Lake Champlain Basin Program

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Toxic Substance Management Strategy: Managing Toxic Contamination of Lake Champlain



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Final Report

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Toxic Substance Management Strategy: Managing Toxic Contamination of Lake Champlain

Executive Summary

The Lake Champlain Toxic Substance Management Strategy is a plan to reduce toxic contamination in Lake Champlain to promote a healthy ecosystem and protect public health as outlined in Lake Champlain's management plan *Opportunities for Action* (plan.lcbp.org). The Toxic Substance Management Strategy delineates strategies for monitoring and reducing several classes of toxic substances found within the Lake Champlain watershed. This strategy will be implemented by the Lake Champlain Basin Program, Vermont Agency of Natural Resources, New York Department of Environmental Conservation, and Quebec's Ministère du Développement Durable, de l'Environnement et des Parcs.

This strategy was written under the premise of the Precautionary Principle, by which preventative actions should be taken when there is the possibility of health or environmental concerns, even when scientific evidence of the threat is not immediately conclusive. Recent research has begun to identify toxins and their sources in Lake Champlain, which can be sourced to many different human activities and human infrastructure within the watershed, and from external sources. These toxins can accumulate in the sediments, remain in the water column, or enter the food chain, ultimately impacting water supplies, flora and fauna in the basin, and human recreational activities.

Categories of toxins that are reviewed in this management strategy include bioaccumulating toxins (e.g. mercury, PCBs), pesticides, pharmaceuticals and personal care products (e.g. medications, soaps), trace elements (e.g. lead, arsenic), road salts, and cyanotoxins (from blue-green algae). A more complete list of toxic substances of concern in the Lake Champlain watershed is provided in Table 2 of this document.

Many of the strategies identified in this document focus on education and outreach to the greater residential and business community in the watershed, either for reduction in use of toxic substances or for proper disposal of the substances. Implementation of monitoring programs for specific toxins is also an important component of the management strategy. Lastly, as many of these emerging toxins are not fully understood, some research into effects and life-span of the toxins is critical to managing them in our watershed.

Lake Champlain Toxic Substance Management Strategy:

Managing Toxic Contamination of Lake Champlain

Goal: Reduce toxic contamination to protect public health and the Lake Champlain ecosystem.

Background

The development and implementation of a comprehensive toxic substance management strategy has been identified as a high priority in *Opportunities for Action*, the Lake Champlain Basin Program's management plan for Lake Champlain. While concentrations of toxic substances in Lake Champlain are low in comparison to other more industrialized areas, detection of chemicals in the lake indicates that management and preventative measures should be implemented to reduce their potential threat to the ecosystem and human health.

The Lake Champlain Basin Program's Technical Advisory Committee convened a Toxins Management Workgroup in 2005 to develop the toxins management strategy, inviting individuals with expertise in toxic substances and their management in the basin. The Toxins Management Workgroup identified substances of concern to Lake Champlain and grouped these toxic substances into classes according to their source, properties and impacts. The groupings provide guidance to managing for different types of chemicals. This toxins management strategy identifies pollution prevention and mitigation strategies and is supported by the *Precautionary Principle*. The precautionary principle is a guideline that states that when there are suspected health or environmental concerns, preventative actions should be taken even when there is not a scientific certainty that harm will ensue. This means that the uncertainty associated with the chemicals found in Lake Champlain and their effects should not preclude management nor actions to reduce and prevent contamination. The strategy calls for management of toxic substances to be employed at multiple levels, including individual, private industry, municipal and state.

I. Introduction

Toxic substances are chemicals, both natural and man-made, that can adversely affect plants and animals, including humans. These impacts may be acute, occurring immediately, or they may be chronic, occurring after a prolonged period of exposure. These toxins are substances that cause an unreasonable risk of injury to a person's or organism's health. Certain toxic substances may come from natural sources, while others are released into the environment due to anthropogenic factors; both can threaten the quality of Lake Champlain.

Toxic substances are a diverse group of chemicals whose toxicity varies due to their physical properties, their quantity, and persistence in the environment. Adverse effects of some substances have been observed in the lake, but the long-term effects on the ecosystem, aquatic life and human health of persistent, low-level exposure to many chemicals are not well understood. Certain types of chemicals may affect the reproduction, development, behavior and survival of aquatic organisms at very low concentrations.

Recent research has begun to identify toxins and their sources in Lake Champlain. However, active sources, routes of transport, delivery, and quantity of these substances need to be identified. Sources of toxic substances include: spills, wastewater treatment plants, industry, storm water runoff, combined sewer overflows, agriculture, landfills, hazardous waste sites, household hazardous materials, and atmospheric deposition.

Once toxic substances enter the environment, they may accumulate in the sediments, remain suspended or dissolved in the water column, or be consumed or absorbed by aquatic organisms and enter the food chain. Some toxic compounds may change form and become different compounds that may have different properties and toxicities.

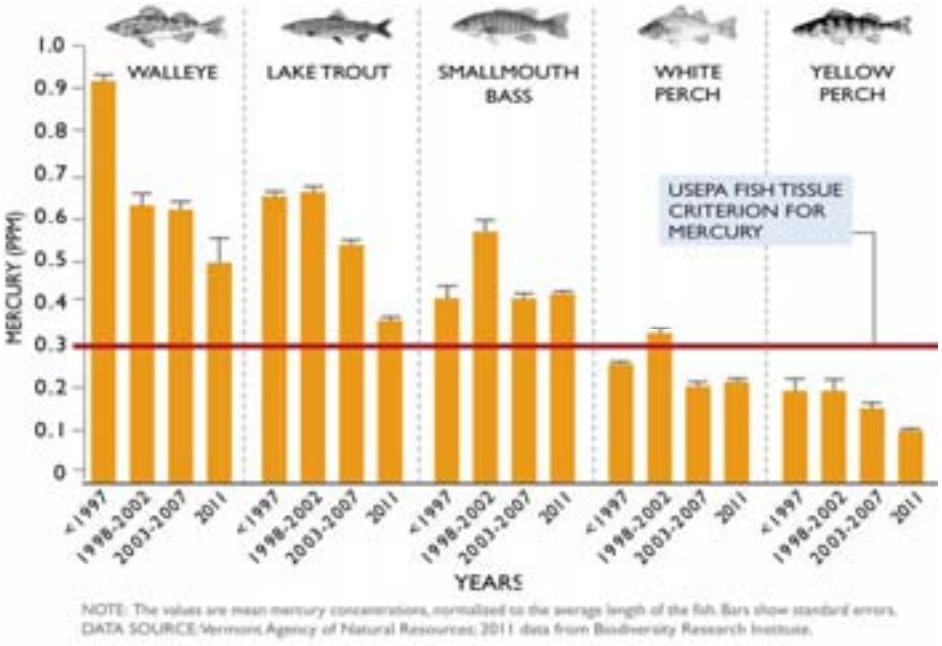
Mercury and polychlorinated biphenyls (PCBs) remain a threat to the lake and human health. Mercury and PCBs are toxins that persist in the environment and accumulate in sediments and aquatic organisms, including fish. Much has been done, in the way of both research and management, to reduce the level of PCB and mercury contamination and the threat to human health and aquatic life resulting from those contaminants. Safe consumption of fish remains a top concern for people residing in the basin; New York, Vermont and Québec continue to issue fish consumptions advisories in order to limit human exposure to mercury and PCBs. Current fish consumption advisory levels for Lake Champlain are provided in Table 1 and Figure 1 below.

Table 1. Lake Champlain Fish Consumption Advisories (from the LCBP State of the Lake Report, 2012)

	VERMONT		NEW YORK		QUEBEC*	
FISH SPECIES	Women/Child (A)	All Others	Women/Child (B)	All Others	Women/Child	All Others
Brown Bullhead	5	no advisory	4	4	8	8
Pumpkinseed	5	no advisory	4	4	no advisory	no advisory
Walleye	0	1	0	> 19" (48cm): 1*	8 < 20" / 4 > 20" (50cm)	8 < 20" / 4 > 20" (50cm)
Lake Trout	1	3	4	4	no advisory	no advisory
Lake Trout >25" (63cm)	0 (incl. child <15)*	1*	0	1*	no advisory	no advisory
Trout: Brook/Brown/Rainbow	3-4	no advisory	4	4	no advisory	no advisory
Chain Pickerel	1	3	0	4	no advisory	no advisory
American Eel	1	3	0	4 (in Cumberland Bay: 1)	no advisory	no advisory
Largemouth Bass	2	6	0	4	8	8
Smallmouth Bass	1	3	0	4	8	8
Northern Pike	2	6	0	4	8	8
Yellow Perch <10" (25cm)	3-4	no advisory	4	4	8	8
Yellow Perch >10" (25cm)	2-3	6	0	4	8	8
White Perch	no advisory	no advisory	no advisory	4	8	8
White Sucker	no advisory	no advisory	no advisory	4	8	8
Redhorse Sucker	no advisory	no advisory	no advisory	4	8 < 14" / 4 > 16" (40cm)	8 < 14" / 4 > 16" (40cm)
All Other Fish Species	2-3	9	0	4	no advisory	no advisory

* = Advisory specific to Lake Champlain. All other advisories are state-wide in NY and VT. The QC advisories are all specific to Missisquoi Bay.
A = The VT advisory applies to women of childbearing age, particularly pregnant women, women planning to get pregnant and breastfeeding mothers, as well as children age six or younger.
B = The NY advisory applies to women of childbearing age, infants and children under the age of 15.
SOURCES: NY Department of Health, 2011-12; VT Department of Health, 2007; QC Department of Health, April 2006

Figure 1. Mercury in Lake Champlain fish by indicator species (adapted from the 2012 State of the Lake report).



The landscape of toxic contamination in Lake Champlain is changing. New chemicals are being used and introduced into the environment on a daily basis. Continual advances in analytical techniques allow for increased detection of compounds that are released into the environment from domestic, agricultural, and industrial applications. Compounds such as pesticides, road salts, detergent additives, and pharmaceuticals and personal care products that are used in our daily lives are all compounds of emerging concern for the Lake Champlain ecosystem. The extent of contamination and magnitude of potential effects from these compounds are poorly understood.

A recent study conducted by USGS in the Lake Champlain Basin indicated that chemicals and their degradates from domestic and agricultural products have been detected in Lake Champlain and its tributaries (Phillips and Chalmers, 2009). Over 70 different chemicals were identified in the study, including flavorants, fire retardants, plasticizers, pesticides and herbicides, fragrances, stimulants, and detergent degradates. Many of these chemicals enter surface water through the wastewater stream. The highest concentrations of pharmaceuticals and antimicrobials detected in the USGS study were detected in the effluent of the wastewater treatment plant that services a hospital. High concentrations were also detected during combined sewer overflow events, when some waste bypasses the treatment plant. However, few contaminants were detected in the waters of Lake Champlain itself. Wastewater treatment facilities remove many types of contaminants, preventing them from entering surface water, but no facility or treatment process is capable of removing all detectable compounds. Overall, many of these *new-generation* contaminants reflect society's presence and culture. Research and management must now focus on these new contaminants and how to prevent them from causing harm.

Detection of chemicals in Lake Champlain and its tributaries indicates that management and preventative measures may be necessary to reduce potential threats to the ecosystem and human health. The overall strategy for the management of toxic substances should be guided by the *Precautionary Principle* (see above). Management for toxins should be employed at multiple levels, including personal, business, municipal and state. Every person living in the basin has the responsibility and ability to prevent toxic substances from reaching the ecosystem.

There are some general strategies that can be employed to manage and prevent toxic contamination in Lake Champlain. General management strategies include:

- Employ the *Precautionary Principle* as the guiding principle to managing toxic contamination. Under the precautionary principal, chemicals should be considered harmful until they are proven to be safe.
- Prevent and reduce toxic contamination to every extent possible.
- Conduct education and outreach to improve pollution prevention practices and increase proper disposal for governments, industries, businesses, and citizens.
- Establish and enhance toxic waste collection programs for agricultural products, household hazardous waste, and pharmaceuticals
- Conduct research and monitoring to improve our understanding of the source, quantity and fate of chemicals within the Lake Champlain Basin, including sediments, tributaries, lake water and wastewater and wastewater treatment effluent.
- Conduct risk assessments to determine the potential impacts of the presence of individual and mixtures of chemicals on human health, aquatic life and the ecosystem.
- Continually evaluate proposed Clean Water Act criteria for chemicals identified as possible toxins and encourage agencies and the public to set water quality standards.

These general strategies can be applied to manage all types of chemicals that are currently present or may enter the lake in the future. Specific strategies have been developed for groups of chemicals. Six groups or classes of chemicals were identified according to sources, properties and impacts (see Table

2). These six classes are not exclusive and specific chemicals may fit into more than one class: bioaccumulating toxins, pesticides, pharmaceuticals and personal care products, trace elements, road salts, other chemicals and cyanotoxins. Each group is discussed in detail and specific management strategies are outlined for each in the following sections.

Other chemical contaminants include chlorinated phenyls, persistent organics and solvents. This group of chemicals remains uncharacterized in Lake Champlain. Pollution prevention occurs through the state Department of Conservation's pollution prevention programs and multi-sector and municipal stormwater permit plants. Hazardous waste site remediation and cleanup occurs through various hazardous waste management programs.

II. Emergency Toxic Spill Response

Representatives from the Environmental Protection Agency (EPA), U.S. Coast Guard, the States of New York and Vermont, county and state emergency management and Canada are developing an emergency response plan in the event of a major environmental release of a toxic substance in the Lake Champlain region. The "Lake Champlain Area Contingency Plan" is scheduled for publication in late 2011. The planning will be carried out by collectively working through the expected response actions to two major environmental release scenarios, involving a major oil spill in Burlington, VT and a train derailment involving several railcars transporting anhydrous ammonia in Rouse's Point, NY. Follow-up work from this effort is expected to highlight ways to strengthen the response capability and coordination among organizations involved in an environmental emergency. The plan will also outline multi-agency command and lines of communication in the event of a toxic contaminant release or spill.

III. Bioaccumulating Toxins

Bioaccumulating toxins are compounds that persist in the environment and accumulate in organisms over time. Contaminants classified as bioaccumulating toxins include PCBs, dioxin/furans, and mercury and methylmercury. Some have been detected in Lake Champlain biota, sediment and water. Their presence in Lake Champlain has lead to fish consumption advisories issued by New York, Vermont, and Québec. These advisories are mainly due to the presence and accumulation of mercury and methylmercury in fish tissue. Extreme doses of bioaccumulating toxins may cause birth defects, cancer or other illnesses, behavioral and developmental abnormalities, and nervous system effects in humans. Elevated concentrations of these contaminants in the environment can result in documented impacts (lesions, reductions in fecundity, behavioral alterations, and increased stress hormones) on aquatic biota that in turn affect humans.

Mercury

Mercury is the most common contaminant of concern in Lake Champlain. While mercury is a naturally occurring element, human activities have greatly increased the amount released to the environment by five to six times in the northeast. The main source for mercury is atmospheric deposition, with the

mercury originating from coal-fired power plants and medical and municipal waste incinerators outside the Basin. Crematoria are an important potential source of local mercury emissions. Other sources include waste water treatment effluent and losses from landfills containing mercury bearing products. A source of the mercury emitted from wastewater is from dental amalgams that may be lost to the sewer systems upon placement or removal from teeth. Products containing mercury include gauges, thermometers and thermostats, batteries, fluorescent light bulbs, paint, and switches and relays. In the environment mercury can be transformed to methylmercury due to microbial activity. Methylmercury is the more toxic form that bioaccumulates in fish.

Management of the waste combustion sources of atmospheric mercury has lead to a regional reduction of atmospheric deposition of greater than 60 percent in the past 8 years. A goal of 75% reduction by 2010 was established by the New England Governors and Eastern Canadian Premiers. Recently a regional Total Maximum Daily Load (TMDL) for the northeast states (NY, VT, CT, NH, RI, MA, ME) was approved by the US Environmental Protection Agency. The goal of the TMDL is to reduce mercury emissions (in and beyond the region) to reduce the deposition of mercury and ultimately concentration of mercury in fish tissues to achieve current health level standards. The TMDL calls for a 98% reduction in atmospheric deposition.

Mercury reductions in the basin can be accomplished through reducing the source of atmospheric mercury from incinerators and electric generating units, by implementing air pollution control technologies and as appropriate, reducing the content of mercury in fuels (e.g., low-mercury coal). In May of 2011, after a long series of court decisions and regulatory response, USEPA initiated rulemaking to enact new "National Emission Standards for Hazardous Air Pollutants." This proposed rule treats mercury and co-emitted hazardous contaminants under §112 of the Clean Air Act, necessitating the application of operations practices on existing and new emissions sources to meet strict emissions levels. The rule envisions emissions reductions of 79% for mercury by 2015, with concomitant reductions in sulfur dioxides, nitrogen oxides, hydrochloric acid, and particulate matter. A modest reduction in total CO_2 emissions is also envisioned.

Proposed regulation in New York would require emissions from coal-fired plants to be reduced by 90% by 2015. Currently Vermont is considered to have minimal emissions from all combustion sources. This does not, however, imply that there is no further management of the problem needed in Vermont, a recognized national leader in the management of mercury in products.

In Québec, the Risk management Strategy for mercury on the website of Environment Canada (EC) describes the state and the actions ongoing in Canada: http://www.ec.gc.ca/doc/mercure-mercury/1241/index_e.htm

Proper disposal of mercury containing products is essential to reducing the inputs of mercury to the basin. Products containing mercury must be disposed of at hazardous waste drop off centers or recycling centers, and should not be disposed of in the household trash. Vermont and New York currently require manufactures to label all mercury added or amended products. In addition, both states have banned the sale of many mercury added products including novelties and fever thermometers.

Mercury is currently monitored and managed for in the basin. Measurements exist characterizing the amount of mercury in water, sediment and biota. A mass balance assessment indicates that 59% of the mercury load to Lake Champlain enters from the watershed, 1% enters from wastewater treatment plants discharging directly to the lake and 40% is deposited from the atmosphere directly to the lake (Gao et al. 2006). Continued measurement and study are necessary to evaluate and fully understand mercury flux and mass balance. In addition, a basin wide fish contaminant monitoring program should be supported with dedicated resources, to continually update fish consumption advisories, and to track efficacy of regional and national control efforts. On a statewide basis, New York has this program in place. Such a program was designed and reported to the Vermont General Assembly in 2006, but has yet to be adopted. Québec MDDEP has a provincial fish contaminant monitoring program with updated fish advisories. For Missisquoi Bay, visit http://www.mddep.gouv.qc.ca/eau/guide/resultat.asp?site=030040080 to view the guidelines for Québec mercury consumption advisories. Mercury contamination in Missisquoi Bay is less of a concern than in other parts of Lake Champlain. In 2003, the mercury concentration in sampled fish was less than the established Québec criteria of 0.5 mg/kg (Table 1). However, mercury contamination is still a major concern in Québec since nearly all of the fish consumption advisories are related to mercury.

Criteria on mercury and other contaminants in Québec can be found at http://www.mddep.gouv.qc.ca/eau/criteres_eau/annexe_16.htm and http://www.mddep.gouv.qc.ca/eau/criteres_eau/annexe_15.htm

Mercury Strategy:

- Support, promote and conduct public education and outreach initiatives on fish consumption, product bans, and proper product disposal at hazardous waste collection sites.
- Conduct additional comprehensive monitoring of mercury levels in fish tissue to ensure proper fish advisories and to evaluate trends in all three jurisdictions.
- Support and influence reductions of atmospheric mercury both within and beyond the basin.
- Conduct additional monitoring on the flux and mass balance of mercury and methylmercury in the lake and basin.
- Develop a single lake-wide fish consumption advisory for each species of sport fish in Lake Champlain

PCBs, Dioxins and Furans

Polychlorinated biphenyls (PCBs) are persistent industrial compounds that have negative human and environmental health effects. PCBs are banned for use, sale or distribution in all jurisdictions of the Lake Champlain Basin by federal law and Canadian permit limitations. PCBs have been monitored in the lake and in fish. High concentrations of PCBs were discovered near Wilcox Dock in Cumberland Bay, NY. New York State Department of Environmental Conservation conducted a two year clean up of the site. Dredging removed a sludge bed composed of wood pulp, wood chip debris, fine organic matter and other processing wastes that had been discharged from local wood product industries that contained high levels of PCBs. A subsequent monitoring program has been in place to test PCB concentrations in sediment, water and fish in the area. A sharp decline in PCB concentrations in sediment has occurred, post remediation. A decline in concentrations in fish has also been observed, although fish advisories

for some species remain. Efforts will be made by management agencies in the Basin to resurvey for PCBs and mercury concentrations in fish tissues every five years. These survey efforts will focus primarily on sportfishes, the dominant fish species consumed in Lake Champlain.

PBDE

Significant health concerns exist for polybrominated diphenyl ethers (PBDEs) in other states and Europe, although concentrations in the basin are uncharacterized. PBDEs are a flame retardant used in a variety of household products including fabrics, furniture and electronics and are ubiquitously found in the environment and fish tissues. The effects of PBDEs on aquatic biota and other aspects of the environment are currently unknown. In Europe and elsewhere, studies have shown that PBDEs bioaccumulate in fish, and have similar toxicity profiles to PCB's. An assessment of the presence of PBDEs in the basin and Lake Champlain fish is a first step in characterizing their effect in the basin, and is warranted. Certain classes of PBDEs have been banned from use in Maine and Washington, and a similar ban was passed by the Vermont General Assembly in 2009 that bans sale and distribution of "octa," "penta," and "deca"-brominated diphenyl-ethers.

PCBs, Dioxins, Furans and PBDE Strategy:

- Monitor the trends of PCBs in fish tissue in Lake Champlain.
- Examine sediment contaminants as a follow-up to the 1994 Lake Champlain Sediment Toxics Assessment in 2016 (25 year follow-up; McIntosh 1994). Analyze sediment cores to look at contaminant enrichment in upper sediment layers.
- Retrospective look at management programs that have been in place addressing these contaminants, corresponding to applicable legislation, industrial standard changes in various jurisdictions.
- Establish monitoring programs for PBDE compounds in Vermont, New York and Québec.
- Encourage legislation to ban PBDE compounds in New York and Québec.

IV. Pesticides

The grouping of pesticides includes herbicides, insecticides and fungicides used in urban, rural and agricultural sites. Pesticides are designed to kill or adversely affect problem species. Herbicides target the reduction of problem plants, insecticides target the reduction of problem insects, and fungicides target problem fungi.

Once applied to target areas, pesticides can enter the lake and tributaries through runoff. Once in the lake, pesticides and their degradates may adversely affect non-target species. For example, while herbicides are designed to protect agricultural crops by eliminating weeds they may affect phytoplankton if they enter the aquatic environment.

In the Basin, commercial pesticide use and sales are tracked by agencies within the three major governmental jurisdictions. Although commercial pesticide use is tracked in all three jurisdictions, tracking is not consistent and not fully comparable. In addition, minimal to no reporting or tracking is

done for private applicators and homeowner use and sales. The use of pesticides in these areas is also unregulated beyond labeled use restrictions and compliance with general pesticide management rules and regulations. There is a need to provide consistent tracking of both commercial and non-commercial (i.e. homeowner) use and sales in all three jurisdictions of the basin. Development of a system for tracking point-of-application use of pesticides for both commercial and private applications should be evaluated.

Pesticides are considered hazardous material. All jurisdictions provide mechanisms for pesticide disposal through hazardous waste collections.

The Vermont Agency of Agriculture Foods and Markets (VT AAFM) and the New York State Department of Agriculture and Markets regulate pesticide use for agriculture and other commercial operations through permitting programs. From 1998 to 2002 the major commercial use of pesticides in the state of Vermont was herbicides applied to land used for growing corn and hay (76%). Other uses included landscaping (12%), transportation right-of-way maintenance (8%), agriculture and forestry (3%) and insect control (1%). No information is available to quantify residential/home use of pesticides, but this is a significant potential source of pesticide contaminants in the Lake Champlain Basin.

VAAFM conducts a pesticide monitoring program which is designed to evaluate if pesticides are entering Vermont's ground water and drinking water sources near agricultural fields. The program was initiated in 1986 and samples water from wells, ponds or lakes that are used as water supplies. The results are used to determine the effectiveness of field practices at preventing contamination of water supplies. The results of the groundwater monitoring program indicate that very few wells (4% of those tested) near agricultural fields have detectable levels of herbicides. Since 1995, no groundwater tested had herbicide levels exceeding EPA drinking water standards for the materials tested.

Corn herbicide use is widespread across the basin. Atrazine is a common herbicide that has been used for corn production since the 1950's. Atrazine and its metabolic degradates are relatively persistent in the environment. New generation herbicides, including dimethamid, generally have shorter environmental half-lives than atrazine. These herbicides are highly potent, and often require smaller quantities to be applied to fields. Herbicides and other pesticides enter surface water though runoff. State, provincial and federal agencies have developed benchmark values, guidance criteria and water quality standards for assessing potential risks to ecosystems and human health resulting from contamination of waters by pesticides. The establishment of comparable pesticide risk assessment benchmarks from all jurisdictions in the basin should be encouraged.

VAAFM has monitored the presence of seven corn herbicides (acetachlor, alachlor, atrazine, dimethanamid, metolachlor, pendimethalin, and simazine) and 9 breakdown products in surface water from 2001-2007. In the basin, six lake sites and seven tributaries are routinely sampled for the presence of these target herbicides. The monitoring indicates that concentrations in surface water peak in July, after agricultural applications and large rain events. Atrazine, dimethenamid, metalachlor, simazine and acetochlor have been detected in surface water. Atrazine and metalachor are the most commonly detected herbicides, with the highest in-lake concentrations detected in Missisquoi and St. Albans Bays and the highest tributary concentrations detected in Jewett Brook, St. Albans. Overall the sampling program indicates that very low levels of herbicides are detected chronically throughout the

lake and the basin. While there have been few detections above EPA benchmark levels, there is a consistent loading of these compounds to Lake Champlain.

Pesticides most frequently detected in Missisquoi Bay through the Québec pesticide monitoring program are herbicides used for growing corn and hay (atrazine and metolachlor). The atrazine is persistent in the aquatic environment (superior half-life in 80 days). Its physiochemical characteristics (constant high and low solubility of adsorption on the organic matter) allow for easy contamination to streams through runoff. It is moderately toxic for the aquatic bodies but, according to the Pest Management Regulatory Agency (PMRA), it does not tend to accumulate in fish (PACR2007-05). The metolachlor does persist in the environment and it is easily washed from soil. It is slightly toxic for the aquatic environment. According to the EPA (EPA 738-R-95-006), the metolachlor does not accumulate easily in fish (low bioaccumulation).

To limit the negative impacts of pesticides used in agricultural lands near streams, the Québec Code of Management of Pesticides imposes distances to be respected during the application of pesticides (Article 30). These standards depend on the importance of the stream and include ditches. The respect for the distances (one meter or 3 meters according to the situation) allows for reduction of the loss of pesticides due to drifting and runoff. Increased awareness with the farmers on this aspect of the Code of Management would allow reducing the discharges in the environment.

In Vermont and New York, the States have primacy to regulate the use of pesticides and ensure all EPA's label restrictions are followed. EPA label restrictions take into account human health and overall environmental sensitivities and are specific to individual pesticide products. In Vermont, commercial pesticide applicators must be licensed to apply any pesticides. The licensing program ensures regular education and updates to pesticide applicators and technology transfer when new pesticides or changes in application methods, such as drift reduction technologies, are developed. In Vermont the Regulations for the Control of Pesticides regulate the storage and disposal of pesticides to ensure water quality is protected.

The domestic use of pesticides is lesser in terms of quantity. Several measures are presented all the same in the Code of Management to minimize the impacts of pesticides (e.g. for the maintenance of lawns and collection of waste pesticides). The Code of Management of Pesticides plans that for the manners others than agricultural, it is forbidden to apply a pesticide within three meters of a stream (Article 29). The establishment and the preservation of natural vegetative streambank by the local residents can also decrease the contamination of waters. The streambank will trap some sediment, on which various adsorbed pollutants (pesticides, fertilizer, etc.) have been documented. Several municipalities in Québec already encourage the implementation of streambank buffers.

Pesticide use patterns are constantly changing as old products are phased out and new products are introduced. Newer generation pesticides are generally developed with the intent of being quicker to breakdown in the environment and less toxic to non-target organisms. These characteristics tend to make the new generation pesticides more environmentally benign. Newer pesticides are often more toxic to the target organism than the pesticide they replace, meaning that less of the chemical is needed, but also that a small mistake in application can lead to a significant environmental effect. Newer generation pesticides, as well as other highly potent environmental contaminants, used in

minute quantities pose a special threat because effects are possible at or below the level at which they can be detected in the environment. The constantly changing use patterns make it very important that a consistent, basin-wide database of pesticide sales and use be developed.

Aquatic pesticides are occasionally applied to specific areas within the Lake Champlain watershed to control growth of plants and algae, and populations of fish and insects. The aquatic herbicides fluoridone (i.e. SONAR) and 2,4-Dichlorophenoxyacetic acid (2,4-D) are among the most commonly used chemicals to control aquatic plant growth. Aluminum sulfate (alum) treatments may be applied to ponds and small embayments to trap phosphorus in the sediments, and prevent algal blooms in the upper water column. Rotenone applications in New York have been used to reclaim small ponds that have been infested with unwanted fish species. Black fly and mosquito populations in Vermont and New York are frequently controlled by applications of *Bacillus thuringiensis israelensis* (BTi) to waterways to control the aquatic larval stage of this insect.

Lampricides are perhaps the most contentious of the aquatic pesticides currently applied in the Lake Champlain watershed. Sea lamprey (*Petromyzon marinus*) are an eel-like fish present in Lake Champlain that prey on lake trout (*Salvelinus namaycush*), Atlantic salmon (*Salmo salar*), and other species of fish in the lake. Sea lamprey populations are primarily controlled through the application of the lampricides TFM (3-trifluoromethyl-4-nitrophenol) and bayluscide (niclosamide). These lampricides are applied to sea lamprey-bearing tributaries and tributary deltas every four years, based on the sea lamprey life cycle. While not harmful to humans at the applied concentrations, research has demonstrated that some species may be affected by the applications – juvenile lake sturgeon, amphibians, and some native mussels. While the current sea lamprey control program has been found to be successful, efforts have been made to reduce lampricide applications wherever possible. The Lake Champlain Fish and Wildlife Management Cooperative (LCFWMC) formed the Sea Lamprey Alternative Control Work Group in the late 1990s to provide advice to the LCFWMC regarding possible projects that would reduce the quantity of lampricide applied to Lake Champlain tributaries. Projects researched to achieve this goal include dismantling of sea lamprey nests during spawning, application of sea lamprey pheromones to optimize lampricide applications, and the development of a population model for sea lamprey in Lake Champlain to explore efficacy of these alternative control strategies. In Québec, pesticide applications into aquatic environments are prohibited by the MDDEP.

Pesticides Strategy:

- Conduct public outreach and education to ensure proper disposal of pesticides through local hazardous waste collections.
- Conduct public outreach and education promoting lawn care that reduces or eliminates pesticide use.
- Conduct education and outreach to promote the use of Integrated Pest Management and better management practices that reduce the quantity of unregulated pesticides uses, including those used for landscaping.
- Develop consistent tracking and reporting across all three jurisdictions to monitor changes in commercial and private use, sales and application of pesticides.
- Continue monitoring and evaluating pesticides in the environment.

- Conduct a risk assessment on pesticide use, runoff and potential effects on non-target species.
- Conduct research on the chronic, low-level, exposure to pesticides on aquatic life focusing on the new-generation compounds. Collaborate with federal, state, municipal and private organizations involved in solid and hazardous waste management planning and activities.
- Support policy favoring comprehensive management of sea lamprey within the Lake Champlain Basin, including alternative management techniques to reduce application of lampricides.
- Confirm that there is no bioaccumulation of pesticides frequently detected in water of Lake Champlain (atrazine and métolachlor).
- Inform farmers of the pesticide application buffer zone near streams and ditches (Article 30 of the Code of Management of Pesticides).
- Inform the local residents about the importance to maintain a vegetative natural and diversified bank in association with municipalities. Inform also standards to be respected for the application of pesticides in border of streams (Article 29 of the Code of Management of Pesticides).
- Inform local residents and municipalities about the importance of maintaining naturally vegetated and diverse buffers, as well as pesticide application regulations in the riparian zone.

V. Pharmaceuticals and Personal Care Products

Pharmaceuticals and personal care products (PPCPs) are the products used in our daily lives for health and cosmetic purposes. They include prescription and over-the-counter medications, soaps and detergents, drugs used for veterinary/agricultural purposes, fragrances, cosmetics, sun-screen products, anti-microbial compounds in soaps, etc. PPCPs contain thousands of chemicals that are ultimately released to the environment through our waste streams (septic and municipal sewage). These chemicals may potentially affect aquatic life and ecosystems and are contaminants of emerging concern. Many of the chemicals found in PPCPs have been detected in streams, lakes and sediments nationwide and have recently been found in the water and sediment in the Lake Champlain Basin (Phillips and Chalmers, 2009).

Although the detection of PPCP-derived compounds in the environment does not necessarily indicate they are adversely affecting the biota, research suggests that some components of PPCPs may affect aquatic biota. Some of the chemicals may be directly toxic to aquatic organisms. Others, called endocrine disrupters, may cause changes to the endocrine (hormonal) system of aquatic organisms. Like other contaminants of concern, these compounds may persist in the environment, may degrade to form other toxic substances or may bioaccumulate in organisms. As these compounds exist as complex mixtures in the environment, they may also have additive or synergistic effects.

Further research and monitoring are necessary to understand the possible effects that PPCPs are having in the environment. The best management tool for preventing possible toxic components of PPCPs from affecting the aquatic ecosystem is to prevent the PPCPs from entering the environment. The proper disposal of PPCPs and discontinued use of potentially hazardous personal care products by individuals within the basin will aid in the prevention of contamination.

Antimicrobials

Many common PPCPs contain antibacterial chemicals, notably the compound triclosan. These products are advertised as being able to kill more bacteria and germs than their conventional counterparts and therefore help decrease illness and infection. The FDA recently reported that antibacterial washes are not more effective than conventional soap and have no proven benefit for the average consumer.

The antibacterial compounds in the personal care products, including triclosan and triclocarbam, are released to the environment. They are detectable in most surface waters and accumulate in sludge of wastewater treatment facilities, and degradates are released into the environment in effluent. Recent studies have shown that wastewater processing of triclosan produces dioxin-like compounds that ultimately accumulate in sediments of receiving waters. Researchers have estimated that up to 30% of the dioxin-like compounds detected in lake sediments may result from chemical degradation of triclosan during waste treatment. Triclosan and triclocarbam are toxic to aquatic biota as they are endocrine disrupters, persist in the environment, contain dioxin and carcinogenic impurities, and degrade to form additional carcinogens. In addition, the chemicals may act to promote potentially resistant bacteria in the environment.

Currently there are no restrictions on the use and release of these compounds. Preventing the release of antibacterial chemicals to the environment through the discontinued use by individuals in the basin is the best management tool.

Pharmaceuticals

Pharmaceuticals, both over-the-counter and prescription drugs, used by individuals enter the environment through the waste stream. These include such compounds as reproductive hormones, pain killers, antibiotics, anti-epileptics, and beta-blockers. Many drugs are not fully metabolized in the body and are excreted in their active state after ingestion. Their metabolites are also excreted. Additionally, expired and unused medications enter the waste stream when they are flushed down the toilet. Agricultural and veterinary pharmaceuticals, particularly antibiotics and steroids, are another source of chemicals entering the environment.

Pharmaceuticals used by individuals in the basin have been detected in the waste water treatment plant effluents, combined sewer overflows and in tributary waters. These include over-the-counter medications such as acetaminophen or diphenhydramine or prescription medications such as codeine or carbamazapine. The removal of pharmaceuticals depends on the type of treatment employed by the waste water treatment facility and the compounds ability to be biodegraded. Some compounds may be removed from the waste water effluent, but may be retained in their active form in the resulting sludge. Because of the quantity of pharmaceuticals used throughout the basin, their potential for entering the environment is significant. In 2006, the average annual prescription rate was 11 prescriptions (including both new and refills) per capita for New York and 12 prescriptions per capita for Vermont. Additionally, while the US population grew 12% from 1994 to 2004 the number of prescriptions purchased increased 68%. The continued and increasing use of pharmaceuticals for individual and veterinary purposes ensures their continued and increasing input into the environment.

Pharmaceuticals are biologically active compounds designed to affect human biology. However, the compounds may have biological consequences for organisms other than humans – even if the organisms

are exposed to consistent, low concentrations of the various compounds. Effects on organisms may range from endocrine disruption, reproductive impairment, abnormal or altered behavior, and toxicity.

Contaminants of Emerging Concern (CECs)

The EPA released a study in 2010 providing a review of available treatment technologies and their ability to remove a number of chemical "contaminants of emerging concern" (CECs). The general CEC classes reviewed in this study included PPCPs, steroids and hormones, pesticides, nonlyphenols, octylphenols, alkylphenol ethoxylate (APEs) compounds, polybrominated biphenyl ether fire retardants, polynuclear aromatic hydrocarbons (PAHs), and other chemicals (i.e., fire retardants and plasticizers). The 16 specific target CECs that were evaluated as part of the EPA review, included the following: bisphenol, caffeine, carbamazepine, DEET, diclofenec, estradiol, estrone, galaxolide, gemfibrozil, ibuprofen, iopromide, naproxene, nonylphenol, sulfamethoxazole, tri(chloroethyl) phosphate, and triclosan. In this report, the EPA also reviewed secondary or enhanced treatment technologies that are most commonly available or currently utilized to remove the common water and wastewater contaminants (solids, BOD, nutrients), such as: the activated sludge process, chlorine disinfection, granular activated carbon, ozonation, ultraviolet disinfection, and reverse osmosis. Although numerous other treatment technologies are currently utilized to remove common water/wastewater contaminants, only limited studies or data are available to accurately evaluate their technology-specific CEC removal efficiencies (including; fixed film biological treatment, biological and chemical phosphorus removal, de-nitrification, and nitrification).

The 2010 EPA review study indicates that the activated sludge process, ozonation, ultraviolet disinfection and reverse osmosis have the greatest potential for removing the greatest number of the studied CECs from municipal wastewater and treated effluent. Other, less studied, technologies that have shown some potential for removing CECs from such media include: phosphorus removal (biological and chemical), de-nitrification, and nitrification. Many of these common treatment technologies are currently utilized to remove long-known contaminants from water and wastewater (i.e., granular activated carbon, activated sludge chlorine disinfection, UV disinfection) and appear to provide measurable and satisfactory removal of new-age chemical contaminants of emerging concern.

Pharmaceuticals and Personal Care Products Strategy:

- Conduct a campaign targeting the basin detailing proper disposal of pharmaceuticals and elimination of the use of products with unnecessary additives (anti-microbial soaps).
- Continue monitoring for the presence of PPCP compounds in water and sediments throughout the basin, targeting wastewater treatment plant discharges, combined sewer overflows, urban and agricultural streams, and other problem areas.
- Conduct research on the effects of contaminants on aquatic organisms and the environment. Examine effects of individual compounds, including endocrine disrupting compounds, as well as admixtures of compounds.
- Develop a list of PPCP compounds of concern to aid in identifying and prioritizing management and reduction strategies.
- Identify appropriate next steps to remove PPCPs from the waste stream.

- Identify research and development options to upgrade opportunities for wastewater treatment facilities (WWTFs) to reduce or remove PPCPs and CECs from the effluent stream.
- Identify opportunities for pretreatment and upgrades at waste water treatment facilities to maximize PPCP removal efficiencies.
- Conduct an education campaign detailing the ineffectiveness of the PPCP compounds in daily use and the potential environmental consequences as the first step to preventing contamination.
- Continue monitoring and evaluating to determine presence and loads of pharmaceuticals in the environment.
- Evaluate the removal of pharmaceuticals from WWTFs and determine if upgrades are necessary and cost effective.
- Initiate new and promote existing pharmaceutical take-back programs to ensure proper disposal of unused pharmaceuticals.

VI. Trace Elements

Trace element contaminants include arsenic, manganese, cadmium, chromium, lead, nickel, silver, zinc and copper. Some trace element concerns relate to previous contamination of sediments, surface and groundwater that occurred at old mining and industrial solid waste disposal sites. Current potential sources include natural geologic formations, stormwater runoff, National Pollutant Discharge Elimination System (NPDES) discharges, aquatic nuisance species control, and air discharges. Within the basin, major sites of concern for trace element contamination and discharge include old mining sites in the Lamoille and Missisquoi drainages and in the Lake and river sediments downstream from those sites. Management of toxins substances in Québec can be found on EC website: http://www.ec.gc.ca/toxiques-toxins/default.asp?lang=En&n=97324D33-1

Trace elements are currently regulated through solid waste rules and regulations and hazardous waste regulations. In addition, permitting programs exist to regulate air and wastewater discharges of trace elements. Preventing trace elements from entering the Lake can be accomplished through better management practices, such as those employed for stormwater. In addition, to reduce trace element contamination in the basin it is necessary to remediate known contaminated sites that are producing contaminated runoff. Contaminated site cleanup occurs through hazardous waste programs, for example Resource Conservation and Recovery Act (RCRA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and various other state programs.

Trace Elements Strategy:

- Promote and support trace element prevention programs, including stormwater/air discharge permitting and hazardous/solid waste management initiatives.
- Monitor trace elements in stormwater runoff.
- Manage stormwater to reduce the amount of trace metals entering the lake.

VII. Road Salts

The contaminant grouping of road salts includes sodium chloride (NaCl) and calcium chloride (CaCl) used for deicing roads and parking lots. Recent evaluation of chloride levels in Lake Champlain indicates that concentrations have increased by 3-5 mg/L (30%) over the last ten years in the Main lake. The EPA has set guidance criteria for chloride in freshwater, and the ongoing monitoring programs indicate that concentrations in the basin typically do not exceed EPA guidance criteria of 860 mg/L for acute and 230 mg/L for chronic levels, except in some stormwater-impaired watersheds. Once chloride enters the aquatic system, remediation is difficult. The primary strategy for remediating chloride is source reduction. Current NYS standards for chloride in surface waters are 250 mg/L.

Sodium and calcium chloride enter surface water through stormwater runoff and groundwater infiltration of chloride applied to road and parking surfaces, as well as from chloride in storage facilities. In Vermont, New York and Québec, the multi-sector general permit programs address salt storage and use issues through required pollution prevention plans.

Ongoing assessments of salt use are being conducted by New York Department of Transportation (NYDOT), Vermont Transportation (VTrans), United States Geological Survey (USGS), University of Vermont (UVM) and Vermont Department of Environmental Conservation (VTDEC). VTrans and NYDOT also report use and application of road salts. Private use of salt on driveways and parking lots is not monitored. The implementation of better management practices to reduce the amount of salts used is the best strategy to preventing salt contamination of the aquatic ecosystem. Meaningful reduction strategies must be implemented for private and municipal applications. NYDOT and VTrans are currently implementing better management practices to reduce the use of salt on highways in New York and Vermont. Applications of brine solutions (mixtures of road salt and water) have been found to improve winter road conditions while reducing the amount of salt needed to maintain safe roads during the winter months.

Road Salts Strategy:

- Public education on proper uses of salt and alternatives to salt.
- Municipal and private property owner education on storage, use of better management practices, alternatives and effective/efficient use patterns, covered salt storage sheds.
- Consider development of a database of municipal and private entity road salt use.
- Demonstrate alternative strategies to road salt.
- Evaluate the potential negative impacts of road salts and road salt alternatives.

VIII. Cyanotoxins

Cyanobacterial toxins (cyanotoxins) differ from the other types of toxic contaminants discussed in this strategy in that they are produced by aquatic organisms which are a natural component of Lake Champlain. Cyanobacteria, or blue-green algae, have been identified to produce microcystins and anatoxin in Lake Champlain. Microcystin is a hepatoxin that can cause health problems including liver damage, and death and anatoxin is a neurotoxin that can cause paralysis and death. Cyanotoxins have become a human health concern in some segments of the lake, as in many areas throughout the world.

Cyanobacteria blooms typically occur in the summer months and into the fall in some segments of Lake Champlain, including Missisquoi Bay and other areas in the north lake. LCBP's partners have monitored blue-green algae and toxin levels in the Lake since 1999. A tiered alert system has been developed to communicate threats to the public. Public advisories are posted on the Vermont Department of Health website.

The jurisdictions in the basin have developed public health guidelines for concentrations of cyanotoxins for drinking water and recreational water. All three jurisdictions issue advisories if concentrations of anatoxin reach 1ug/L for both drinking and recreational water and if concentrations of microcystin reach 1 ug/L for drinking water. The recreational standard for health advisories for concentrations of microcystin vary among the jurisdictions. Vermont issues advisories if concentrations reach 6 ug/L, New York issues advisories if concentrations reach 11 ug/L, and Québec issues advisories if concentrations reach 16 ug/L.

The Province of Québec enacted the 2007-2017 blue-green algae intervention plan to outline their strategy to reduce harmful algal blooms in waterbodies throughout Québec, including Missisquoi Bay. The plan details methods to address three primary issues including improving knowledge about causes of blooms, reduction in phosphorus pollution, and increasing public awareness toward prevention of blooms and impacts to public health. More information about this plan can be found on the QC MDDEP website: http://www.mddep.gouv.qc.ca/eau/flrivlac/algues-en.htm

The management of cyanotoxins must be accomplished through managing blue-green algae populations in the lake. Reducing the occurrence of blue-green algae blooms will be achieved through nutrient management and reduction; specifically, phosphorus and perhaps, nitrogen. The phosphorus total maximum daily load (TMDL) program and the Québec phosphorus control strategies are the primary approaches to nutrient reduction for the Lake.

Cyanotoxins Strategy:

- Continue monitoring and providing public advisories for cyanotoxins in Lake Champlain.
- Support efforts to reduce and manage nutrients in Lake Champlain to reduce cyanobacteria.
- Develop one Lake Champlain Blue Green Algae alert system or standard.

References

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Phillips, P. and Chalmers, A. (2009), Wastewater Effluent, Combined Sewer Overflows, and Other Sources of Organic Compounds to Lake Champlain. JAWRA Journal of the American Water Resources Association, 45: 45–57. doi: 10.1111/j.1752-1688.2008.00288.x

McIntosh, A. 1994. Lake Champlain Sediment Toxics Assessment Program - An Assessment of Sediment-Associated Contaminants in Lake Champlain - Phase I. Lake Champlain Basin Program Technical Report# 5A. http://www.lcbp.org/techreportPDF/5A_Sediment_Toxics_Exec_Feb1994.pdf

Resources available via the World Wide Web:
Chloride Levels in Lake Champlain:
http://www.anr.state.vt.us/dec/waterq/lakes/docs/lcmonitoring/lp_lc-chloride.pdf
EPA 2010 review document:
http://water.epa.gov/scitech/swguidance/ppcp/upload/cecliterature.pdf
LCBP's Opportunities for Action:
http://plan.lcbp.org/

US EPA: http://www.epa.gov/
QC MMDEP: http://www.mddep.gouv.qc.ca/index_en.asp
US FDA: http://www.fda.gov/
USGS: http://www.usgs.gov/
VAAFM: http://www.vermontagriculture.com/
NY DEC: http://www.dec.ny.gov/
VTANR: http://www.anr.state.vt.us/

COMPARABLE TOXIC SUBSTANCE MANAGEMENT PLANS:

Anacostia River Toxic Substance Management Plan:
http://response.restoration.noaa.gov/book_shelf/1046_Management_Plan.pdf
Pennsylvania State Toxics Management Strategy:
http://www.pacode.com/secure/data/025/chapter16/chap16toc.html
Long Island Sound Toxic Substance Management:
http://longislandsoundstudy.net/about/our-mission/management-plan/toxic-substances/
Buzzards Bay Toxics Plan:
http://www.buzzardsbay.org/newccmp-toxics.htm

LIST OF ACRONYMS

APE: Alkylphenol Ethoxylate
BOD: Biochemical or Biological Oxygen Demand
BTi: Bacillus thuringiensis israelensis
CEC: Contaminants of Emerging Concern
CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act of 1980
EC: Environment Canada
EPA: Environmental Protection Agency (Federal)
FDA: Food and Drug Administration (Federal)
LCBP: Lake Champlain Basin Program
LCFWMC: Lake Champlain Fish and Wildlife Management Committee
MDDEP: Ministère du Développement Durable, de l'Environnement et des Parcs (Québec)
NPDES: National Pollutant Discharge Elimination System
NYDOT: New York Department of Transportation
PAH: Polynuclear Aromatic Hydrocarbons

PBDE: Polybrominated Diphenyl Ethers
PCB: Polychlorinated Biphenyls
PMRA: Pest Management Regulatory Agency
PPCP: Pharmaceuticals and Personal Care Products
RCRA: Resource Conservation and Recovery Act
TFM: 3-trifluoromethyl-4-nitrophenol
TMDL: Total Maximum Daily Load
USGS: United States Geological Survey (Federal)
UV: Ultraviolet Light
UVM: University of Vermont
VT AAFM: Vermont Agency of Agriculture, Food and Markets
VTRANS: Vermont Department of Transportation
WWTF: Wastewater Treatment Facilities

Table 2. Toxic Substances of Concern

Group	Contaminants	Assessment	Source	Regulations	Next Steps
Bioaccumulating Toxins	PCBs, Mercury, Methylmercury, dioxins/furans	These are persistent contaminants found in Lake Champlain biota, sediment, water. Levels of PCBs and mercury in fish are sufficient to result in consumption advisories lakewide and in many Basin waters.	Sources of mercury are now largely atmospheric, but also include wastewater treatment facilities' discharges and losses from landfills containing mercury bearing products.	Management actions have been implemented to reduce contamination of these bioaccumulating substances. PCBs are banned for use, sale or distribution. Legislation in VT, NY and QC, requires labeling of mercury added products, a phase out of many mercury added products, and a ban on the disposal of mercury added products.	Public education and outreach initiatives on fish consumption, product bans, and proper product disposal at hazardous waste collection sites. Additional comprehensive monitoring of mercury levels in fish tissue to ensure proper fish advisories and to evaluate trends in all three jurisdictions. Reduce atmospheric mercury both within and beyond the basin. Monitoring the flux and mass balance of mercury and methylmercury in the lake and basin. Monitor the trends of PCBs in fish tissue in Vermont waters and in the main lake
Pesticides	Herbicides, Insecticides, Fungicides	Some of these contaminants are found in the Lake at levels near or above standards or guidelines.	These are products that are used commercially, agriculturally and residentially. They enter the lake through erosion and runoff during storm events.	All pesticides are regulated at the federal and state levels, detailed permitting programs exist for some pesticides for agriculture and commercial uses.	Public outreach and education to ensure proper disposal of pesticides. Public outreach and education promoting lawn care that minimizes or eliminates pesticide use. Education and outreach to promote the use of Integrated Pest Management and Best Management Practices that reduce the quantity of unnecessary pesticides use. Track and report changes in commercial and private use, sales and application of pesticides in all three jurisdictions into a unified database.

					Risk assessment on pesticide use, runoff and potential effects on nontarget species. Continue monitoring and evaluating pesticides in the environment Research the effect of chronic, low-level, exposure to pesticides on aquatic life
Pharmaceuticals and Personal Care Products (PPCPs)	Medications, Antibiotics, Antidepressants, fragrances, surfactants, detergent metabolites, antimicrobial additives	Pharmaceuticals and Personal Care Products have been detected in the water and sediments of the Lake and tributaries. There is limited knowledge on the levels and effects of these compounds in the environment although research indicates some may be affecting aquatic organisms and ecology.	All of the products and medications used by people in the basin have the potential to enter the lake. Typically products enter through wastewater treatment plant discharge and septic systems.	NYS has issued guidance on the proper household disposal of pharmaceuticals and is promoting its "Don't Flush Your Drugs" campaign. NYS has enacted legislation (S 7560A: Drug Management and Disposal Act) that requires notice on proper disposal of drugs to be posted in all stores that sell pharmaceuticals. No other current regulations exist to reduce or prevent contamination.	Continue education and outreach on the proper disposal of pharmaceuticals and expand to include elimination of the use of products with unnecessary additives. Monitor for the presence of PPCP compounds in water and sediments throughout the basin. Research the effects of contaminants on aquatic organisms and the environment. Develop a list of PPCP compounds of concern to aid in identifying and prioritizing management and reduction strategies. Identify appropriate next steps to remove problem PPCPs from the waste stream. Identify opportunities for pretreatment and upgrades at waste water treatment facilities to maximize PPCP

					removal efficiencies.

Trace Elements	Arsenic, manganese, cadmium, chromium, lead, nickel, silver, zinc, copper	These are persistent contaminants found in localized areas (sediment, water or fish) at levels above standards or guidelines, indicating potential risk for humans and wildlife.	Current potential sources include natural geologic formations, stormwater runoff, NPDES discharges, aquatic nuisance control activities, and atmospheric deposition. Much of the concern for trace elements is related to legacy contamination of sediments and water at mining, industrial and solid waste disposal sites.	Solid waste rules and regulations exist to ensure proper disposal and to prevent contamination. Contaminated site remediation and clean up occur though hazardous waste management programs.	Promote and support trace element prevention programs, including stormwater/air discharge permitting and hazardous/solid waste management initiatives. Monitor trace elements in stormwater runoff. Manage stormwater to reduce the amount of trace metals entering the lake. NYS will revise its ambient water quality standard for Arsenic in its next triennial review standards rule making.
Road Salts	NaCl, CaCl	Concentrations of salts have increased in the Lake and tributaries over the last 10 years.	Salt used to deice roads and parking lots enters the lake through runoff. Road salt storage sites may also be direct sources of chloride to the lake.	There are currently no water quality standards regarding chloride concentrations in VT or QC. EPA provides guidance criteria for acute and chronic levels. Permitting programs address salt storage and use issues. NYS provides standards for chlorides in regulation (6 NYCRR 703.5) and total dissolved solids (including chlorides) in 703.3.	Public education on salts proper uses and alternatives. Education on storage, use of better management practices, alternatives and effective/efficient use. Develop a database of municipal and private entity road salt use. Demonstrate alternative strategies to road salt Evaluate the potential negative impacts of road salts and road salt alternatives
Cyanobacterial toxins	Mycrocystin, anatoxin	Toxin producing algae and toxins have been detected at levels above human health standards in areas in the Lake.	Species of algae produce toxins, including microcystin and anatoxin that are hazardous to human health. Excess nutrients entering the lake are likely one	The states and Québec have guidelines for the amount of cyanobacterial toxins in drinking water and recreational waters. Phosphorus control strategies are the primary approach to reducing	Monitor and provide public advisories for cyanotoxins in Lake Champlain. Support efforts to reduce and manage nutrients in Lake Champlain to reduce cyanobacteria.

			factor causing toxic algae blooms.	toxic algae blooms in the lake.	
Other Chemicals	Chlorinated phenols, PBDEs, Persistent organics, solvents	Known to be used or occur in the Lake Champlain Basin, but have not been characterized in the Basin. PBDEs are a significant health concern in other states and Europe, but are uncharacterized in Lake Champlain.	PBDEs leach into the environment throughout the life of the product containing them. PBDEs travel huge distances in air and water. Hazardous waste sites and landfills containing PBDE products are current sources of PBDEs to the basin.	Certain PBDEs are banned for use and sale in the United States. The Department of Environmental Conservation pollution prevention programs and multi-sector and municipal stormwater permit plans aid in the prevention of contamination.	Undertake a monitoring initiative for PBDE compounds. Encourage legislation to ban PBDE compounds in Vermont, New York and Québec. NYS will establish ambient water quality criteria for PBDEs.