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# TOXICANTS, HEALTH AND REGULATION SINCE 1945

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# 5 CHEMICAL INFRASTRUCTURES OF THE ST CLAIR RIVER

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Dead life falls to the bottom of the seabed, settles in the mud. Sand and silt slowly gather above. Time passes, sediment presses, seas recede. Under pressure the once live substance waits. Millennia pass, then, in 1858, oil that has lain in the archive of sediment for so long is pulled up into activity by North America's first commercial oil well in Oil Springs, Ontario, Canada. Oil gushes higher than the treetops, slathering the workers and the land, turning the Black Creek black, running into the Sydenham River which then empties nearby into the St Clair River.

The St Clair River forms a natural passage between wide Lake Huron and shallow Lake St Clair. Water then continues to flow south as the short Detroit River, which then empties into Lake Erie. Within the Great Lakes region that straddles Canada and the United States, the St Clair and Detroit Rivers together cut a border between the United States on the west bank and Canada on the east. Water flows from mostly white Sarnia at the top of the St Clair River down towards the ruins of contemporary majority black Detroit. Today, the St Clair is a deep water shipping channel connected to inland shipping laneways leading out to the Atlantic Ocean. The river is crossed by bridges that carry railroads and highways that then go on to traverse continental North America. What began with one oil well and a short pipeline to the nearby town of Petrolia, is today Canada's Chemical Valley, where 40 per cent of the country's petro-chemical processing is accomplished.[1]

Chemical Valley – which sits just below the city of Sarnia, Ontario and across the river from Port Huron, Michigan – first expanded beyond oil with a polymer rubber processing plant. Dow Chemical opened the plant in 1942 as part of the Canadian war effort. Gracing the back of the 1971 Canadian ten dollar bill, the plant etched in purple ink is a symbolic origin point of a national industrial history. Today this polymer plant is joined by over sixty other refining plants. Oil now pulses through Enbridge's transcontinental pipeline for 2,306 km from the Alberta Tar Sands to be processed in Chemical Valley and distributed across North America and beyond. A web of pipelines leads down to the United States, and interconnect local plants. Chemicals made in one refinery are pumped into another in a matrix of interconnected industrial frenzy. Some twenty-eight pipelines connect the US and Canada beneath the St Clair River. The river which runs past Chemical Valley has become a dense hub of industrial activities, mobilities and histories, a crucial crossroads in the petrochemical driven economies of North America. Called 'The Corridor', the waterway is the birthplace of both the commercial oil well and the Ford Motor Company. Petroleum was reproduced as gasoline to feed cars, cars themselves were made, steel forged, rubber refined, but so too was styrene, chlorine and perchloroethylene (for dry cleaning), as well as plastics that have become the consumer props of everyday twentieth century habits. Canals were dug, pipes buried, power grids laid, towns created, coal burned, jobs found and lost. Petro-chemicals, through Chemical Valley, have brought new things to life.

Starting with the petro-chemical history on the St Clair River, this paper is an attempt to think about infrastructures, forms of life and time in a site inundated with industrial chemicals.

## Chemical Infrastructure

What counts as an infrastructure? Concrete assemblages of factories, pipes, jobs, machines, roads and utilities, is a probable response. Sarnia-Lambton County, in which Chemical Valley is located, is celebrated for its industrial infrastructures. Its bridges built especially for transporting hazardous waste, its pipelines, smoke stacks and its eight power generators together form the substrate for a 'vast network of petrochemical and refining processes' that quintessentially qualify as an infrastructure.[2] The science and technology studies scholar Susan Leigh Star has rethought the common understanding of infrastructure as a physical supporting system and instead has reframed infrastructure not as a thing, but as a multidimensional set of relational properties that become an 'ecology of infrastructure'.[3] They are arrangements that structure relationships that emerge from human and non-human activity, which then go on to shape life again. Infrastructures are recursive, their temporal reach formed of many looping effects. Infrastructures are spatial arrangements of relationships that draw humans, things, words and nonhumans into patterned conjunctures. In other words, for Star infrastructures are built ecologies. Exactly what activities, relationships and temporal reaches make up a built ecology is not necessarily obvious. Infrastructures, as Star argues, are typically transparent to us, in that we don't particularly notice them unless something goes wrong. What is included in an infrastructure is an open question; what relationships are seen as making up a built ecology is contestable. Not all aspects of infrastructures are celebrated in the glossy brochures of business groups and



corporate partnerships. Some relationships are harder to track, harder to perceive and harder to arrange. Thus, this paper asks questions about the built ecology of this petro-chemical intensive corridor. What sedimented relationships, activities and material dispositions structure life along the St Clair?

The infrastructures along the St Clair River are made up of more than visible pipes, roads and refineries. They include what I will call *chemical infrastructures* that materially and unevenly shape human and non-human life in time and space.[4] By chemical infrastructures, I mean the spatial and temporal distributions of industrially produced chemicals as they are produced, consumed, become mobile in the atmosphere, settle into landscapes, travel in waterways, leach from commodities, are regulated (or not) by states, monitored by experts, engineered by industries, absorbed by bodies, metabolized physiologically, bio-accumulate in food changes, break down over time or persist. Chemical infrastructures are regulated and ignored, studied and yet filled with uncertainties. Many different disciplines and communities of experts make knowledge about chemical infrastructures, but this happens piecemeal – some studying fish, others engineering smokestacks, some tabulating emissions, others diagnosing illnesses. Chemical infrastructures, importantly, are spatially and temporally extensive. They are translocal, connecting moments of production and consumption, moving across borders, and traversing scales of life. They are temporally distributed, as some chemicals break down quickly, and others persist and are present for the *longue durée*, some causing immediate responses in organisms, others only provoking effects that take generations to see, working a slow injury on ecologies or organisms, or even planetary atmospheres. With the term chemical infrastructures, I am naming the pathways and processes of industrial chemicals as it structures the lives and times of both human and non-human.

Chemical infrastructures have been built into the landscape of the St Clair River for over a century. The forms of life possible here, for humans and nonhumans, are deeply shaped by the manufacture, regulation and dispersion of industrial chemicals: industrial chemicals are linked to creating jobs, widening rivers, changing ecosystems and altering physiologies. Twenty-five years ago Donna Haraway asked 'Why should our bodies end at our skin?', offering the 'material-semiotic figure' of the cyborg as an ontological politics for attending to the ways living-being was already constituted via technoscience.[5] At that moment, feminists were resisting a politics that posited bodies as natural entities, and instead insisting that any version of 'nature' or 'biology' at the end of the twentieth century was *already* conditioned by technoscience. To this we might add, that any reference to life in the twenty-first century is already conditioned by the chemical distributions of industrialism. Thus, in a similar spirit, one might pose the question, what is the place of industrial chemicals in the built ecologies that structure and constitute life? What figuration of infrastructure does environmental politics demand that we notice?

The notion of chemical infrastructures is meant to highlight the *uneven spatial and temporal distributions* of industrial chemicals and their diverse effects on life. What aspects of life are fostered and what aspects are abandoned in a chemical infrastructure? What is reproduced through chemical infrastructures and what averted and abandoned? What purposefully persists and what is unintentionally altered? Chemical infrastructures are importantly not just about the present, but also about the past; they include sedimented relationships, what happened that is not known, what persists and lurks. Time in chemical infrastructures often works through remainders, buried relationships or creeping accumulations. The temporal pace of chemical infrastructures is often slow or delayed, what Rob Nixon calls 'slow violence'.[6] Knowledge of past chemical events can be difficult to recover. At the same time, we may still be waiting for the effects from the past to show themselves.

It is this temporal aspect of chemical infrastructures – their slowness, their persistence, their creeping accumulation, their latency – that this portrait of the St Clair River emphasizes. Latency is a synonym of lag. Technically, it is the period of time between a stimulus and a response, the gap between one event and another. In medicine, latency time is similar to an incubation period. Latency time is the lag between infection and infectiousness. Or it is the wait between chemical exposure and symptom. To be latent is to be dormant, a potential not yet manifest. In temporal terms, latency is the wait for the effects of the past to arrive in the present. As such, latency is a movement from past to present or even to future. It is the inverse temporal orientation of anticipation – in which the not-yet future reorients the present.[7] In comparison, latency in ecological time describes how the submerged sediments of the past arrive in the present to disrupt the reproduction of the same. Through latency, the future is already altered.

## Latency and the St Clair River

Latency, I want to argue here, is useful when looking at the chemical infrastructures that are at stake for life in and along the St Clair River area. As the site of a chemical infrastructure, the St Clair River is not only a buzzing node in North America's petro-chemical network, it is also a landscape saturated with the effluent of industrialization. Since the 1950s, through layers of industrial processes, the 'excess' chemicals of production have been steadily moved into the waters, airs and ground of this region. At least since the 1950s, chemical dumping into the St Clair has been a source of public anxiety and scientific study. In the 1970s, in the wake of Love Canal, people also became increasingly concerned about the storage of industrial sludge and petroleum processing waste in salt caverns dug into the region's natural geology of underground salt deposits. Six hundred meters under the earth's surface, seventy-three caverns on the Canadian side of the river each hold the equivalent of three large surface petroleum tanks. Worry, too, has bubbled up over the great algae blooms that were strangling Lake Erie. In the 1960s, Lake Erie was declared a 'dead lake', as oxygen depletion caused by abundant algae had destroyed its ecosystem, killing local fish and plants. In 1969, an oil slick on the nearby Cayuga River, then considered the most polluted in the United States, caught fire in a location just before it pours into Lake Erie. Anxiety over the accumulated chemical alteration of waterways visible as sludge on the river's surface helped to prompt the first Great Lakes Water Quality Agreement of 1972, which was strengthened in 1978. The result, in the 1980s, was the pushing of effluent skyward, through stacks into the air. Today, the skies of Chemical Valley are thick with vapour, bright with flames of flares, and punctured with smokestacks decorated with twinkling lights.



Yet even in the 1980s, the past returned. In 1985, a toxic sludge congealment as big as a basketball court – known as the 'Sarnia Blob' – appeared in the St Clair River following a leakage of liquid industrial waste into the river from a cavern operated by Dow Chemical. The Blob was provoked by a leak of 2,500 gallons of perchloroethelyene into the river, which then congealed with chemicals from previous spills to form a sludge of arsenic, copper, cadmium, chromium, iron, lead, mercury, nickel, zinc, polychlorinated biphenyls (PCBs), hexachlorobenzene, phosphorus, manganese, oil, grease and a cocktail of at least thirty toxic compounds known as polyaromatic hydrocarbons.[8] Dow was fined $16,000 for the spill and then vacuumed up the sludge. Maxwell Cohen, chairman of the International Joint Commission that revised the Water Quality Agreement in 1978, described the latent presence of toxic chemicals in the area as 'the revenge of the industrial past and the chemical present'. That revenge is finding a variety of forms, he explained: 'Companies that were legally in business 50 years ago and dumped materials that now have proven to be lethal, or semi lethal ... No one controlled them 50 years ago, or 40 years ago, or even 30.'[9] The past defers its violence into the present.

In the contemporary time, river and lake sediment have become a contested site that materially archives this chemical past. To remove the sediment is to disturb it, and hence to release the toxic residues of the past back into animation. Yet the river and lake floors are not frozen in time – they continue to move and flow. PCBs, though banned in the 1980s, continue to move through the St Clair and Detroit Rivers and across Lake Erie, with intensive accumulations along the shores and inside canals. As a deep water shipping corridor, the riversides erode and the central channel is regularly dredged. Waste water continues to flow, and sediment is at stake. The chemical archive refuses to remain latent.

PCBs, along with mercury, have become the signature contaminants studied in these waterways. Both are persistent, and both were dumped in the river indiscriminately in the mid-twentieth century. Importantly, both can be studied because they are among the rare contaminants that are strictly regulated, with PCB production even banned. Their presence archives past regulatory actions, not the present, and thus do not call into question the effluent of the contemporary industrial frenzy. Maps of current PCB levels reflect the national origins of the studies that make them, the shores of Canada above or the US below become white space where data ends. Over time, PCBs flow down the river with the current into the Detroit River and into Lake Erie, a location marked with data points that shine red and purple to mark concentrations equal to or greater than a hundred times the 'Probable Effect Limit' of 277 mg of PCB per kg of sediment.[10] Other studies offer snapping turtle eggs as useful embryonic samplers of PCB levels in the waterways.[11] PCBs are reproductive toxins, giving their persistence a particular intergenerational form.

## Informating Chemicals

Squeezed between Sunoco and Shell, the Aamjiwnaang First Nation is a small Ojibway group whose ancestors have long lived along the St Clair River. As a colonized people, the Aamjiwnaang First Nation (referred to in Canadian government documents by the bureaucratic name 'Sarnia Indian Reserve 45') lays sovereign claim to its small territory of 1,280.5 hectares wedged amidst the refining factories of major multinational corporations, such as Imperial Oil, Sunoco, Shell and the old polymer plant. In recent years, environmental justice activists at the Aamjiwnaang First Nation have worked with local doctors, scientists and lawyers to document the first known case of a dramatic reduction in birth ratio of boys to girls, not associated with a specific acute industrial or nuclear accident.[12] From 1999 to 2003, only thirty-five boys were born out of a hundred children.[13]

This site and community sits at the cross hairs of multiple scales of governmentality: that of First Nation governance, of Ontario and Canadian environmental regulation, of the US and Michigan governance that controls the other side of the river and of Ohio on Lake Erie, each involving different state agencies and histories. As the US's largest supplier of oil, Canada remains deeply invested in spatializing this region as a zone that is attractive to production and refinement. Moreover, it is the provincially owned coal power plant that contributes the most air pollution to Chemical Valley.[14] Directly on the other side of the river sits Michigan's twin coal-powered plant. Regulations do not prevent chemical emissions, but rather manage them in a setting fostered by the state as a designated zone of industrial activity. Regulation does not so much prevent emissions as produce a structure of quantitative practices for assessing limits, collecting data and making models. The anthropologist Kim Fortun calls this the *informating of environmentalism*, in which research and governance converge on questions of data collection, circulation and display.[15] The informating of environmental governance has become exemplary of neoliberal practices that seek to monitor chemical emissions rather than to enforce specific standards.



On the Canadian side of the St Clair, regulatory practices at the federal and provincial levels exemplify this informating of governance. Most regulation happens provincially, and the province of Ontario has generated lists of 'point of impingement' standards for some 300-odd industrially produced emissions. The 'point of impingement' refers to the moment an emission leaves the property line of an industrial facility. However, more important is the rule-by-permit structure of Ontario regulation, which takes its scale of regulatory concern as an individual industrial facility, to which it grants what is called 'Certificates of Approval'. Certificates of Approval are site specific, and hence weigh the economic costs of a facility and its existing equipment against the point of impingement standards. Through the Certificate of Approval, industrial facilities are individually given permission to pollute, and must generate annual reports about their equipment and success in reaching point of impingement standards, and file incident-specific reports about unapproved releases. In other words, through this permit process, pollution is permitted, managed and turned into data practices. This is what the province, on its Ministry of Environment website, calls 'doing business in Ontario'.[16] Importantly for the chemical infrastructure of the St Clair River area, Certificates of Approval are only facility specific and hence do not consider the possible cumulative effect to a region that has a concentration of industrial facilities.[17] In other words, regulations structurally make the intensity and multiplicity of sources of industrial chemicals in air and water invisible. The recently passed Open for Business Act promises to streamline this permitting process further.

At the national level, industrial facilities again have to file a report on their emissions of select federally listed 'toxic' chemicals, and the collective data is then published annually as the National Pollution Release Inventory, a largely informational exercise. The data in the informational reports are created by industry itself, or by for-profit environmental consulting firms that specialize in meeting this bureaucratic requirement. Such environmental consulting firms do a brisk business along the St Clair. In Chemical Valley, an industry consortium records ambient air quality levels with a set of eleven air-monitoring stations and makes this data available online. In contrast, the provincial Ministry of Environment runs only one such station in the city of Sarnia itself, some distance from the industrial corridor. Data production about this site, thus, is deeply contaminated with industry. The regulations form a discursive weave of data within which the materiality of industrial chemicals slip between, out the stacks, over fences and into imperception.

What is known about the chemical infrastructure of Chemical Valley also comes from Aamjiwnaang environmental activists, ecologists, local NGOs and transnational NGOs such as Global Community Monitor. Their many efforts attempt to document the complex and chronic chemical exposures that are almost entirely unmeasured by the Canadian government through such techniques as body burden analysis and grass-roots bucket air sampling. On a clear odourless day in March 2008, members of the Aamjiwnaang First Nation's bucket brigade gathered an air sample near their cemetery. Tested in the United States, carbon disulphide was present in the sample at 41 μg/m³.[18] Neither the US or Canada has a federal air standard for carbon disulphide.

According to the Canadian Environmental Protection Act of 1999, carbon disulphide is not considered 'toxic'. This is not due to lack of evidence about the possible health effects of carbon disulphide, but rather because the 'mean' level of carbon disulphide that the population of Canada is exposed to as a whole does not exceed the standard of 'tolerable concentration', which has been pegged at 'the concentration for reduced peroneal motor nerve conduction velocity in a population of viscose rayon workers exposed' over a lifetime.[19] Thus, 'toxic' becomes a calculated regulatory condition, rather than a chemical property. According to the Canadian Environmental Protection Act, a chemical must first be present in a large enough quantity to constitute a danger.[20] The US, in juxtaposition, has an Occupational Safety and Health Association (OSHA) short-term exposure limit for workplaces of 36 μg/m³ (or 12 ppm) in fifteen minutes. Diverse studies have pointed to carbon disulphide as a reproductive toxin, with exposures of 13 to 77 ppm shifting sperm morphology, decreasing hormone levels and causing menstrual irregularities in humans.[21] Another study reported increased spontaneous abortion at exposures of 2 ppm.[22] Carbon disulphide, which is carried away easily by wind, has an atmospheric half-life of twelve days, moves over property lines, and then winks out of existence, leaving in its place the lag between exposure and harm, wafting in a state of regulatory invisibility and air testing illegibility.

At the Aamjiwnanng First Nation, the violent effects of externalized chemical excess has been tracked in the last decade by locally crafted community health surveys, and body maps that have documented the embodied effects of living in Chemical Valley. It is difficult to sustain such efforts as it is hard to raise funding, and members of the Aamjiwnanng Nation must continue to find work in the plants of Chemical Valley. Researchers can arrive, collect and share data and then leave, not directly involving themselves in local environmental politics. While efforts like bucket sampling can catch snapshots of chemical exposures of the present, and community health surveys track health responses to the past, neither type of knowledge provides data with the necessary temporal arrow: that past exposure leads to later health problems. Environmental justice activists have learned the painful lesson that chemical injury is not just displaced *spatially* with super stacks, toxic trading and selective plant placement, but also that chemical injury is displaced *temporally*, such that accountabilities exceed the scope of individual lives, bioaccumulating or persisting over time, across regulatory regimes, beyond research grants and into the conjectural future.



## Intergenerational Life

If the changed sex ratio of the Aamjiwnaang First Nation is the effect of past releases of chemicals, the temporal lag makes putting cause and effect together elusive. And this is the rub for chemicals that act as reproductive toxins or that can trigger cancers. The effects are not necessarily felt at the moment of the exposure, but later, in the future. Even if a chemical decomposes rapidly, winking out of existence, the effect it had on the organisms it encountered in its brief life might not be felt for years. Within the uneven spatial and temporal extensions of chemicals, people are 'living in prognosis', as anthropologist Lochlan Jain explains.[23] They are structurally living in the unknown individual probability of a statistical possibility, waiting for a symptom to arrive that can only point retrospectively and conjecturally to a possible harm.

In the case of endocrine-mimicking chemicals this latency is intensified, as endocrine-mimicking chemicals have a particularly intense effect on shaping developing fetal life – life not yet born, hence future life. Endocrine-mimicking chemicals, then, can manifest health effects in the next generation. Or the embodied response may not even be felt until the next generation, the grandchildren that will not be born. For example, research into the effects of the estrogenic chemical bisphenol A (BPA) on pregnant mice has found that the significant effects occur not so much for the fetus *in utero*, but for the eggs being formed inside that fetus, and hence effects are manifest for the potential grandchildren who will not be born.[24]

Here, the lives not born along the St Clair River may well be the effect of exposures endured by their grandmothers. Hence the sex-ratio effects experienced by the Aamjiwnanng First Nation may be the latent response of an acute exposure two generations ago. Or it could be the effect of continuous, multiple, accumulated multi-generational exposures crossing a threshold that has not become an epistemologically legible measure. Either way, the effects become a chemical manifestation of an ongoing colonial violence.

A 2006 national body burden study called 'Polluted Children, Toxic Nation' conducted by the NGO Environmental Defence included a family from Aamjiwnaang. Describing a world permeated by chemicals, in which collectively 'we are polluted', the study focused on sets of grandparents, parents and children, and tested the Plain family of Aamjiwnaang, composed of grandfather (who had the study's highest concentration of PCBs), father (who had the study's highest overall chemical burden), and granddaughter (who had one of the lowest overall chemical burdens, with only seventeen reproductive toxins detected). How to tally the intergenerational effects of this chemical infrastructure is a politically charged project towards making the layered temporal existence of industrial chemicals visible.

Amidst the cacophony of studies, a chemical infrastructure is only ever partially tallied, only selectively perceivable, despite the many ways data proliferate. Industrial chemicals cross between bodies, link generations, mix in the air, cycle through the water, blow out a chimney, seep through a crack, cross property lines, and haunt the sediment, yet all the regulations together do not make the chemical infrastructure particularly visible. The production of data as the primary product of regulation offers the fantasy that management is underway, that chemicals have been logged and as such contained. Corporate good neighbour reports by Imperial Oil, promotional efforts by the local Chemical Sustainability Alliance, and national toxic registries all work together to form the fantastical discursive effect of rendering Chemical Valley as unpolluted.

While work has gone into showing how the violence of this chemical infrastructure has concentrated in the space of Aamjiwnaang land (a parcel made available to such injury by a colonial history of displacement) it is also the case that the possibility of chemical injury exceeds the region of the St Clair River, traveling in commodities around the globe. The health effects of chemical infrastructures are also thus more ubiquitous in what S. Lochlann Jain calls 'commodity violence', in which the harmful effect of commodities are probabilistic for the population, but not causally isolatable or predictable at the individual level.[25] It is only as a commodity danger that BPA has become legislated against in Canada, not as an industrial ingredient.

In fact, the research that gave rise to the notion of 'endocrine disrupters' was sparked in part by the effects of plastic labware, particularly the test tube ingredient nonylphenol. Plastics, and the chemicals they leach, moved into laboratory practice, and in this way asserted their presence in cell biology research. Ana Soto and Carlos Sonneshein, whose early work on endocrine disrupters was prompted by plasticware in 1989, used this work to develop the first commercial endocrine disrupter assay.[26] In other words, the nonylphenol in the labware helped to materialize the test by which a substance is experimentally definable as an 'endocrine disrupter'. Soto and Sonneshein have extended their research into endocrine-mimicking chemicals as part of a more general theory about metazoan (animal) cell proliferation, and hence cancer. It has long been an assumption that metazoan cells are by default quiescent, while plant cells are by default proliferating. Hence animal cells, according to this understanding of quiescent, need to be stimulated to reproduce or become cancerous. Soto and Sonneschein, in contrast, argue that metazoan cells are also by default proliferant, but that there are cytoplasma inhibitors that halt their proliferation.



Endocrine, and endocrine-mimicking chemicals, can inhibit these inhibitors, and thus, by virtue of indirect negative feedback, release cells into a proliferating state. In this way, cancer does not become a problem of genetic mutations stimulating cells to proliferate but rather, of chemical agents interfering with inhibitors that prevent proliferation. In other words, proliferation is a latent property of animal cells.[27] Or put another way, latency is a crucial capacity that regulates cellular proliferation and reproduction. Chemical itineraries into plastics and then into bench science experiments, have prompted this lesson that changes the very epistemological orientation of cancer research and helps to give us the category of 'endocrine disrupters'.

Cancer is a serious concern in Sarnia, despite the fact that the city's relative prosperity stands in stark contrast to the decayed industrialism, shrinking population and poverty of a once-proud Detroit, past symbol of American capitalism. The good life of Sarnia has an unusually high rate of rare cancers. For men living in the community who have worked in the refineries, the overall cancer rate is about 34 per cent higher than the provincial average, the lung cancer rate 50 per cent higher, the mesothelioma rate (linked to asbestos) is five times higher and the asbestosis rate nine times higher. Recently, a Wilm's cancer cluster, a kind of childhood kidney cancer, has been identified on the United States side of the river. Wilm's cancer tumours have been correlated with maternal exposure to pesticides.[28] Cancers, with names and medical treatments, are just one way of living in prognosis within chemical infrastructures. Reproductive toxins are yet another, and unlike cancers, lives that are not born are largely uncounted and unnamed. There is no medical treatment for a past harm that happened before birth, and perhaps even before conception. There is no life to treat. The possible role of past exposures to endocrine-disrupting chemicals in the changed sex ratio among the Aamjiwnaang is difficult to prove. Nearby Sarnia shows no such change in sex ratio. Other known cases of human sex-ratio changes have been linked to acute occupational exposures or industrial accidents.[29] Almost no state funded research has been conducted to help study this question.

In contrast, the study of sex-ratio change and other effects tied to sex is flourishing in local freshwater biology research. On the St Clair, herring gulls have been found to have a reduction in males, and a greater portion of male embryo death. Snapping turtles are feminized. White perch have a 45 per cent rate of being intersex in the St Clair.[30] Non-humans can be dissected and even killed for the sake of developing better knowledge about the chemical infrastructure saturating the ecosystems. Their shorter life cycles make intergenerational harms easier to track and even accessible to study with laboratory-based experiments. Intersex organisms and changes in the ratio of males to females are bound together in studies that register such organism and population level alterations as signs of the unseeable chemical infrastructure swirling in the St Clair.

The round goby has emerged as a living sentinel for endocrine-disrupting chemicals in Great Lake waterways.[31] The round goby is a fish from Europe, first found in the St Clair River in 1990, likely transported there in the ballast water of ships. Since then, the round goby has rapidly come to occupy all five of the Great Lakes. Gobys are bottom feeders. In other words, they feed off the layer of micro-organisms, and particularly the mussels, that live in surface sediment. Mussels, in turn, are filter-feeding invertebrates known to bioconcentrate contaminants. Thus chemicals have found a new route of bioaccumulation in the round goby. At the same time, the round goby is so successful as an invasive species because it is relatively pollution tolerant. Nonetheless, round goby populations show signal sex changes in response to endocrine-disrupting chemicals. Ecotoxicologists capture goby samples in sites expected to have high levels of contamination and perform a variety of tests that cannot be done to human bodies, including dissection and measuring of the chemical load in tissue and livers, as well as the checking the condition of gonads. In particular, male urogenital papilla that are shorter in length, a skewed sex ratio (which has a rare higher rate of females in the Detroit River), and the presence of eggs and sperm in male goby testes are all signals of endocrine-disrupting chemicals.[32] So too is the presence of vitellogenin, an egg yolk precursor that is protein synthesized in the liver, which is not expressed in males unless they are exposed to xeno- estrogens.[33] In the last few years, students working at local universities have developed a PCR assay for the presence of vitellogenin in the round goby. Thus, the round goby, which lives only two to three years, is becoming a 'signature of contamination' organism for the Great Lakes, a living assay that provides a way to sample and map the presence of endocrine disrupters.

Fish play an important role in the chemical infrastructure of the St Clair. Commercial fishing was banned in 1970 because of the presence of mercury, one of the first environmental regulatory acts governing the river. Fishing was also a source of food for many who lived along the St Clair, including the Aamjiwnaang, and thus the Aamjiwnaang were among several First Nations communities who in the 1970s were diagnosed as having Ontario Minamata Disease, a form of mercury poisoning first diagnosed in Japan.[34] The Dow factory that sits directly upstream from Aamjiwnaang land has manufactured chlorine since 1947 using the mercury cell method, a process that released methylmercury (which is more toxic than mercury and readily crosses blood–brain and placental barriers) into the river. Elders remember playing with mercury in the local creek, and harvesting mercury to sell on the black market.[35] The loss of this traditional food source was yet another manifestation of colonial violence in chemical form. Aamjiwnaang residents are warned to eat only one fish per week, and pregnant women and children are warned to eat only one fish per month. Today, recreational fishermen along the river are surveyed about whether the fish they catch are 'tainted', and are asked to use their sense of smell and taste to evaluate fish safety. Dow is considering 'capping' the sediment along their stretch of the river with concrete in an effort to contain the mercury of the past.



## Refusing to Remain in the Past

Chemical infrastructures have histories. But these histories refuse to remain in the past. Gaps in time, between chemical emission and effects, work to support the regulatory fantasy that the chemical infrastructure is safely contained as good business. The chemical industry calls this Reponsible Care™. However, on occasion the chemical infrastructure does spike into visibility with a tragic event – the actions of chemicals become acute and no longer incremental. Local industries and municipalities, as well as the Aamjiwnaang First Nation are all participants in the Chemical Valley Emergency Coordinating Organization (CVECO) put in place along Chemical Valley since 1952. The CVECO helps to prepare inhabitants for chemical disasters and coordinates emergency response among industries, running a radio channel specifically for announcing emergency codes. Since 1980, an annual Sarnia Area Disaster Simulation drill is hosted in Chemical Valley. Preparedness is exercised, and the promissory harm is glimpsed. A chain of emergency sirens run through Chemical Valley, including Aamjiwnaang land. When the sirens roar, residents are asked to 'Shelter, Shut and Listen', sealing themselves in their homes. Sirens are tested every Monday at 12:30, becoming a sonic reminder of anticipatory harms. Sirens too are part of the chemical infrastructure, auguring its possible future.

From the capacity to induce proliferation in cell biology labs, to the multi-generational reproductive effects that become a structural violence for communities, to the persistence of PCBs in turtle eggs, to sediments that won't stay still, to sirens warning of a future yet to come, chemical infrastructures are shaped not just by space but by time. A goby assay or a bucket sample can show recent or immediate exposure. A community health chart or sex-ratio count can show the bodily effects of an unknown past event. There remains a crucial temporal gap in knowledge-making. The multi-jurisdictional regulatory confluence at the St Clair does little to fill this gap. Instead, it secures a space 'open for business', in which data production can work to give permission to industries to continue to add chemical flows and drifts, with effects deferred into the future, and unaccounted for. The sediment, meanwhile, still holds many pasts releasable into the present. Time works its insidious loops in the toxic world, largely untracked. Chemical infrastructures are waiting for their many stories to be told.

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## 6 Torny, 'Managing an Everlastingly Polluted World: Food Policies and Community Health Actions in the French West Indies'

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