Landscape As Infrastructure

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ABSTRACT According to a national report on brownfields redevelopment titled *Recycling America's Land* (USCM 2006), more than 400,000 sites with real or perceived environmental hazards dot the American landscape today. That legacy is estimated to be worth more than $2 trillion in devalued property. Underlying this legacy is a major network of post-war infrastructures—airports, harbours, roads, sewers, bridges, dikes, dams, power corridors, terminals, treatment plants—that is now suffering major decay from lack of repair and maintenance (ASCE 2008, Infrastructure Canada 2007–2008, Choate and Walter 1983). In revisiting a series of milestone events in the history of North America, this paper draws a cross-section through phases of industrialization in the 19th and 20th centuries in order to track how the necessity for infrastructure accidentally emerged from crisis and failure. A series of patterns and shifts are identified to expose the paradoxical, sometimes toxic relationship between pre-industrial landscape conditions and modern industrial systems. The underlying objective of this essay is to redefine the conventional meaning of modern infrastructure by amplifying the biophysical landscape that it has historically suppressed, and to reformulate landscape as a sophisticated, instrumental system of essential resources, services, and agents that generate and support urban economies. Three contemporary streams of development including urban ecologies, bio-industries, and waste economies are explored briefly to discuss future fields of practice.

KEYWORDS Landscape, infrastructure, urbanism, mobility, ecology

In the last century, capital and power became more important than land.

—John Kenneth Galbraith, 1967

Nineteen-sixty-seven, the year that renowned economist John Kenneth Galbraith released his revolutionary bestseller *The New Industrial State* (1967), was a year of landmarks. It was the year that marked the end of General Motors' two-year–long Futurama exhibition that attracted over 29 million people at the New York World's Fair. For the largest employer in the US, 1967 also saw the introduction of three new models including the Cadillac Eldorado, the Chevrolet Camaro, and the Pontiac Firebird. While GM celebrated the production of its one millionth US-made car that same year, it also faced a major labor backlash outside its headquarters in Detroit, amidst a year of civil-rights rioting across the country in cities such as Newark, Plainfield, Cleveland, Cambridge, Buffalo, and Milwaukee. Nineteen-sixty-seven was also the year that the Outer Space Treaty banned the use of nuclear weapons in space while underground nuclear testing continued in Nevada's Yucca Flat. Nineteen-sixty-seven was the year that the Vietnam War passed its midway mark, just before San Francisco's 1968 Summer of Love. It was also the year of Apollo 4, the first unmanned flight in earth's orbit returning never-before-seen images of planet Earth.

More importantly, 1967 was the year that a small staff of five at the *Milwaukee Journal,* after successfully campaigning to stiffen the law against water pollution in Wisconsin and the Great Lakes, was awarded the Pulitzer Prize for Public Service. The award was a notable advance in the national effort for the conservation of natural resources against the dangerous trends of downstream contamination from Wisconsin's mainstay industries of papermaking, brewing, cheesemaking, and vegetable canning. A decade later, as a result of those efforts in the "Genuine American City," President Jimmy Carter signed the Federal Clean Water Act, which had the ambitious goal of eliminating all wastewater discharges into the nation's waters by 1985. Though the statute fell short of this goal, largely due to non-compliance and non-enforcement (Hoornbeek 2005), the Clean Water Act did cast light on a dark industrial age when Americans could not swim in major rivers like the Mississippi, Potomac, and Hudson; an age epitomized by incidents in the Great Lakes like the fires on the oily surface of Cleveland's Cuyahoga River, the declaration of Lake Erie as a dead zone, the over-fertilization of Lake Ontario from sewage and detergent discharges, and the mercury contaminations that closed fisheries on Lake Superior, Lake Michigan, and Lake Huron.

By the second half of the 20th century, a paradoxical yet visible correlation could be grasped between industrial processes and environmental resources, especially around the Great Lakes, once the industrial nerve centre of North America. Now, the region is burdened with the highest concentration of contaminated sites

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Figure 1. Toxic Topography: aerial view of the Love Canal on the shoreline of the Niagara River in Upstate New York. (©2008 TeleAtlas courtesy of Google Earth)

and waters in North America; second only to the state of California (USEPA 2007). Therefore, 1967 represents a turning point in the history of North America as a period that left a legacy of industrial production, infrastructural decay, and pollutants on the contemporary landscape (Kirkwood 2001). The failure to return land to productive reuse and reinvest in public works signals that conventional approaches to redevelopment and remediation have reached a tipping point. The financial magnitude and logistical complexity of the challenge facing the North American economy can no longer be resolved by singular, specialized or technocratic disciplines such as civil engineering or urban planning that once dominated 20th-century reform. How then can a different understanding of infrastructure[1]—the collective system of public works that supports a nation's economy—jumpstart a new era of remediation and redevelopment across North America? This moment in history demands a reconsideration of the conventional, centralized, and technocratic practice of infrastructure and the discipline of civil engineering that have overshadowed the landscape of bio-physical systems—as a decentralized infrastructure—that predates the dynasty of modern industry.[2]

FAILURES & ACCIDENTS

The quest for a more contemporary understanding of infrastructure in North America begins with a reconsideration of modern mass industry best revealed through a series of failures and accidents rather than by design or planning. In the Great Lakes Region there are two sites with two decisively different outcomes that exemplify the legacy of modern industry in the 20th century: the first is a chemical dumpsite in Niagara Falls, New York, and the second is a demolition dumpsite in Toronto, Ontario.

The Love Canal

In 1978, during the construction of the LaSalle Expressway in southeastern Niagara Falls, over 20,000 tons of toxic waste was discovered in what is now recognized as America's most notorious dumpsite. The 16–acre site—a 1-mile-long, 15-feet-wide and 10-feet-deep trench that was originally built by William T. Love at the turn of the 20th century as a hydroelectric and transportation project between the upper and lower Niagara Rivers—was used as a chemical dump between 1942 and 1953 by the Hooker Electrochemical Company (Figure 1). Prior to that, it was used as a weapons dump for the

United States Army starting in World War I. Prior to its military-industrial use, the canal was bucolically used as a local swimming basin during the summer and as a skating rink during the winter. Once filled and capped, the site was then reluctantly sold by the Hooker Company to the City of Niagara for a dollar. With the baby-boom pressure after Word War II, the municipality permitted the construction of a school and a 100–home neighborhood on top and around the former dumpsite. From the mid-1950s through the 1970s, a record number of illnesses including rashes, burns, miscarriages, birth defects, and cancer were recorded by the Love Canal Homeowners Association and later attributed to high levels of dioxin in the ground (CHEJ 2001). Now infamous, Love Canal was the first contaminated site to gain national and international attention due to the scale and magnitude of its consequences. That recognition was instigated by the ground level research of Lois Marie Gibbs, a proactive mother who formed the Love Canal Homeowners Association in the mid-1970s after discovering the location of the dumpsite beneath her son's elementary school. Recalling the culminating incident of Love Canal in the spring of 1978, former EPA administrator Eckardt C. Beck observed there had been a period of record rainfall in the region:

> Corroding waste-disposal drums could be seen breaking up through the grounds of backyards. Trees and gardens were turning black and dying. One entire swimming pool had been popped up from its foundation, afloat now on a small sea of chemicals. Puddles of noxious substances were pointed out to me by the residents. Some of these puddles were in their yards, some were in their basements, [and] others yet were on the school grounds. Everywhere the air had a faint, choking smell. Children returned from play with burns on their hands and faces. (http://www.epa.gov/history/topics/lovecanal/01.htm)

That same year, the school was closed, pregnant women and children were evacuated, and home-grown vegetables were banned, after the discovery of dangerous leaching from the buried toxic materials. To prevent further risks of human and environmental contamination, the state purchased and leveled 239 homes near the canal, and relocated 900 families a year later. After President Jimmy Carter declared Love Canal a federal disaster emergency zone in October 1980, everyone in the Love Canal area was evacuated and relocated with money advanced by the state and federal governments. For one of the first times in the history of North America, the incident signaled a clear and present association—an ecology—between industrial operations and the bio-physical systems that underlie them.

The toxic tragedy of Love Canal spawned the development of what would become one of the most important legislative programs in the US, the 1980 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), aimed at reversing the dangerous trend of chemical dumping, groundwater contamination and air pollution. The legislation heightened environmental awareness of incidents around the world from the Tar Ponds incident in Nova Scotia, Canada (1981), to the nuclear reactor accident in Chernobyl, Ukraine (1986). Known as the Superfund, this 1.6 billion dollar federal program originally directed the US Environmental Protection Agency to clean up a list of 480 national priority sites. With the growing concern over groundwater quality, the program has expanded to staggering proportions and now includes more than 1300 sites throughout the country. However, with its emphasis on the legislative attribution of blame and responsibility, the Superfund program failed to gain traction on the actual remediation and clean up of sites. Despite its heroic intentions, the Superfund's polluter-pays and one-size-fits-all policy has failed due to mounting costs of litigation and generic remediation technologies applied to depressed local economies and site-specific ecologies (NCPA 1996). Today, after a 200-million-dollar lawsuit, the evacuation of over 200 families and 50 million dollars in site remediation, the remaining legacy of Love Canal's past is a bulldozed community, a razed school, a vacant street, and a fenced-in berm.

Figure 2. Constructed Ecology: the crenellated jetty of the Leslie Street Spit which projects 5 kilometers southward from the shoreline of Lake Ontario, near Downtown Toronto. (Photograph by Pierre Bélanger)

The Leslie Street Spit

While the Love Canal incident catalyzed the era of post-industrial remediation in the US, another lesser known dumpsite some 300 kilometers across Lake Ontario from Niagara Falls, tells a different yet equally informative story. Projecting southward from the shoreline of Downtown Toronto, the dumpsite is a linear headland constructed with waste materials, mostly concrete and rubble from urban operations such as the excavation of urban sites, the construction of subway tunnels, the demolition of buildings from the city centre and the dredging of the Toronto Harbour in the 1960s, 70s and 80s (Figure 2). Generically dubbed the Leslie Street Spit, the headland was initiated by the Toronto Port Authority as a shoreline disposal program in proximity to the downtown area that would simultaneously function as a coastal barrier for the city's inner harbor. Furthermore, the silty clay geology underlying the city proved to be an ideal base material for the construction of the headland with excavated urban materials. During the 40–year period that spanned the development of the downtown area, the headland slowly grew into what is now a five-kilometer-long peninsula.

Due to protracted neglect precipitating from the failure of the anticipated shipping boom, emergent vegetal and animal species slowly colonized the peninsular landmass in the 1980s and 1990s. Unplanned and undesigned, the accidental ecology of plants, birds, and mammals that took over this large wasteland within walking distance of the downtown area attracted considerable attention from a different constituency. As early as the mid-1980s, urban ecologist and landscape architect Michael Hough was one of the first to recognize the case of the Leslie Street Spit as "one of the most significant wildlife habitats in the Great Lakes region in an environment where industrial growth has destroyed many of the habitats birds require, and has rendered others toxic" (1983, 140). With the intervention of the Toronto and Region Conservation Authority in the late 1990s, the headland was preserved as one of the most unique constructed wildernesses in North America (TRCA 2000).

As a polyfunctional infrastructure, the headland operates today as an active dumping ground during regular business hours, and an ecological recreation area during off-hours for the more than five million inhabitants of the Greater Toronto Area, while continuously operating as a coastal protection barrier for nearby island communities. As a by-product of the logistics[3] of city building, the headland provides visible evidence of the underlying correlation between the mechanics of urban construction, industrial dumping, and land manufacturing. Often dismissed as clandestine, accidental or temporary, field operations-such as excavation, demolition, de-engineering, dredging, backhauling, backfilling and storage-are all representative operations and sites forming a decentralized landscape prevalent throughout North America that may have previously seemed disconnected and disorganized. The cases of active lakeshore reconstruction over the past 200 years, including the more than 350 lakeshore disposal facilities in the Great Lakes currently in operation (USACE 2008) testify to the longevity and endurance of this paradoxical practice.

SHIFTS & PATTERNS

The historical, industrial, and environmental contexts of Love Canal and the Leslie Street Spit may appear to be exceptional, but they are not unique. From a distance, the historical reclamation of land in the Great Lakes Region lays the groundwork for better understanding how mass-industrialization has shaped the North American landscape. A brief re-examination of land patterns and economic shifts over the past 200 years, along with prevailing ideologies, can elucidate how that relationship has changed and evolved.

The Rust Belt

The pattern of contaminated sites in the Great Lakes Region is the result of economic shifts in a geo-political region historically known as the Rust Belt; a region that spans from Wisconsin and Illinois to Pennsylvania and Upstate New York. [4] During and after the two World Wars, the region underwent an accelerated rate of growth in the areas of weapons production, chemical processing, and automotive manufacturing. The abundance of iron ore, coal, and fresh water in proximity of the commercial nerve centre of the Northeastern Seaboard were primary resources feeding the development of large industrial cities. Several decades later, this rate of transformation was reversed: the US steel industry, one of the basic manufacturing industries, for example, collapsed from 509,000 workers in 1973 to 240,000 in 1983. The widespread de-industrialization and de-militarization of the region caused large-scale incendiary attrition across cities such as Gary, South Bend, Detroit, Flint, Toledo, Cleveland, Akron, Canton, Youngstown, Wheeling, Milwaukee, Sudbury, London, Hamilton, Buffalo, Syracuse, Schenectady, Pittsburgh, Bethlehem, Harrisburg, Wilkes Barre, Wilmington, Camden, Trenton, Newark. This litany of names is associated with the post-industrial fallout in the wake of relentless globalization (Garreau 1981). Heightened by the international mobility of corporations, the deindustrialization of the Rust Belt stemmed from national trade deregulation policies beginning with GATT (General Agreement on Tariff and Trade) in 1946 and ending with NAFTA (North American Free Trade Agreement) in 1994. Both policies opened international borders southward to Mexico and across the Pacific westward to Asia, where labor and raw materials were cheaper and environmental laws less stringent. As a result of global outsourcing (Friedman 2005), and plant relocations led to industrial de-corporation, land undevelopment, population unemployment, and deurbanization across North America. Abroad, global relocation of industry created a surrogate urbanization: for example, Bangkok has replaced Detroit, Shanghai replaced Cleveland, Taipei replaced Toledo, and Mexico City replaced Milwaukee (Jones 2006).

Flint. This economic fallout further precipitated the population decline of inner cities in the Rust Belt from the 1950s onward, leaving them victims of decaying oversized infrastructure, contaminated vacant land, and heavy tax burdens. In his award-winning documentary *Roger & Me* (1989), Michael Moore criticized the General Motors Corporation and CEO Roger Smith for closing down all the assembly plants in Flint, Michigan, leaving over 40,000 people jobless and the entire city bankrupt in the 1980s. Despite big-idea regeneration projects, such as the $13–million Hyatt Regency Hotel or the $100–million AutoWorld theme park, tourism has failed to redress the generic landscape of General Motors plants and lots, now lying largely vacant and abandoned. Flint's economy was rendered immobilized by the inexorable force of global capital mobility (Dandaneau 1996; Harvey 1996). Today, the most industrially active areas of the city are ironically two landfills that flank the city of Flint on the north and south ends. However, the overgrown banks of the Flint River are a testament to the imminent rebound of its biodiversity from neglect and abandonment. Decline seems to have become the progenitor of ecological regeneration. As a catalytic infrastructure, landscape is rendered visible at the precise moment at which the city fails.

Youngstown. The failure of Flint's urban recovery contrasts sharply with the case of Youngstown, Ohio. Today, a contemporary form of landscape regionalism is being applied in the urban political work of Jay Williams who was elected as the young, new mayor of Youngstown in 2005. The former steel town lost more than half of its 170,000 residents in the past 20 years due to countless plant shutdowns such as Republic Steel and Youngstown Sheet & Tube Company. Lands abandoned after the fallout of heavy industry total more than the 15,000 acres that John Young originally purchased in 1802 when he founded the city. In 2006, there were some 12,000 vacant commercial and residential properties. In a remarkably un-American, un-industrial way, Williams proposed a strategy of protracted shrinkage of the city rather than growing its way back to prosperity. Williams's strategy is novel in that it calls for an overall downsizing of the city by razing derelict buildings, cutting off oversized or unnecessary infrastructure, banking vacant land, and re-zoning heavy industrial districts. Triggered by fiscal deficits and opportunistic land uses, the general organization of the city's lands was made possible through the processes of overlay zoning and land banking. Power and sewage is being removed from fully abandoned tracts of land. Vacant lots turned into pocket parks where back taxes are exchanged for land stewardship by neighbouring residents. Remaining lands are assembled and amalgamated in one huge land bank for future reorganization.[5] In the meantime, these opened lands serve another unintended yet essential service: they expand permeable surface coverage area and increase groundwater infiltration when considering the 535 miles of asphalt pavements it must maintain. Stormwater runoff collected in the pipe-and-gutter system is decreased, justifying the strategic dismantling of the system. In some areas, the strategic removal or closure of roads accommodate the construction of new plants further contributes to this objective by effectively enlisting transportation systems as part of the overall structure of the urban landscape (Figure 3). The typical menu of mixed-used housing with green space thus becomes irrelevant. Instead, old land uses are swapped for new designations, and new uses can be swiftly superimposed. The traditional, sluggish process of legislative re-zoning is bypassed with the opportunistic use of overlay zoning. One of the major outcomes of this legislative shortcut involves a 3,300–acre corridor of light industrial lands (for non-polluting green industries) lining the Mahoning River.[6] Once the sewer of the valley's steel mills, the Mahoning now figures as the conduit of Youngstown's future.

Echoing Richard T. Ely's approach to land economics during the crisis of the Great Lakes Cutover in the 19th century, Williams's decommissioning strategy suggests a general process of deurbanization, where industrial un-development and land un-incorporation will ultimately reduce the tax burden on citizens and maintenance burden on the public works department. Instead of romanticizing its industrial past, Youngstown hopes to capitalize on its high vacancy rates and underused public spaces to become a culturally rich bedroom community serving Cleveland and Pittsburgh, both less than 70 miles away (Lanks 2006; CYYSU 2005). For Youngstown, suburbanization is necessary and imperative for recasting its urban future (Bruegmann, 2005).

Figure 3. Demobilization, Dezoning & Deurbanization: an evacuated area of Ward 3 in the former steel city of Youngstown, Ohio. (Photograph: ©2008 Digital Globe courtesy of Google Earth; diagram by Pierre Bélanger and Hoda Matar)

STREAMS & SYNERGIES

Although deindustrialization has been the dominant effigy in the history of the Rust Belt and the Great Cutover, mass urbanization is currently causing considerable change. Geopolitical forces—such as trade deregulation, product outsourcing, automated manufacturing, biomedical research, and just-in-time delivery—signal a significant structural shift across North America. From former industrial states to new urban economies, this massive transition is, however, coinciding with erosion of national infrastructures. Isolated incidents such as bridge collapses, dyke failures, levee breaks, coastal flooding, power outages, water shortages, road cave-ins, decaying sewers, and deferred maintenance, when considered together, provide evidence of the limited capacity of conventional infrastructure to deal with the complex challenges of mass urbanization. Historically, mono-functional approaches to the design of infrastructures have typically segregated the basic provisions of water, waste, transport, food, and energy into separate, unrelated departments. At large regional scales, bureaucratic separation of infrastructural services is proving costly and ineffective. Over long periods of time, it can also be dangerous.

As an alternative, the collective body of the ideas and strategies forwarded by Richard Ely (1854–1943), Frank Lloyd Wright (1867–1959), Benton Mackaye (1879–1975), Michael Hough (1928–), Lois Marie Gibbs (1952–), and Jay Williams (1971–) is relevant and informative. They provide a basic, albeit imperfect, understanding of how we conventionally perceive infrastructure as a mere collection of public utilities. As methods, this body of work provides a basic understanding of the efficiencies and synergies made possible through the decentralization of urban structure and the de-engineering of urban infrastructure made possible by design. Illustrated by the transformation of the Great Lakes Region over the past two centuries, those changes are inseparable from global-regional economic shifts and the ecological imperatives they face. Probing current sectors of economic change in the region provides insight into new, more flexible, and more efficient approaches to infrastructure. Along with the synergies they engender, three contemporary streams of development are explored briefly: urban ecologies, bio-industries, and waste economies. The shift from conventionally large, centralized industries of mass production to a decentralized pattern of production signals a new era for urban economic

Figure 4. Great Lakes Watershed: the 43 Areas of Concern (AOCs) in the watershed region of the Great Lakes, jointly designated by the US-Canada Great Lakes Water Quality Agreement. (Diagram by Pierre Bélanger and Dave Christensen)

regeneration, land use distributions, and site redevelopment opportunities.

Urban Ecologies

Over the past two decades, the emergence of the field of landscape ecology (Forman 1986, 3–31) has contributed to a more in-depth understanding of the long-term effects of industrialization and urbanization on biophysical systems. Together with late-century visualization technologies (e.g. satellite photography, ground penetrating radar, and deepwater sonar imaging) and the explosion of the environmental sciences (from deepwater limnology to terrestrial agro-forestry), these effects can now be better understood both at the macro and micro scale, especially with advances in the metrics of dynamic water flows and watersheds. Endogenous and exogenous processes, such as eutrophication, combined-sewer overflow, sediment contamination, invasive flora, exotic fauna, depleted water reserves, and seasonal floods can no longer be perceived as isolated incidents but rather as part of large, constructed hydrological ecology that is entirely and irreversibly connected to the process of urbanization (Del Tredici 2006). The slow, yet large-scale accumulated effects of near-water industries and upstream urban activities once considered solely at the scale of the city, are now more effectively understood at the scale of the region.

At the centre of this imminent ecological renaissance is a massive remediation program in the Great Lakes Region spearheaded by the International Joint Commission (IJC). As a bi-national organization established by the 1909 Boundary Waters Treaty, its mandate is to advise on the use, replenishment, and quality of boundary waters in Canada and the United States. Two of the most pressing challenges addressed by the commission are sediment decontamination and combined-sewer overflow on water quality in the Great Lakes.[7] Recognized as the largest most important sources of contamination entering the food chain in Great Lakes rivers and harbors, polluted sediment from decades of industrial and municipal discharges has historically limited remediation and redevelopment efforts. As a result, the IJC has initiated a massive cleanup program at the scale of the Great Lakes Region. Remedial action plans are currently underway for 43 sites listed as high-priority areas of concern (Figure 4). The transboundary program involves multilateral funding and cross-border legislation to accelerate cleanup and redevelopment of the most contaminated sites, mostly harbors in the downstream region. Upstream, strategies for groundwater infiltration (using permeable surfaces, instead of gutters and pipes) and sewage management (using sludge recycling instead of central waste water treatment) aim to reduce loads on stormwater systems while contributing to groundwater infiltration. According to the Center for Watershed Protection, costs for decentralized systems for stormwater management are estimated to be three to five times less than the cost of conventional buried systems when considering their full life-cycle costs (ECONorthwest 2007). Notwithstanding canopy coverage, the abundance of available surface area in suburban developments makes them excellent candidates for future transformation. In the aggregate, suburban patterns are more flexible to change than their rigid inner city counterparts. As a result, contemporary practice should become accountable for watershed-level parameters ranging from surface permeability, groundwater dynamics, downstream effects, and subsurface geology.

With the growing rate of urbanization of the Great Lakes Region, the IJC is now confronted with the rapid depletion of freshwater supplies that, according to the World Water Federation, is estimated between six to nine times the rate of replenishment. The new adage is that water will be the oil of the 21st century (Annin 2006). Attention to the design of urban ecologies will therefore take on pressing relevance for city-builders at large.

Bio-Industries

With attention focused on regional water resources in the past decade, the Rust Belt region is shifting to a more diverse economic base where some of the fastest growing industries are largely agrarian: viticulture (wine-making and grapevine crops), silviculture (timberlands and dimensional lumber mills), and floriculture (greenhouses and nurseries). Well into a decade of burgeoning expansion, growth rates in the bio-industry have oscillated between 5 and 10 percent, with retail expenditures topping 50 billion dollars a year for cut flowers, cultivated greens, potted flowering plants, bedding plants, sod, ground covers, nursery crops, bulbs, cut Christmas trees, and every other nursery, or greenhouse product imaginable.

> So competitive has it become to conventional heavy industry, the bio-industries are in fact exploding. Floriculture—plants for bioremediation and bioengineering for example—is currently outpacing all other major commodity sectors in sales growth according to the U.S. Department of Agriculture Economic Research Service since the early 1990s. (De Groot 1998)

Bio-industries can further be distinguished from conventional industries in what they take, what they make, and what they waste (Hawken 1993). These developments echo a prediction made by the inventor of the assembly line almost a century ago. Henry Ford proclaimed that:

> The fuel of the future is going to come from fruit like that sumach out by the road, or from apples, weeds, sawdust—almost anything. There is fuel in every vegetable matter than can be fermented. There's enough alcohol on one's year yield of an acre of potatoes to drive the machinery necessary to cultivate the field for a hundred years. (*New York Times* 1925, 24)

Vegetal production[8] is rapidly grabbing hold in the Great Lakes and will keep expanding thanks to global warming, where northern areas of America are opening up to agriculture (UCS 2008). There are three types of bio-industries: greenhouse start-ups in the fertile Niagara Region that doubled between 2000 and 2005; the construction of America's first indoor composting facility on the site of a former tire manufacturing facility in the Hamilton Harbour in 2005; and the construction of the Northeast's first bio-fuel plant on the site of a former brewery in Fulton, New York in 2006. The emerging stream of bio-industrial development signals an important shift whereby economies formerly based on the import of non-renewable hydrocarbons (oil, coal, natural gas) are being outgrown by economies of regionally

Figure 5. Carbohydrate Matter: fresh sludge from a wastewater treatment plant for reuse in compost and agricultural fertilizers. (Photograph by Pierre Bélanger)

renewable carbohydrates (soils, vegetal materials, biomass, and wind) (Figure 5).

Waste Economies

The contemporary challenge of mass-landfilling (Miller 2000; Bélanger 2006a) effectively signals a turning point in the handling of garbage in big cities. Unilateral solutions to garbage collection and disposal that emerged from mid-20th-century industrialized forms of planning and engineering can no longer deal with the magnitude and the complexity of urban waste streams. Closing the material loop[9] is the most significant shift in the economies of waste management. It shows that the unilateral dependence on landfilling can be counteracted through new, previously unforeseen economic and ecological synergies that exist between public regulatory agencies and private turnkey enterprises where it matters the most: at the source of waste in urban areas (Lynch 1991; Berger 2006).

One of the most recent and informative examples of the potential effectiveness of this urban strategy is a new, state-of-the-art composting facility in the Hamilton Harbour, contaminated with polychlorinated biphenyls (PCBs) and petrohydrocarbons (PHCs). Built by a world-class public-private partnership between the City of Hamilton's Waste Division, Maple Reinders Constructors (a Canadian design-build company), and the Christiaens Group (a Dutch composting and mushroom technology expert), the 40–acre facility can process at full capacity up to 90,000 tons of wet organic garbage every year, big enough for the disposal needs of a city of 1 million people (Figure 6). Built on the site of a former tire manufacturing plant as the first and largest indoor facility of its kind in North America, the operative costs at this central composting facility (CCF) are 25 to 35 percent lower than landfilling costs, simultaneously offsetting the cost of pre-development bioremediation, including in-situ deep molasses injection. As a result, the neighboring landfill that was once the most active industrial site in the region is straddling bankruptcy and rapidly being squeezed out of the waste-handling market altogether (Marley 2003).

The statistical effect of recycling can be staggering. For example, if all of the 25.5-million tons of durable goods now discarded into America's landfills each year were reclaimed through reuse, it is estimated that more than 100,000 new jobs could be created in this industry alone (Platt 1996). Through employment spin-offs and technological innovation, the multiplier effect

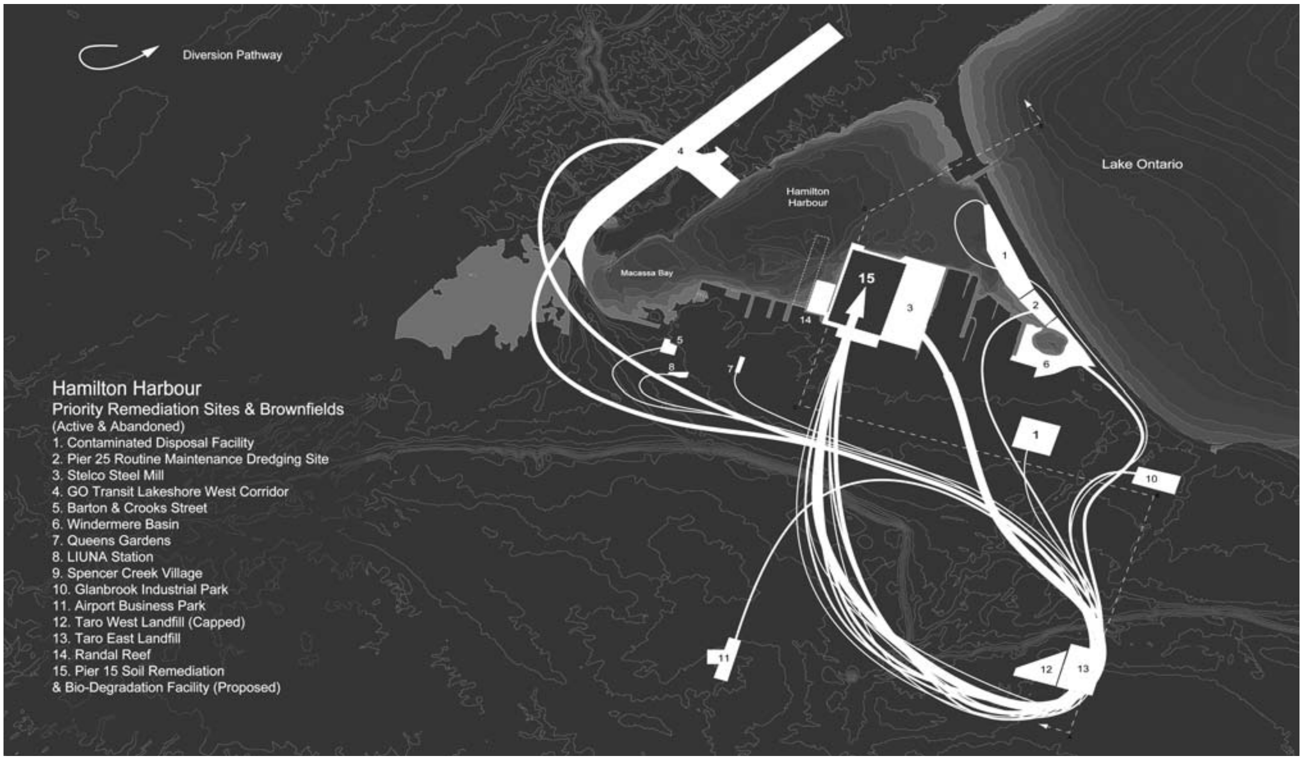

Figure 6. Systems of Diversion: flows of contaminated soils from brownfields and organic solids from landfills in Hamilton, Ontario redirected to new soil remediation and composting facilities. (Diagram by Pierre Bélanger and Rick Hyppolite)

of the recycling industry eclipses the conventional industry of waste landfilling. This concept is, echoed by the Northeast Recycling Council where recycling now provides the bedrock for large, robust manufacturing industries in the United States that use reusable materials. It provides manufacturing industries with raw materials such as recycled newsprints, recycled cardboards, recycled plastics, and recycled metals that are less expensive than virgin sources (Chertow 2005). In the 21st century, it seems that waste will be the new food (Figure 7).

The synergies and spin-offs from contemporary streams of development demonstrate how new efficiencies and new spaces may be created when urban systems are designed to be tightly integrated into regional land-based resources. When compounded, these streams of development point towards the effectiveness of landscape-based strategies that can solve multiple challenges at once. Broader-scale regional materials management programs testify to that effectiveness. Developed in the mid-1990s from tighter environmental controls and stronger economic synergies, the US Department of Agriculture's Comprehensive Nutrient Management Planning Program (USDA 2008) and the US Army Corps of Engineers' Beneficial Material Reuse Management Program (USACE 2008)—involving the diversion and land application of sludges and dredgeates, respectively—are two significant examples of land reclamation strategies that have the potential to restructure the historical relationship between downstream and upland sites within regional watersheds.

With more than 70-million tons of sediment dredged from the ports of Great Lakes cities over the past 30 years, there is a considerable potential for landscape practitioners to engage in the design and planning of sites involving the diversion of excavated materials from the mouths of rivers towards inactive or abandoned industrial sites (Voros 2005; GLC 2006). For example, where bioremediation alone cannot solve the challenge of brownfield redevelopment, the cascading effect of new integrated regional economies offers a significant model for the reuse of land, where remediation costs may be offset by the overall returns from productive land redevelopment. Achieving greater economies and ecologies of scale, these urban-regional operations can be considered self-generating and self-maintaining. At this precise moment—when these landscape operations are essential—they become infrastructural (Allen 1999).

Figure 7. Landscape of Disassembly: the sorting, shredding, bundling and melting operations at Triple M Metals in Brampton, Ontario, one of North America's largest, most modern recyclers of ferrous and non-ferrous metals. (Photograph by Pierre Bélanger and Jacqueline Urbano, 2008)

INFRASTRUCTURE REDEFINED

From a distance, the histories and complexities of land transformation and infrastructure deployed in the 18th, 19th, and 20th centuries present important evidence of a large system of biophysical resources, agents, and services that support urban economies in North America. Whereas in the past, industrial economies were forced to contaminate or destroy the environment in service of the economy, today that equation is being reversed. Mutually co-dependent, the economy is now inseparable from the environment, and so are modes of production. From a geo-economic perspective (Conway 1983), several underlying pre-conditions can be deduced from the historic, logistical bond between land transformation and urbanization:

A. *Wasting is natural:* there is a built-in process to the patterns of urbanization and modes of production that has and always will generate waste. The creation of circular economies that will handle the by-products of these processes is inevitable (Ford 1926, 89–98).

B. *Globalization is irreversible:* there exist global economic forces that exercise significant and relentless impact on the economy of urban regions and industrial modes of production. Harnessing those forces with regional conditions is paramount (Sassen 1998).

C. *Urban systems are regional:* over time, the multiplier effect of urban-industrial operations impacts considerably a region through job spin-offs, supply chains, and distribution networks. Dependent on regional population distribution and world demographics, the full extent of urbanization is yet to be determined (Koolhaas, 1991).

D. *Sprawl is inevitable:* perpetuated by the proliferation of global distribution networks instead of centers, global mobility gradually leads to expansion or abandonment of urban-industrial regions. The design of horizontal urban systems in relationship with decentralized and diversified networks of mobility will dominate practice (Bélanger 2006b).[10]

E. *Ecologies are constructed:* there exists a complex biophysical system (hydrology, geology, biomass, climate) that preconditions modes of production that are inextricably bound to urban systems (populations, markets). The watershed is the

Figure 8. Greenhouse Effect: aerial view of Leamington, Ontario, the greenhouse capital of North America. (©2008 GeoEye courtesy of Google Earth)

most basic and irreducible structural element in this system.

Once the sole purview of the profession of civil engineering, infrastructure—which includes the management of water, waste, food, transport, and energy—is taking on extreme relevance for landscape planning and design practices in the context of the changing, decentralizing structures of urban-regional economies. Food production and energy networks can no longer be engineered without considering the cascade of waste streams and the cycling of raw material inputs (Figure 8). Landfills, land farms, laydown and storage areas, and sorting facilities can no longer be designed without their wastesheds. Highway networks, sewage systems, and subdivisions can no longer be planned without their watersheds. Put simply, the urban-regional landscape should be conceived as infrastructure.

As an integrative and horizontal discipline that transcends disciplinary boundaries (Corner 2004), landscape practice stands to gain momentum by widening its sphere of intervention to include the operative and logistical aspects of urbanization. Though they may seem banal, these aspects can help bridge the current economic-ecological gap. The engineering of basic elements such as topography, hydrology, and biomass as a system can be instrumental in the amplification of invisible yet fundamental processes that support urban development. Those elements are best expressed through flexible methods of representation that include process diagrams and logistical schedules. As a dualized practice, design can be strategically deployed between two different scales: short, immediate periods of time with large geographic effects, over long periods of time. Design, and the research that preconditions it, therefore becomes telescopic (Cosgrove 2003), capable of integrating multiple scales of intervention at once.

Enabling this dualized design methodology is a double agency in practice. Long-term, visionary outlook (prevalent in large public authorities) must be matched with expeditious, project-oriented focus (typical of small-medium enterprises) in order to address economic, environmental, and social imperatives. The gradual deprofessionalization of conventional disciplines towards common ecological and economic objectives will allow flexible public-private practices to cut across sluggish specializations that all too often stunt land redevelopment and economic renewal. These co-operations can usurp stylistic variations or disciplinary differences in project execution. In stark contrast to the 20th century paradigm of speed, the effects of future transformation will be slow and subtle, requiring the active and sustained engagement of long-term, opportunistic partnerships that bridge the private and public sectors.

Design of surface systems, synchronization of material volumes, logistics of implementation, re-zoning of land across boundaries, sequencing of land transformations over time, synergies between land uses, and reciprocities between different agencies, can therefore augment and accelerate these strategies, placing emphasis on performative effects of practice rather than their end results. The new paradigms of longevity and performance decisively break with the Old World pictorial, bucolic, and aesthetic tradition of landscape design. Instead, they give landscape planning and design a logistical and operative agency as a practice that deals with complex, multi-dimensional systems. By design, the synthesis of urban operations—coupled with the reflexive mechanisms that underlie them—can therefore lead toward the development of this contemporary landscape practice; one that is urgently needed for the present and future reclamation of urbanizing and deurbanizing land in the Great Lakes region and North America. [11]

From the 40 million acres of abandoned stump fields of the 19th-century Cutover, to the industrial wreckage of the 50,000 brownfield sites in the Rust Belt, to the management of the 6-quadrillion liters of fresh water in the Great Lakes, a reconsideration of logistical urban infrastructure is pressing. From the transformation of mono-functional industrial structures to the design of multi-layered, urban-ecological systems, greater attention and integration to the landscape of waste, water, transport, food, and energy may in fact elucidate the more fundamental processes that underlie and precondition the ongoing and unfinished urbanization of North America. Seen over time, these nascent processes may appear as incredibly subtle or fleetingly ephemeral, but will prove as an extremely stable and robust infrastructure for the 21st-century economy of the New World.

NOTES

1. The concept of infrastructure originated during military planning over the past 500 years but gained importance in the US during the Great Mississippi Flood of 1927. The term now refers to a set of systems, works, and networks underpinning modern societies and economies. The term comes from *infra* (1927, Lat. “below, underneath, beneath”) and *structure* (1440, Lat. “action or process of building or construction”) (Merriam Webster, 2008).
2. The decentralized pattern of the modern industrial landscape in North America originates from Euclidean planning principles dating back to the landmark federal court case in 1926: *Village of Euclid, Ohio vs. Ambler Realty Co.* (272 US 365). Zoning remains to this day one of the most instrumental mechanisms in the social, spatial, and economic structure of regions (Willhelm 1962).
3. Logistics is essential to infrastructure. It connotes the planning and management of the flow of resources, goods, and information including the energy, waste, and people between points of production and consumption. When applied to urbanism, the logistical use of land entails the management of large volumes of fluids (hydrology) and large volumes of aggregates (topography). Pre-dating the US Army Corps of Engineers, logistics was applied in large-scale earthworks and reclamation projects by the US Corps of Topographical Engineers (Beers, 1942).
4. The deindustrialization and decline in population of inner cities in the Great Lakes region is nothing new. Prior to the mechanical industrialization of cities in the Rust Belt, the virgin forest regions of the Mid-Western United States and central Canada were clear cut, slashed, and mined during the late 19th century onwards. Known as the Great Cutover (Kates 2001), over 65% of the 40–million acres of choice timber in Michigan, Wisconsin, Minnesota, Ohio, Upstate New York, and Ontario were stripped bare and shipped to modern commercial centers such as Philadelphia, New York, and Washington. The crisis created a generation of influential thinkers and practitioners including Benton Mackaye, P.S. Lovejoy, Richard T. Ely, and Frank Lloyd Wright. From a distance, their work sponsored landscape-level reclamation strategies that relied on the re-zoning of the land, taking it

out of singular industrial use and prescribing multifunctional land uses that were directly generated from soil types, micro-climates, and water dynamics that were primarily agrarian in function (Mackaye 1917; Sutter 1999; Ely and Wehrwein 1940; Wright 1958; and Rabinowitz 2004).

5. Agrarian land uses such as produce fields, horse ranches and cow pastures are permitted on residential lots larger than three acres (Associated Press, 2007).
6. The *Youngstown 2010 Citywide Plan* provides exhaustive information on the transformations of the city from post-industrial ghost town to metropolitan suburb (CYYSU 2005).
7. Twenty-four billion gallons of municipal sewage are dumped into the Great Lakes annually as a result of combined-sewer overflow (SLDF 2006).
8. Before the advent of alcohol prohibition and well before the supremacy of southern oil barons, vegetal fuel sources such as hemp, soy, and corn were widely promoted by Henry Ford and Rudolf Diesel (Pahl 2005).
9. Material loops refer to the circulation of materials in contemporary manufacturing processes viewed as systems. Resource inputs (steel, petroleum, cement, sewage) are treated equally as waste outputs (slag, plastic, sulfuric gas, sludge). Regionally scalable, the decentralization of urban waste streams creates circular economies creating lines of production and landscapes of disassembly (Bélanger 2007).
10. Decentralization of urban regions opens new territories for occupation and renewal. Often misunderstood (Bruegmann 2006), the global phenomenon of decentralization stems from the leveling of socio-economic structures in the 20th century made possible by the rise of individual purchasing power, single-family housing, and automobility. This universal transformation is further enabled by the democratic organization of large populations in large metropolitan regions, the increase in consumer credit, and the birth of instant communication from standardized technology systems (Friedman 2005; Rand 1966).
11. As a propensity to optimize the occupational carrying capacity of land, urbanization also entails the process of deurbanization. Both involve spatial restructuring where the latter involves land re-zoning, land abandonment, structural de-engineering, building mothballing, fiscal foreclosures, and population redistribution. Starr (1976), Stites (1989), and Ouroussoff (2007) provide compelling accounts of the efficacies of deurbanization prevalent in the work of Soviet disurbanists during the industrial revolution in the USSR.

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