local economies by rampaging industries dependent on Lake use and identity erasure through ecological effects, exacerbated by lagging government action. Preliminary evidence and general trends following other pollutants suggests that CECs disproportionately affect minority populations in urban areas and have a significant effect on rural areas. Per- and polyfluoroalkyl substances (PFAS) are one of the more discussed CECs in the Great Lakes and their effects on these communities are currently being researched. Research has linked PFAS contamination to military facilities, industrial plants, and wastewater treatment plants (Hu X., 2016). This statement is corroborated by Cathy Wusterbarth, a Need our Water (NOW) representative advocating for the cleanup of PFAS contaminated water in Oscoda MI, as she discussed how the decommissioned Wurtsmith Air Force base near her home has heavily contaminated local tributaries and that the government often chooses rural areas for these bases.

Previous studies have also concluded that manufacturing sites tend to be constructed near minority populations (Mohai P. 2015). While few specific studies have been conducted on CEC presence near Great Lakes minority communities, the disproportionate appearance of industrial sites indicates the potential for higher CEC exposures (and potentially effects) in some rural and minority communities.

While the extent to which CECs harm human health has been explored previously in this report, the effect CEC contamination has on local economies and livelihoods is equally significant. CEC pollution has pressured local economies by disincentivizing recreation in areas that profit from tourism, devaluing property. Cathy Wusterbarth discussed how visible clusters of PFAS foam can be seen on bodies of water in Oscoda, making these popular swimming locations unsafe to use. Given the importance of vacation homes in the area, an inability to use popular recreation sites might cause families to locate elsewhere, contributing less capital to the Oscoda economy. Homeowners (whether vacation or permanent) in communities like Oscoda also potentially face lowering property values due to CEC plumes contaminating ground and surface water sources. Property values are lowering due to Michigan laws governing pollution, as the EGLE (Michigan Department of Environment, Great Lakes, and Energy) will not issue new well permits at properties where PFAS concentration is above 70 ppt (EGLE Declaration of Restrictive Covenant Part 201 H). With groundwater being

Industrial Pollution in the Calumet River. (EPA)

unfit for use, homes are forced to truck drinking water in. Distributing water this way requires homeowners to build and maintain external water tanks which are expensive and raise electricity bills, further lowering property values (Konwinski 2019).

The conditions affecting Oscoda are prevalent in many Great Lakes communities, however pollution also has hindered other practices reliant on the Great Lakes. CEC pollution follows similar trends to previous contamination events that have, in some instances, brought fishing activity to a halt in certain areas. Great Lakes fisheries have suffered from multiple stresses historically, such as overfishing, while today stresses including CEC exposures pose ongoing risks. (Proffitt 2019). Reproductive inhibition and chemical contamination have grown so severe as to have caused total fishery shut downs a few times in the past (Hudson, 2014). Modern CECs may be functioning in similar ways to pollutants that have previously shutdown fisheries. Studies on pharmaceuticals and PCPs shows that bioaccumulation in fish can alter behavior by stimulating increased feeding in some predators, which could have effects on prey numbers relative to predators, though more studies need to be conducted to assess the full impact (Brodin 2014). Legacy chemical pollution has also lead the EPA to issue consumption guidelines, which advise state governments and tribes to issue advisories that suggest healthy consumption levels for fish ("Fish and Shellfish" 2020). Advisories have already been announced for PFAS near sources of the substance around the Keweenaw Peninsula and Northwestern Lake Michigan (Williams, 2016). Advisories have also been put into place in Oscoda for fish and deer ('Fish and Wildlife' 2021),

Discussion on community effects of CECs tends to be inherently health and economy based, yet the tendency for these pollutants to help subvert culture and identity is equally as dangerous. Pollutants in the Great lakes have helped destroy or degrade natural resources inherent to indigenous peoples in the area, which has in turn forced these communities to move away from traditional hunting and farming practices. While studies specifically on CECs are lacking, Indigenous Communities in the Great Lakes have been exposed to pollutants that originate from the same sources as many CECs, suggesting the potential for these chemicals to add to burdens of indigenous peoples that are already struggling with challenges stemming from historic disempowerment. For example, the Anishinaabe people who live on the Aamjiwnaang reservation in Sarnia Ontario, just south of Lake Huron, share their source of water with 62 industrial facilities. Research on these lands has found elevated levels of cadmium in trees and inhabitants have found oils on rocks that have been traditionally used in sweat lodge ceremonies.

Bullhead fish with tumor on mouth most likely due to pollution, found in Lake Erie. (EPA)

Contamination of other natural resources has been detrimental to other Indigenous traditions, forcing this "dying culture" to "[reform] to North American Society", as quoted from Anishinaabe member Ron Plain (Bienkowski 2012). Mining operations and vegetation change in the Great Lakes have also helped to decimate the Manoomin (wild rice) population, removing a once extremely common part of some Indigenous Communities' diets (Brandes 2019). Case studies conducted throughout Wisconsin, in places such as Perch Lake and the Sand Point Sloughs in Wisconsin, have documented Manoomin loss in areas threatened by mining effluent and processes such as agricultural ditching (NOAA 2020). Increased exposure to new CECs in these communities is dangerous because these CECs threaten to exacerbate an already grim situation, and future monitoring and research on CECs in these communities is integral to protecting natural resources and practices inherent to indigenous peoples' culture.

Multiple Great Lakes communities have faced issues regarding CEC contamination and have been frustrated with the limited government response. Cathy Wusterbarth summarized concerns with the government in detail when discussing Oscoda's interactions with state government. The Michigan Department of Environmental Quality (now Department of Environment, Great Lakes, and Energy) and the Air Force were aware of the PFAS contamination from their base in 2012. of November 2020, there are only a ninth of the necessary filters in place to provide adequate water quality. The government has also offered to pay for filtration systems in homes that are contaminated above 70 ppt PFAS, As though Cathy emphasized that

without resident action she does not think aid like that would have been implemented. Cathy also discussed how there are a growing number of grassroots groups pushing for stronger PFAS use and clean up laws that have run into similar stumbling blocks.

CECs have the potential to undermine more than just health, as they have either directly affected or had strong potential to affect property values, Great Lakes economies, and cultural identities of Indigenous People. Government interaction has also been perceived as much less than satisfactory, as affected people are seeing a sluggish process in mitigating pollutant contamination. Major gaps appear specifically in CEC contamination, with the exception of PFAS in some communities, and in order to prevent further turmoil to these communities extensive research needs to be done on CEC concentrations and their explicit effects on Great Lakes communities along with more aggressive government actions to accelerate cleanup activities and reduce CECs from industrial, military, and other facilities.

TOOLS TO ADDRESS CECS

Though by definition, CECs are not well regulated or regularly included in monitoring programs, a number of federal, state, and local tools have been developed to address CECs. These tools include research programs, surveillance programs, regulatory programs, and non-regulatory programs. Many Great Lakes-focused tools are supported by the Great Lakes Restoration Initiative (GLRI), a multiagency effort to protect and restore the Great Lakes. The GLRI has provided approximately $3.48 billion to 16 federal agencies for restoration projects, including the EPA, U.S. Fish and Wildlife (USFWS), and U.S. Geological Survey (USGS) (https://www.glri.us/funding). This section will summarize the various existing federal, state, regional, and market-based approaches to managing CECs, with an emphasis on U.S. programs. With a Great Lakes focus in mind, state or regional efforts beyond the Great Lakes will not be included.

RESEARCH & MONITORING PROGRAMS

Relatively few CECs have been monitored in the Great Lakes due to a lack of available resources. What resources are available are typically used in efforts to monitor legacy contaminants instead. Additionally, analytical methods have not been developed to monitor many CECs in environmental media (IJC 2009). While there is no coordinated monitoring scheme for CECs, various programs exist throughout different government agencies to monitor such contaminants, including:

Unregulated Contaminant Monitoring Rule (UCMR)

The UCMR, operated under the Safe Drinking Water Act, is used by the EPA to collect data for unregulated contaminants that are suspected to be found in drinking water. Every 5 years, the EPA issues no more than 30 contaminants to be monitored by public water systems. UCMR results, in addition to other considerations, help the EPA determine whether to regulate certain contaminants (https://www.epa.gov/dwucmr).

EPA Toxic Release Inventory (TRI) Program

The TRI tracks the management of toxic chemicals that may be dangerous to human health the environment. Certain facilities of various industries must annually report how much of each chemical they manage through recycling, energy recovery, and treatment or release into the environment. The National Defense Authorization Act (NDAA) for Fiscal Year 2020 added 172 PFAS chemicals to the list of chemicals covered by TRI (https://www.epa.gov/toxics-release-inventory-tri-program).

USGS Toxic Substances Hydrology Program

Through the Toxic Substances Hydrology Program, USGS is investigating the sources, presence, and magnitude of CECs in the environment. The goal of this research is to better understand the contaminants from their source to their "receptor organism" (https://toxics.usgs.gov/investigations/cec/index.php).

CDC National Biomonitoring Program (NBP)

The National Biomonitoring Program measures over 300 environmental chemicals, including CECs, in human tissues and fluids. This data can be used to track exposure trends and better understand how different CECs affect the human body (https://www.cdc.gov/biomonitoring/index.html).

Agency for Toxic Substances and Disease Registry (ATSDR) Biomonitoring of Great Lakes Populations (BGLP)

The ATSDR is working with state health departments to collect health data from vulnerable populations in the Great Lakes region, including Native Americans, shoreline anglers, licensed anglers, and Burmese refugees and immigrants. This data is collected as part of the GLRI to assess exposure to priority legacy contaminants and CECs in susceptible populations (https://www.atsdr.cdc.gov/sites/great_lakes_biomonitoring/index.html).

NOAA Mussel Watch Program

The Mussel Watch Program monitors the concentrations of contaminants in bivalves and sediments in coastal waters and the Great Lakes, as an indication of environmental health. The Mussel Watch program has a number of research projects with a specific focus on CECs. (https://www.regions.noaa.gov/great-lakes/index.php/great_lakes-restoration-initiative/toxics/mussel-watch-expansion/)

U.S. Fish and Wildlife Service Midwest Contaminants of Emerging Concern Project

The USFWS CEC team works to understand how CECs might affect aquatic life in the Great Lakes, in partnership with the EPA and other governmental agencies. (https://www.fws.gov/midwest/es/ec/cec/index.html)

Department of Defense (DoD) Emerging Chemicals (EC) Program

In 2019, the DoD established the EC program to identify ECs, evaluate the impacts of ECs to people, the environment, and the DoD, and to take action against ECs (Department of Defense, 2019).

USEPA Great Lakes National Program Office (GLNPO)

The GLNPO coordinates efforts between the US and Canada under the Great Lakes Water Quality Agreement to accomplish the objectives of the GLRI action plan. The GLNPO, which is co-located in the EPA Region 5 offices, manages multiple programs that pertain to CEC monitoring and surveillance (including the following: https://www.epa.gov/aboutepa/about-great-lakes-national-program-office-glnpo)

- **Great Lakes Integrated Atmospheric Deposition Network (IADN)**
  The IADN is a binational network of stations across the Great Lakes that monitors the concentrations of persistent toxic chemicals in Great Lakes air and precipitation. These stations assist in identifying sources of toxic chemicals and discovering CECs in the Great Lakes region. (https://www.epa.gov/great-lakes-monitoring/great-lakes-integrated-atmospheric-deposition-network)

USFWS personnel performing fish collection activities on the Great Lakes. (EPA)

- **Great Lakes Fish Monitoring and Surveillance Program (GLFMSP)**
  The GLFMSP is a long-term monitoring program operated by the EPA that surveys top predator fish in the Great Lakes for contaminants every year. The Great Lakes Emerging Chemical Surveillance Program screens specifically for CECs to provide insight into what contaminants should be regularly monitored under the GLFMSP. (https://www.epa.gov/great-lakes-monitoring/great-lakes-fish-monitoring-and-surveillance)

- **Great Lakes Sediment Surveillance Program (GLSSP)**
  The GLSSP measures legacy and emerging chemical concentrations in Great Lakes surface sediment and sediment cores. (https://www.epa.gov/great-lakes-funding/great-lakes-sediment-surveillance-program-2020-rfa)

Minnesota Department of Health (MDH) CEC Initiative

Through the CEC Initiative, the Minnesota Department of Health collaborates with stakeholders to identify CECs, investigate their effects, and share information with the public (https://www.health.state.mn.us/cec#:~:text=The%20CEC%20initiative%20allows%20MDH,potential%20to%20enter%20our%20waters.).

REGULATORY PROGRAMS

Federal Regulatory Programs

Because of the varying definitions of a "chemical of emerging concern," many chemicals go unregulated despite their detection within the Great Lakes Basin. Most regulatory efforts stem from governmental organizations to strive to protect and conserve the environment as well as public health, such as the EPA. Although there is no federal statutory or regulatory definition of CECs, generally, the term refers to unregulated substances detected in the environment that may present a risk to human health, aquatic life, or the environment. As previously mentioned, the EPA monitors CEC's through its Emerging Chemical Surveillance Program, which is broken down into the following categories: surfactants, flame retardants, pharmaceuticals, personal care products, musks and fragrances, and unregulated industrial chemicals (Persoon, 2010).

The Toxic Substances Control Act (TSCA), which was passed in 1976, authorizes the EPA to obtain testing information from manufacturers to regulate over 86,000 chemical compounds and substances. Through this act, the EPA has the authority to both allow particular uses of a chemical and restrict or ban the substance entirely in extreme cases. However, food, drugs, cosmetics, and pesticides are excluded from this list; which include potentially dangerous CECs that may be regulated by other laws.The act has been most recently amended in 2016, granting the EPA more investigative powers into critical compounds used in an array of business operations. Failure to follow provisions under TSCA can lead to strict penalties, including fines.

Under the federal Safe Drinking Water Act (SDWA), which was originally enacted by Congress in 1974, functions to protect the quality of drinking water in the United States. As one of the largest freshwater sources in the world, the Great Lakes provide drinking water for approximately 10 percent of the US population and 30 percent of the Canadian population. Through the SDWA, the EPA establishes maximum contaminant levels (and goals) for regulated contaminants (EPA, 2015). Current EPA regulations for drinking water sources limit microorganisms, disinfectants, inorganic chemicals, select organic compounds, pesticides, herbicides, and volatile organic compounds. As of 2015, there are 94 contaminants that are regulated under the SDWA (EPA, 2004).

The CEC that has received the most attention from federal and state governments is per- and polyfluoroalkyl substances (PFAS), and has ignited both public and Congressional action to fulfill the need for rigorous identification, detection, and regulation action to protect human health and the environment. Under the Clean Water Act of 1972, which establishes the basic structure for regulating water pollutants and discharge into surface water, the EPA has the authorization to address certain CECs including PFAS. As a result, the EPA can leverage the Clean Water Act to prohibit the discharge of pollutants from point sources without a permit, as well as set contamination limits through permits to achieve restoration and maintenance of "the chemical, physical, and biological integrity of the Nation's waters." Therefore, it is important to note that while the EPA can prohibit discharge without a permit only from point sources, it cannot prohibit discharges all together.

In terms of many of the aforementioned categories of CEC's, many are found on an unregulated contaminant list, called the Drinking Water Contaminant Candidate List (CCL), which was first approved in 2008. This is formally the list updated via the Unregulated Contaminant Monitoring Rule, under the SDWA.

The EPA makes the decision to regulate contaminants in drinking water, which may include some of those previously monitored through the UMCR at a national level. (EPA, 2015) The list has been amended five times since, most recently in January 2021, through which new chemicals are added based on their frequency of occurrence in public water supplies and potential health impacts. The main obstacle in converting monitoring into fully fleshed out regulation of the CECs is primarily the need to demonstrate the effects of the chemicals on health and the environment. Without solid, unobjectionable, long-term proof of a negative impact, many of the CECs will only continue to be monitored without any tangible enforcement to limit their concentrations in the Great Lakes Basin, amongst other drinking water sources. Unfortunately, the effects of many CECs are still in the process of being understood, and therefore will require more research and study before more stringent regulations are implemented by the EPA.

The Resource Conservation and Recovery Act (RCRA) was mandated by Congress to give EPA authority that creates the framework for the proper management of hazardous and non-hazardous solid waste, including CEC pollutants. (EPA, 2002) Similarly, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as Superfund, functions to manages the disposal of hazardous solid waste that threatens the environment and or public health as a result of leakage, spillage, or general mismanagement. CERCLA authorizes cleanup responses in two ways: short-term removal and long-term environmental remediation(EPA, 2019). These actions can be conducted only at sites listed on EPA's National Priorities List (NPL).

The Food and Drug Administration (FDA) has also implemented some regulations in order to assess the risk to the environment caused by manufacture, use, and disposal of human and animal pharmaceuticals which may contain harmful contaminants such as CECs. It is worth noting that the FDA mainly has authority to reduce direct risks to human health rather than threats after a chemical has entered the environment. Thus, the FDA only needs to do an environmental assessment of drugs potentially released in the environment in certain situations. Ultimately, the FDA only exhibits regulatory authority over a limited number of CECs that fall under the pharmaceutical category.

In conclusion, while the federal government has exercised some of its powers to regulate potentially harmful CECs, EPA has encountered challenges to implement more stringent control over the pollutants. Much is still unknown about the long-term effects of CECs to the environment, human, and aquatic life in the Great Lakes and beyond. Therefore most CECs are still only being monitored and researched without any solidified regulation for their concentration levels.

There is concern about regulation preceding science, and thus regulatory steps may seem premature when there is limited scientific data on the chemical's effects. Alternatively, it can prove beneficial to be proactive, as the precautionary principle argues, as there will always be scientific questions but at times it makes sense to take action while some questions remain to prevent further detriment. However, many chemical substances have gained international attention, and thus there is hope that CECs will continue to be identified, and will be upgraded from simple screening programs to more tangible policies both nationally and locally.

State and Local Regulatory Programs

Within the United States, there are eight states that border the Great Lakes: Michigan, Wisconsin, Indiana, Ohio, Illinois, Minnesota, Pennsylvania, and New York. Thus, many of these states have researched and implemented their own regulatory programs to preserve the quality of the surrounding Great Lakes in the interest of human and aquatic health.

States including Michigan and Wisconsin are in the process of implementing regulatory programs to limit the concentration of different categories of CECs including PFAS. Michigan is finalizing their Maximum Contaminant Levels (MCL) for CECs and enforce quality standards for the Great Lakes and its tributaries. (Michigan EGLE, 2020) As of today, Michigan has already finalized fairly stringent MCLs for PFAS, and may be looking into more stringent water quality standards for surface waters.

The southern region of Lake Michigan receives significant attention from the nearby communities due to its higher density population and industrialized surroundings. Major cities such as Chicago, IL, and Milwaukee, WI, and their surrounding residential areas have begun to address the rise of CECs through voluntary monitoring and research, which could help inform policy and regulation both at the state and federal level. However, despite their large populations, these cities often still do not have a lot of the resources to support their own research, and monitoring for CECs and other toxic chemicals has proven challenging for volunteer citizens.

States in the region would benefit from increased federal resources and guidance for regulatory research, and monitoring programs, including community science programs that may be able to assist with monitioring in some cases. Thus, it seems the initiative should be led by the federal government to set the standard for water quality assurance and chemical pollutant regulation. While it is not feasible to monitor all the chemicals and pollutants that could present potential harm, an implemented assurance and chemical pollutant regulation.

While it is not feasible to monitor all the chemicals and pollutants that could present potential harm, an implemented ranking systems that prioritizes higher risk pollutants across different regions would allow for expedited data collection and a more thorough understanding of the nature of these chemical to avoid premature regulation. There is a need for more data on both environmental levels of CECs as well as guidelines for criteria indicating potential harm (i.e. water quality criteria). This also means more toxicological data is needed to identify hazards to human health and the environment.

International Agreements and Commissions

The Great Lakes Water Quality Agreement (GLWQA) was created in 1972 between the United States and Canada to provide the necessary framework to identify binational priorities to improve water quality. Together, the two nations work to restore and protect the waters of the Great Lakes. that pose a threat to both nations. One challenge, however, is the Agreement does not provide any additional regulatory authority; it is instead up to both nations to work together to develop programs , both independent and coordinated, to address CECs. (IJC, 2017)

These chemicals of mutual concern to the United States and Canada are addressed in Annex 3 of GLWQA. As of 2016, the US and Canada identified eight chemicals as the first set of chemicals of mutual concern (CMC) for which binational strategies to manage the chemicals by the US EPA and Environment and Climate Change Canada (ECCC) are to be developed. The eight chemicals that were officially designated CMCs are:

- Hexabromocyclododecane (HBCD)
- Long-Chain Perfluorinated carboxylic acids (LC-PFCAs)
- Mercury
- Perfluorooctanoic acid (PFOA)
- Perfluorooctane sulfonate (PFOS)
- Polybrominated Diphenyl Ethers (PBDEs)
- Polychlorinated Biphenyls (PCBs)
- Short-Chain Chlorinated Paraffins (SCCPs)

Together, through application of domestic water quality standards, criteria, and guidelines, the US and Canada monitor and evaluate the progress of the pollutants, regularly share monitoring information, and target the CMCs through binational strategies. There is a need on both sides to develop more water quality standards, given that there are very few to date for CECs--partly due to the limited data on which to base the standards.

EPA Administrator Lisa Jackson and Canadian Environment Minister Peter Kent signing the updated GLWQA in September, 2012. (EPA)

The International Joint Commission (IJC) is a binational institution charged with managing and protecting shared waters along the US-Canadian border. The IJC was created through from the 1909 Boundary Waters Treaty between the US and Canada, which provides general principles for preventing and resolving disputes over shared waters. The IJC is the body that implements the treaty, and therefore has the authority to issue orders of approval which can place conditions on related projects such as dams, bridges, or diversions. (Clamens, 2005) The IJC's regulatory authority is primarily concerning water quantity, such as for the flow between the lakes. They are also responsible for addressing shared water quality concerns, including providing recommendations to the federal governments to protect the waters of the Great Lakes.

Additionally, the Great Lakes Fishery Commission was established in 1954 to facilitate successful cross-border cooperation between Canada and the US to ensure the two nations work together to improve and perpetuate the fishery. The Great Lakes Fishery Commission works across boundaries to encourage cooperation to protect the valuable resources the lakes offer. (Sheehan, 2018)

The Commission has five main responsibilities to protect the life and communities in the Great Lakes:

- to develop a binational research program aimed at sustaining Great Lakes fish stocks
- to coordinate or conduct research consistent with that program
- to recommend measures to governments that protect and improve the fishery
- to formulate and implement a comprehensive sea lamprey control program
- to publish or authorize publication of scientific and other information critical to sustaining the fishery

The commission formulates their strategies based on the advice of management committees, scientists, fishery managers, and academic experts for the benefit of the fishery and the millions of citizens who depend on the resource for food, subsistence, recreation, and income. It is important to note that the GLFC traditionally has not had much focus on toxic chemicals.

NON- REGULATORY PROGRAMS

As previously mentionedd, little to no regulation of CECs by the government often leads to public outcry, such as with public exposures to PFAS compounds, estrogen-like compounds, and microplastics found in food and healthcare products (Bloomberg News, 2016; Scruggs, 2013). The United States has adopted a risk-based approach to chemical management that puts the burden on regulators like the FDA or EPA to prove that a substance is acceptable for human or environmental health once it is introduced to the market. Comparatively, the European Union has followed a more precautionary approach, such that chemicals must be demonstrated to be acceptable for use before entering into the market. Because of this difference, specific regulations for certain CEC's are not defined by the EPA or FDA. Furthermore, without government intervention, the usage of chemical products is difficult to manage in a supply chain, especially in those that are large-scale. Many companies are owners of smaller brands, and may have hundreds or even thousands of different supply chains operating around the globe, and managing the chemical usage of each of these supply chains can be difficult (Scruggs, 2013). With the lack of comprehensive scientific understanding and federal or state regulations of these compounds, industry representatives have taken it upon themselves to develop sustainable and safe chemical management programs to aid in the reduction of these compounds. The main goal of these non-regulatory, opt-in programs is to help guide sustainable chemical management from inception to end-of-life, and reduce human and environmental exposure throughout the supply chain and encourage companies to develop safer, greener alternatives. These programs may be especially useful for industries operating within the Great Lakes region.

The US Environmental Protection Agency states that voluntary programs can consist of the following four methods to achieve environmental and human health improvements:

- require firms or facilities to set specific environmental goals;
- promote environmental awareness within the industry and encourage process change;
- publicly recognize firm participation;
- use labeling to identify environmentally responsible products

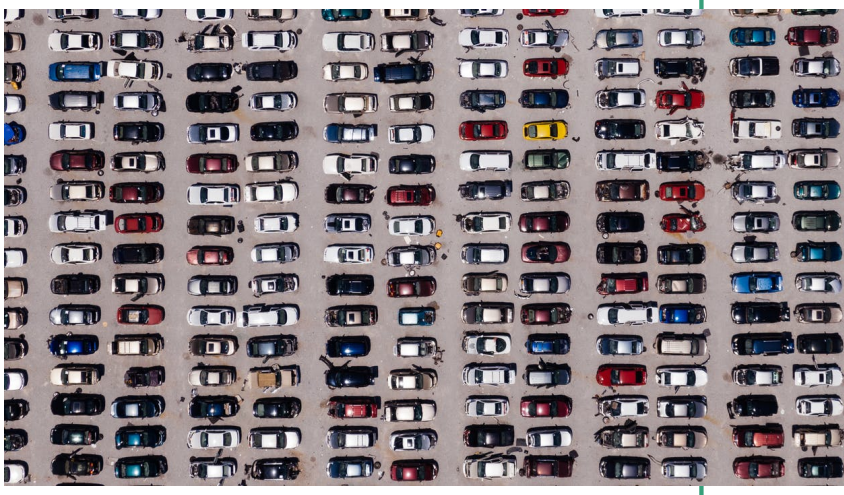
(Environmental Protection Agency)

It must be noted that most voluntary programs and organizations combine a number of these methods. The non-regulatory organizations and programs discussed in this section are defined by five main characteristics:

- Aimed at industry, by industry
- Free or low-cost, non-mandatory participation
- Not held to abide to program rules by law
- Market-based
- Aimed at increasing public awareness and perception of chemical producing and using companies

Defining Green Chemistry Programs

There are several non-regulatory programs which aim to practice green chemistry. Green chemistry is defined by the EPA as the design of chemical products that reduces or completely eliminates the use of hazardous substances, from production to end-of-life use. Green chemistry aims to eliminate pollution and hazardous substances at the source, resulting in the reduced need for chemical remediation after production, and reduce exposure risk for the public or environment (American Chemical Society). In the Great Lakes region, preventing pollution at the source is of particular importance. As a whole, the US chemical industry itself is not self-regulatory, but in recent years several programs have been created to assist in the self-regulation of chemical use as social responsibility, research best practices and alternatives, and spread knowledge to the public about green chemistry and chemical management.



Government-led Programs

EPA Green Chemistry Program
The EPA Green Chemistry program began in 1996 following the 1990 Pollution Prevention Act, which aimed to reduce hazardous substances from entering any waste stream into the environment (EPA). The Green Chemistry program is a voluntary, award-based program where participating companies or researchers submit proposals to further innovations in sustainability and green chemistry. This prestigious award is presented annually, and recognizes new chemical innovation and technologies that incorporate the use of green chemistry into the chemical design, manufacture, and use of products in several different categories.

Responsible Care Initiative, American Chemistry Council
The Responsible Care Initiative began in Canada in 1984, and was adopted into the US in 1988. Today it is practiced by companies in 68 countries. In the US, participation for Responsible Care Partners require CEO-level commitments to uphold the program goals and sustainability principles, which include:

- Promote the safe use of chemicals, informed sustainability decision-making and accelerated innovation by providing information on the impact of chemicals and creating frameworks to enable transparent decision-making
- Address environmental impacts of operations and products, including achieving measurable reductions in GHG emissions and pollutants through manufacture and production; conserve materials and reduce waste; aim to reduce marine debris
- Go beyond regulatory requirements to manage, monitor, and report progress through Responsible Care, which includes third-party certification and transparent reporting

(Swarr et al. 2019, American Chemistry Council, International Council of Chemical Associations, Canadian Chemistry)

Chemical Footprint Project by Clean Production Action
The Chemical Footprint Project is a program of the nonprofit Clean Production Action to further the concept and practice of chemical footprinting with the goal of reducing the use of chemicals of high concern. The Chemical Footprint Project Survey evaluates responders' chemicals management systems against best practice to measure and reduce chemical footprints. CFP is different from similar programs in that it is the first initiative to publicly benchmark corporate progress in chemical management and safer chemicals use. Participating companies complete a survey and get a score from 0 to 100. Third party validation is not required (meaning companies self-report), but they get additional points if responses are independently validated. Participating companies with CFP include: Levi Strauss, Clorox, Johnson and Johnson, Target, Philips, Walmart, and Hasbro.

Nonprofit- led Programs

BizNGO
BizNGO is a network program that aims to bring businesses, governments, and NGOs together to promote the creation and adoption of safer chemicals and materials to create a healthier economy, environment, and society. BizNGO consists of four working groups--Chemical Management, Hazards Assessment, Sustainable Materials, and Public Policy--to develop safe chemical management guidelines. NGO's are often at the forefront of identifying emerging chemical concerns (Rossi et al. 2011), and communicating directly with the industry sector provides the avenue to develop direct and appropriate chemical management initiatives. BizNGO is partnered with several big-name corporations and serves as the catalyst for creating the vision of sustainability that companies strive to achieve.

US Green Chemistry Institute
The Green Chemistry Institute (GCI) is a nonprofit centered around promoting and advancing green chemistry. Since 2001 it has been partnered with the American Chemical Society (ACS) to address the intersection of chemistry and the environment on the global scale (ACS). The Green Chemistry Institute's goals are centered around science, education, and industry to provide research, advocate for progress, and accelerate sustainable chemistry in industry sectors (ACS) based on the UN's Sustainable Development Goals. GCI achieves these missions by providing international conferences, webinars, research, and grants to industry actors, researchers, and students.

Supply Chain Solutions Center by Environmental Defense Fund
The Environmental Defense Fund (EDF) is a large environmental nonprofit, working since 1967 to conserve environmental resources. EDF's Supply Chain Solutions Center is described as "a digital hub for sustainability resources, best practices, thought leadership and news" aimed to solve industry-specific needs around issues such as energy, zero waste, sustainability, chemical management, and sustainable agriculture (EDF). Their five pillars of sustainable

chemical leadership are 1) institutional commitment, 2) supply chain transparency, 3) informing customers, 4) safer product design, and 5) public commitment. The Supply Chain Solutions Center offers several valuable resources to consumers on their chemical consumption, such as a chemical footprint calculator, and resources for safer food, personal care, packaging and cleaning products. There is also an emphasis on resources and effects of chemical management for individuals of color, which is especially pertinent considering that individuals of color, particularly Black individuals, can face greater exposure to toxic chemicals than their white counterparts (Zota et al. 2017).

Auto Industry Participation in Chemical Management Programs

Michigan's automotive industry directly employed approximately 291,000 Michigan residents in 2017 and brings in around $16B of revenue each year, making it Michigan's top employed industry, and is home to the headquarters of Ford Motor, Chrysler, and General Motors (MICHauto, 2019). While 74% of CO_2 emissions and an estimated 30% of the United States' total greenhouse gas emissions are contributed from vehicles (Union of Concerned Scientists, EPA), there are also several ecological concerns related to the automotive industry stemming from the supply chain, such as PFAS, paints and lubricants used in steel plating, and heavy metal leaching into soil and ground water from junkyards. In 1991, the EPA partnered with the largest auto manufacturers in Michigan to promote voluntary pollution prevention, determine persistent toxic chemicals being used and released, and explore opportunities to reduce the waste stream through the supply chain.

Managing contamination from end-of-life products is crucial to out-of-service products being largely unregulated and oftentimes sent to sit in junkyards or landfills. Based on review of program and company websites, while the largest auto companies are not participants in the chemical management programs discussed in above sections, several auto companies have developed buy-back, trade, and recycling programs to help mitigate the amount of waste produced from out-of-service vehicles and auto parts. Ford Motor Company established the Ford Core Recovery Program in 2003 to help reduce waste produced from vehicles. The program successfully collected and recycled approximately 120 million pounds of auto waste. The program however, was discontinued by Ford in 2012 due to administrative restrictions.

Around half of US Ford dealerships are also members of the Go Green Dealer Sustainability Program, which aims to improve energy efficiency at participating dealerships (Ford Sustainability Report 2018, Better Buildings). Similarly, GM has 152 landfill-free facilities, approximately 100 of which reuse, recycle, or compost approximately 90% of waste from daily operations. GM also recycles more waste from its facilities than any other automaker worldwide (GM, 2019).

Several third-party companies and organizations are also working to divert auto waste from landfills. The Clean Manufacturing Technology Institute (CMTI) based at Purdue University strives to provide technical assistance, education, outreach, and research services to facilitate the adoption of pollution prevention and clean manufacturing strategies by manufacturing facilities located in Indiana. The Great Lakes Pollution Prevention Roundtable (GLPPR) was a blog that existed for 25 years and worked to provide information about pollution prevention and management regarding green chemistry and engineering; technical assistance; behavior change and sustainability; and sustainable electronics in the Great Lakes region, but ceased operations in 2018 due to lack of funding. GLPPR produced several reports and publications about industry emissions in the Great Lakes region. For example, in 2015, Michigan was the Great Lakes state to emit the most GHG emissions through the transportation and manufacturing sectors, and Illinois was the highest in primary metals emissions (Bannon-Nilles et al. 2017). The role of GLPRR was not to act as an intervening or regulatory body, but rather to serve as a resource for educational services about pollution in the Great Lakes region. Third party companies and organizations such as CMTI and MICAR in Michigan also provide services to prevent pollution. The Michigan Certified Automotive Recycler program is sponsored by Automotive Recyclers of Michigan and is accredited by the Automotive Recyclers Association (ARA). MICAR certifies auto parts recycling companies and ensures that participating third-party companies are satisfying MICAR standards, participating in the MICAR audit program, and comply with membership requirements established by the ARM to meet performance standards set by the recycling and auto industries.

No major auto manufacturer has publicly advertised themselves as being a partner or collaborator of any of the discussed programs above. While this does not necessarily mean that no auto companies are partners with the above organizations, since it is not required to announce partnerships with organizations such as the

Chemical Footprint Project or Responsible Care Initiative, it is pertinent to wonder why one of the top industries in the United States would not want to be seen as participants in these management programs.

Implementing chemical management programs minimizes ecological and public health risks, worker deaths, and improves industry efficiency (OECD, 2020). While it seems as though certain manufacturers have their own sustainability programs, such as Ford's Partnership for a Cleaner Environment (PACE) program, which has been in service since 2014 (Ford, 2016), and aims to help their suppliers minimize their impact on the environment, or GM's internal goals of achieving 50% reused materials in all vehicles by 2030 (GM Sustainability Report, 2019) these programs are broadly focused on increasing efficiency in water, energy, and plastics usage at facilities and dealerships, with little emphasis on sustainable chemical management and third-party validation to reduce bias in self-reporting.

Strengths and Weaknesses of Non-regulatory Green Chemistry Programs

Absence of Public Advertising and Third Party Validation

Due to lacking federal classification and regulation of CEC's, non-regulatory programs such as the ones discussed in this report have been created as a way to promote efforts in green chemistry and sustainable chemical management practices from within industries themselves. Without any guidelines of official regulation or consequences for breaking program guidelines, however, such non-regulatory programs may fall short in their ability to fix the issue at hand. Because most non-regulatory programs are free to join and do not have federal or legal guidelines attached to them, industries must self-report and self-regulate their chemical management. Industry self-reporting has historically been shown to have many limitations in the chemical industry, leading to widespread pollution exposures, employee injuries, and lack of legal ramifications afterward (King et al. 2017, Prakash et al., 2011, 2012; King et al. 2000). The Chemical Footprint Project, for example, does not require third-party validation when scoring businesses based on their chemical usage. Businesses are incentivized to obtain third-party validation of their reports in order to gain a higher score, but this is not required.

Furthermore, participating companies in both the Chemical Footprint Project and Responsible Care programs are not required to disclose their participation to the public, which arguably goes wholly against the core ideals of transparency to the public when participating in such programs. While the Responsible Care program was created as an effort towards achieving social responsibility, studies have suggested that the chemical industry does not announce or advertise that the effort also "seeks to avoid stronger and more costly legislation and regulation" of chemicals and products that may severely impact human or ecological health (Givel, 2007).

Within the automotive industry, the risks of self-regulation are even higher with no third-party organizations to advocate for more progressive initiatives or provide public pressure to follow through with each company's goals. For example, who is holding GM accountable to actually achieve 50% reused and recycled materials in their vehicles by 2030 as promoted in their annual sustainability report? What will happen if GM (or any other company) falls short on that goal? While customers and the market may influence initiatives such as electric vehicles, other sustainability goals are more easily forgotten if they are not achieved, especially if the public is not made aware of them.

Combining Program Types

Non-regulatory programs have the potential to self-regulate the chemical industry without the influence of government interference, but only if the industry is open to self-regulation. The non-regulatory programs discussed above, despite certain flaws, are essential, progressive programs that are crucial in assisting protect consumers and the environment from toxic chemicals.

Based on the findings from this section and the section above regarding regulatory programs at the state and federal levels, it is worth noting that there is a need for both types of programs: government regulatory, and industry and nonprofit non-regulatory. Non-regulatory programs can spread awareness, education, and help instill best practices so that companies can stay ahead of regulations and avoid future legal problems. Additionally, consumers want to know that the products they use every day are safe for consumption; companies that disclose chemical phase-outs and promote chemical-free products can help foster positive relationships with their consumers, avoid negative publicity, and can provide a competitive edge against competing products and companies that may not have yet phased out certain chemicals (Scruggs, 2013). Pairing federal and state programs with non-regulatory initiatives can help assist in making sure that toxic chemicals are phased-on at a national level and that all chemicals and industry users are held to the same standard of sustainability and consumer safety.

CONCLUSIONS & RECOMMENDATIONS

As explained in this report, CECs pose a cyclical dilemma, in which lack of scientific knowledge deters regulatory decision-making and vice versa. This dangerous cycle, in combination with regulatory inefficiencies, has allowed for thousands of potentially harmful chemicals to enter the Great Lakes. Numerous studies have detected worrisome concentrations of CECs in drinking water, surface waters, and a variety of other environmental media, bringing attention to the urgent need for action against CECs. It is critical that the U.S. improve its chemicals management approach to identify and prevent future CEC contamination and reduce the amount of CECs currently in the environment.

Criticisms of the U.S.'s current strategy to managing CECs point out the inconsistencies among approaches between states and federal agencies, in addition to a broader lack of cohesion and collaboration among institutions. Managing CECs once they have already been created has also proven to be more costly and less effective than using a precautionary approach. The provided recommendations aim to address these criticisms by encouraging collaborative, proactive strategies to fill research gaps and design effective regulations in a timely manner. It's important to note that these recommendations only focus on U.S. and binational efforts, although strong chemicals management on the part of Canada is also crucial to protect the Great Lakes.

The following recommendations aim to improve the scientific understanding and management of CECs. These recommendations are largely derived from other studies, which are cited with each recommendation.

Safe Drinking Water Act (SDWA)

- Amend the SDWA to allow the EPA to select more than 30 contaminants for monitoring through the UCMR (GAO, 2014)
- Adjust the statutory time frames for the monitoring and regulatory determination cycles so that UCMR data can be used to support regulatory determinations in the same cycle (GAO, 2014)

TSCA

- Create protocols to minimize bias and ensure transparency in the TSCA review process (Singla et al., 2019)
- Replace the new TSCA scoring scheme with a stronger method of determining the quality of studies (Singla et al., 2019)

Great Lakes Water Quality Agreement

- Accelerate work to eliminate or continually reduce CMCs in a timely manner (IJC, 2017)
- Strengthen the CMCs under the GLWQA to target PFAS as a class (CELA, 2019) (Kwiatkowski et al., 2020)
- Consider an approach for designating chemicals, such as personal care products and pharmaceuticals, that may be unrealistic to eliminate, but need stronger management

Management Recommendations

- The EPA should develop a national list of priority CECs to guide federal and state agencies in prioritizing research and regulatory efforts (ACWA and ASDWA, 2019)
- The federal government should engage state agencies in establishing a national agenda to address CECs, who have been at the front line of identifying and prioritizing CECs in their communities (ACWA and ASWA, 2019)
- Federal and state agencies should expand the range of involved stakeholders in the chemicals management process, including citizens, industry, universities, and nonprofits (Hartmann et al., 2018)
- Chemicals management should adopt a proactive product lifecycle approach, which would be more effective than managing chemicals after their production (CELA, 2019; Klaper and Welch, 2011; IJC, 2009)

- The EPA should establish a universal definition for chemicals of emerging concern to prevent confusion and inconsistent standards (Anderson et al., 2016) (GLC, 2017).

- Researchers and decision-makers should assess and manage chemicals in classes, rather than individually to accelerate the decision-making process (IJC 2009) (Klaper and Welch 2011) (Kwiatkowski et al 2020)

- The U.S. and Canada should increase communication and coordination to implement binational CEC monitoring and management programs in the Great Lakes (Great Lakes Commission 2017) (IJC 2009)

- Industries with high usage of chemicals such as the automotive industries should provide more transparency and publicly advertise sustainability goals

- The use of third-party validation and consequences for failing to fulfill sustainability goals while participating in non-regulatory programs may help keep companies accountable for sustainable management practices

- The automotive industry should increase transparency in participating in sustainable chemical management programs and should partner with programs such as Responsible Care or the Chemical Footprint Project

Research Recommendations

- The U.S. should establish a national multi-agency research program to coordinate CEC studies among agencies (Klaper and Welch 2011)

- The U.S. and Canada should provide more funding for external research through academic institutions and non-profits

- The U.S. and Canada should develop a strategy to share available toxicological and monitoring data with the public and decision-makers to increase transparency, inform decision-making, and encourage cohesion among approaches (Hartmann et al., 2018)

- Researchers should focus on measuring the breakdown products of CECs and how they impact the environment, wildlife, and human health (CELA 2019) (Klaper and Welch, 2011)

- Researchers should explore how chronic exposures to PFAS affect wildlife and the human body (ACWA and ASDWA, 2019).

- Researchers should investigate how mixtures of CECs with other chemicals or non-chemical agents affect humans and wildlife (ACWA and ASDWA 2019) (IJC, 2009) (Novak et al., 2011)

- Researchers should identify and implement approaches for early warning systems for CECs through modeling and monitoring

- Researchers should investigate how CECs cycle through a wider range of environmental media

- The federal government should provide more support for research on green chemistry

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