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ReBuilding the Royal City: Companion report for systems map

Raphael Lopoukhine

This report is a companion to the ReBuilding the Royal City Systems Map and aims to identify the enablers, barriers, and norms to fostering the circular economy in the construction, demolition, and renovation industry in Guelph and Wellington County. The research is based on a literature review and over 30 expert interviews. The key findings include the global demand for resources doubling, the interlinked climate and affordability crises, and the pressure to build net-zero, resilient, circular, and affordable homes and buildings. Although recycling solutions exist, less than one-fifth of Canadian CRD materials are diverted, and circular building design and operation are basically non-existent in the region. Provincial leadership would have the biggest and sustained impact system-wide, but local governments have many front-line regulatory interactions that shape the current system. There are few incentives, regulations, or building standards related to deconstruction, material reuse, and circular building design and operation. However, businesses are working under tight margins using circular processes and developing circular products. The report suggests that knocking down barriers to foster the reuse of voluminous items like concrete, clean wood, brick, and gypsum would improve diversion rates and build the foundation of a reclaimed materials market. The report also highlights that homeowners face several barriers to turning information about upgrading their homes into action, and contractors play a crucial role in supporting them. Despite challenges, there are many potential opportunities to increase waste diversion, deconstruction, materials reuse, and the development of circular buildings in Guelph-Wellington.

KEYWORDS: report, circular economy, construction industry, waste management, resource demand, recycling, upcycling, landfill, regulations, economic opportunity, behavioural constraints, systemic design analysis, Guelph-Wellington, Smart Cities, Zero Waste Economic Transformation Lab.

RSD Topics: Architecture & Planning, Economics & Organizations, Policy & Governance

About this report

This report is a companion document to ReBuilding the Royal City Systems Map outlining the current regulatory, economic and behavioural components of the current take-make-waste development industry. It is based on a literature review and over 30 interviews with experts, waste management professionals, architects, engineers, contractors, builders, waste haulers, recyclers, upcyclers, officials, manufacturers, associations, deconstruction and reuse professionals, and more.

The report and systems map were prepared for the Zero Waste Economic Transformation Lab at the Circular Opportunity Innovation Launchpad as part of the Guelph-Wellington Smart Cities initiative.

- A high-quality PDF of the Map is available here:
<https://coil.eco/wp-content/uploads/2023/01/ReBuilding-the-Royal-City-Systems-Map-2.pdf>
- A high-quality PDF of the Companion Report is available here:
<https://coil.eco/wp-content/uploads/2023/01/Rebuilding-the-Royal-City-Systems-Map-Companion-Report-1-1.pdf>

Goal of the research

The research project examined what are the main enablers, barriers, and norms to fostering the circular economy in the construction, demolition, and renovation industry in Guelph and Wellington County. By exploring a Systemic Design analysis to understand the regulatory context, the economic landscape, and individual orientations, we sought to uncover opportunities that could help advance the circular economy.

Key Findings

The key findings from our investigation are as follows:

System observations

- Globally, resource demand is expected to double, Canadian landfills are filled with construction, renovation, and demolition (CRD) waste, while Ontario is set to run out of landfill space.
- Industry and regulators face interlinked climate and affordability crises and numerous challenges, opportunities and pressure to build net-zero, resilient, circular and affordable homes and buildings, faster and cheaper.
- The growing technological maturity of the building industry, climate sophistication of investors and governments, as well as opposition to new landfills and queries are helping to drive change in the current system.
- Despite available options for recycling, less than one-fifth of Canadian CRD materials are diverted, despite data showing that number can be reversed.

Circular ecosystem

- Diverting CRD waste from landfill has a clearer and easier path forward since recycling solutions exist in the market, but many of those existing solutions downcycle the materials.
- Source separation is required to extract the highest amount of clean materials, reduce contamination, and increase the likelihood of upcycling or reuse.
- Reclaimed and recycled materials are costly and used sparingly.
- Circular building design and operation are basically non-existent in the region but would have a greater long-term impact on changing the system.

Materials

- Metal is widely recycled across the system because the cost signal makes it worthwhile.
- Knocking down barriers (cost, availability, consistency, contamination) to foster the reuse of some of the most voluminous items – concrete, clean wood, brick

and gypsum – would help considerably to improve diversion rates and build the foundation of reclaimed materials market.

Regulatory

- Despite interest in building the circular economy, a recent discussion paper for the federal Green Building Strategy barely mentions the circular economy.
- To build a more circular economy, provincial leadership would have the biggest and sustained impact system-wide, but local governments have many front-line regulatory interactions with the building and waste industries that shape the current system.
- Policy change has and can lead to new economic opportunities, but any changes that increase delays in the planning department would raise concerns.
- Seeking provincial environmental compliance approval is a long, complex and uncertain process, causing some stakeholders to think twice about undertaking new recycling or waste management endeavours.
- There are few incentives, regulations, or building standards related to deconstruction, material reuse, and circular building design and operation.

Economic

- When the development industry leverages material salvage, it is to limit waste rather than for the economic benefit of the materials or the tax receipt (when using Habitat for Humanity ReStore's not-for-profit services).
- There are businesses working under these tight margins that are using circular processes and developing circular products.
- A more favourable regulatory and economic environment would help spur more opportunity.

Behaviour

- Cheap tipping rates and low-cost virgin materials drive most CRD waste to landfill, while resource depletion and climate impacts threaten this well-worn behaviour. Recent supply chain disruptions from the pandemic and extreme

weather events have bolstered the case for local production and sourcing of materials.

- Using reclaimed and recycled materials in buildings is inconsistent, hard-to-use and under-appreciated and, as a result, is limited to expensive custom projects.
- A fee on contaminated CRD loads at the City of Guelph transfer station to incentivise clean loads has done the opposite. The added risk, cost, and time on haulers send them to private transfer stations, and more CRD loads end up in landfill.
- Homeowners face a number of barriers to turning information about upgrading their home to reduce their environmental impact into action and, more often than not, turn to their trusted contractor to support their activities.

Opportunities

- While there are lots of challenges, there are also many potential opportunities that can help increase waste diversion, deconstruction, materials reuse, and the development of circular buildings in Guelph-Wellington

Context

Global resource use set to double

The building sector is responsible for 40 percent of global resource use, and the consumption of raw materials is set to nearly double by 2060 (OECD, 2019). Meanwhile, the global buildings and construction sector accounted for 39 percent of energy- and process-related carbon emissions in 2020 (UNEP, 2021). The extraction of raw materials, fuels and food contributes to 90 percent of biodiversity loss and water stress (UNEP, 2019). G20 countries account for close to 75 percent of global materials use, and unless efficiency, circularity and sustainability are broadly adopted, environmental pressures will continue to compound (OECD, 2021).

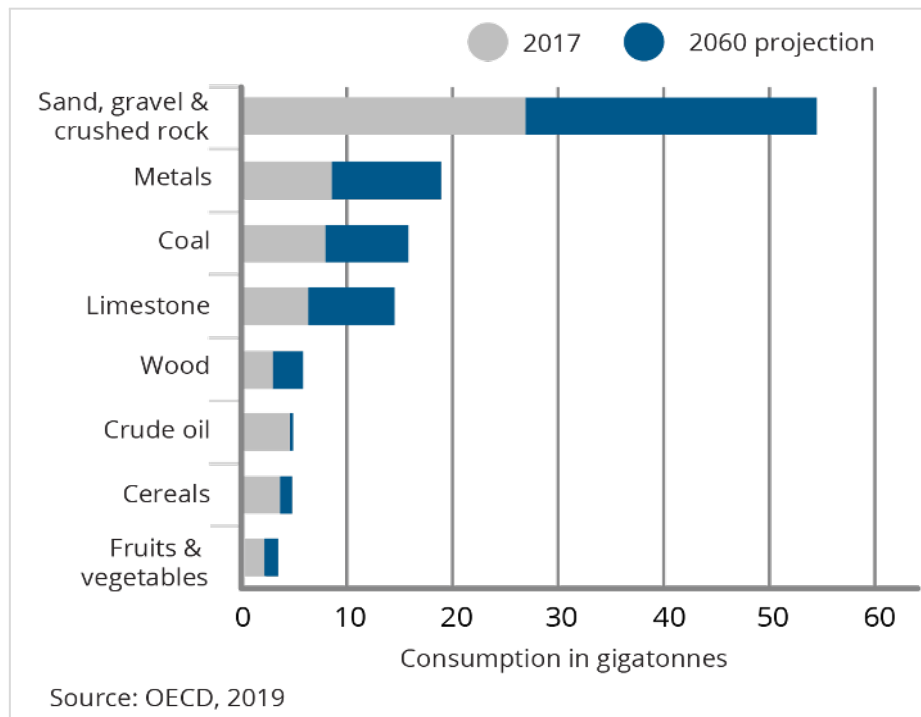


Figure 1. Global resource use projected future.

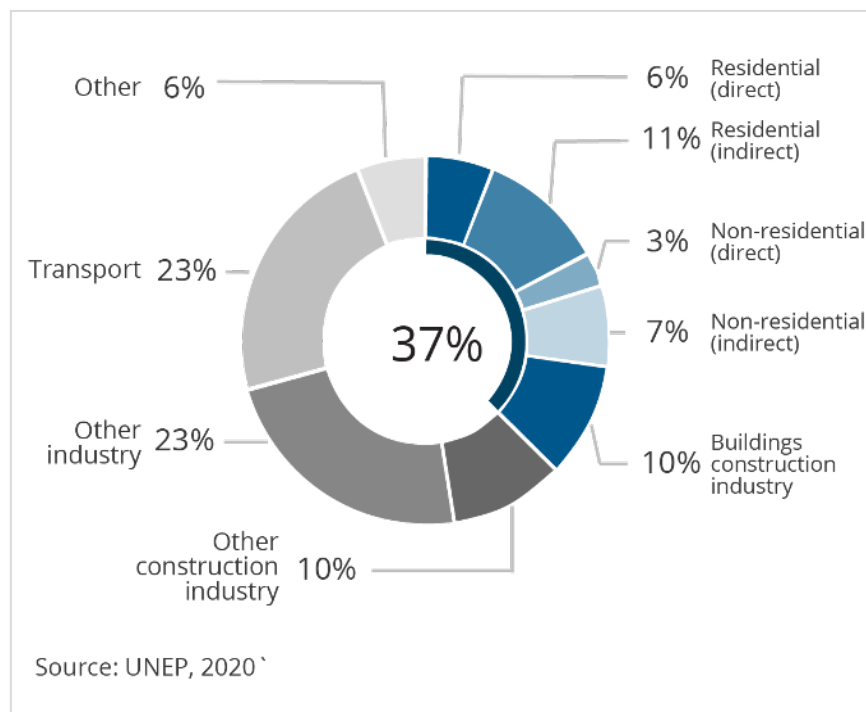


Figure 2. Global buildings and construction emissions.

Construction waste and carbon pollution in Canada

In Canada, 3.4 million tonnes of construction materials are sent to landfills annually, accounting for around 1.8 million tonnes of embodied carbon (Delphi, 2021). In 2015, about 16 percent of CRD waste was reused or recycled, while the remaining 84 percent was sent to landfill (CCME, 2019).

In 2019, the building sector accounted for 12.5 percent of Canada's total greenhouse gas (GHG) emissions, primarily from burning fossil fuels for heating (18 percent with electricity included) (ECCC, 2022). When the impact of construction, materials and waste is included, the number is much larger.

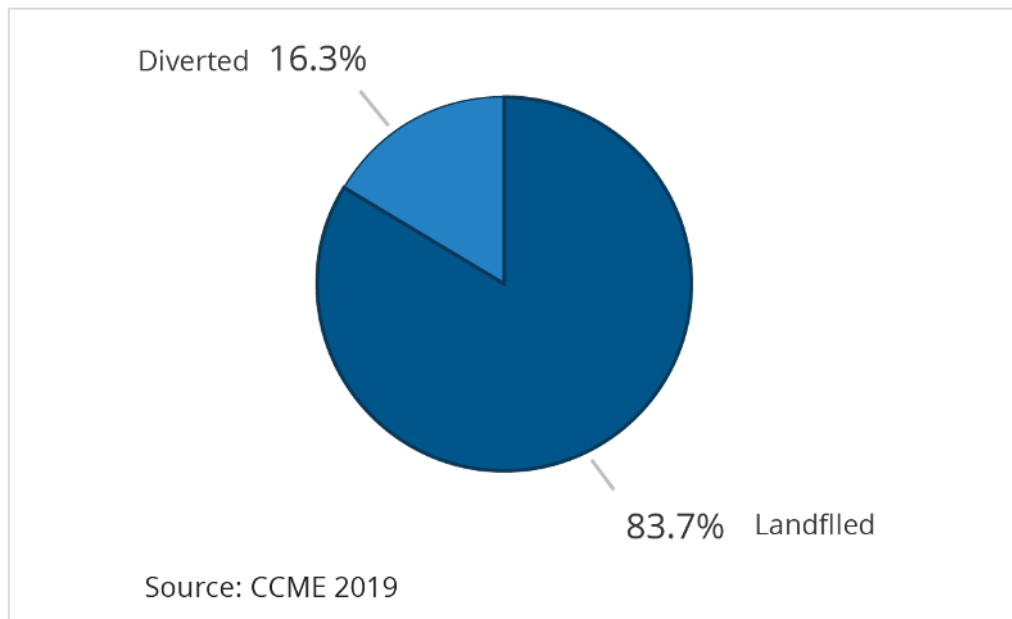


Figure 3. Canada's CRD waste.

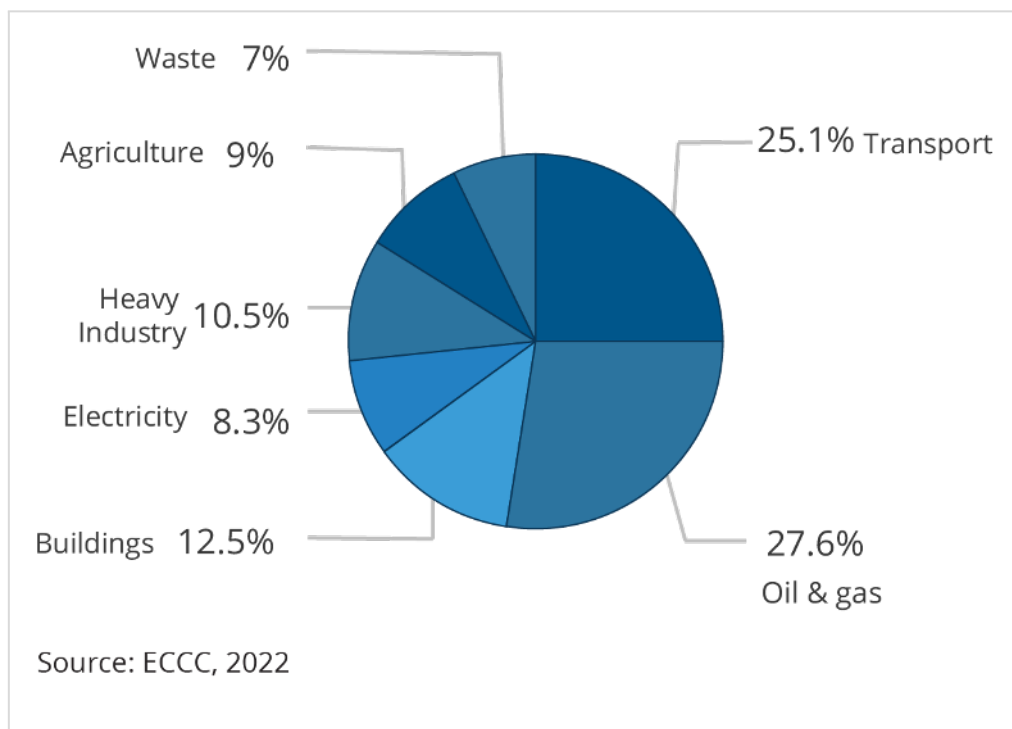


Figure 4. Canada's GHG emissions.

Ontario's shrinking landfill capacity

Ontario is one of the lowest cost provinces for landfill tipping fees, while also next door to much lower cost jurisdictions in the United States. As a result, 27 percent of Ontario waste is landfilled in the United States (OMWA, 2021). In Ontario, over 60 percent of Ontario's waste is disposed of in seven landfills, while Ontario's current landfills are to reach capacity in 10 to 15 years, depending on the availability of exports to the United States (OMWA, 2021).

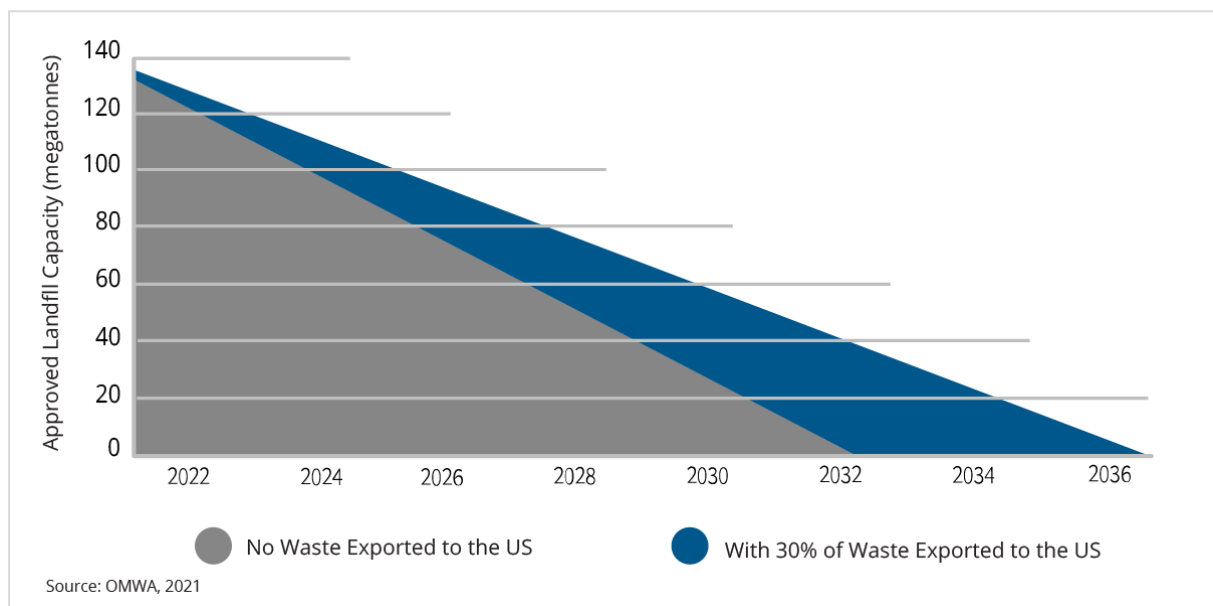


Figure 5. Ontario's landfill capacity.

Expanding the local circular building ecosystem

The circular built environment includes the design and operation of buildings and infrastructure, building deconstruction and disassembly, material reuse, and diversion of building materials (diversion that downcycles the materials into lower-quality products is not considered a part of the circular economy).

Circular building design and operation

Circular building design is the upfront application of circular design principles and standards to eliminate waste, design for flexible use, modular reuse, durability and the end-of-life disassembly of materials (Delphi, 2021). Buildings designed for

deconstruction would, among other things, use fasteners instead of nails and eliminate the use of adhesives and spray foams to ensure buildings can be easily deconstructed into their original components.

Buildings can be turned into material passports or material banks for planned recovery and reuse by being designed for disassembly and by leveraging building information modelling (BIM) systems to capture the relevant information on materials, components, and products (Heinrich & Lang, 2019).

How a building is designed for adaptability or durability can have a sizable role in extending the life of a building, but how it is used, maintained, and renovated can also have a significant impact. The use of products as a service, product-life extension, innovative leases, and circular supplies can increase the sustainability of buildings (CESS, 2021).

While designing buildings to be circular from the start would have the biggest impact on the system, the impact would be longer in scope since buildings built today last for decades. One survey of over 200 buildings demolished in Minneapolis in the early 2000s found 45 percent of demolished non-residential buildings were 25 to 50 years old, while 54 percent of residential buildings were 75 to 100 years old (O'Connor, 2004).

Deconstruction and source separation

Deconstruction consists of methodically deconstructing a building, typically by hand, to ensure that the materials are separated into components rather than typical mechanical demolition. Deconstruction leads to increased recycling and reuse because the materials can be easily source separated into their components.

Whether it is construction, renovation or demolition/deconstruction, to get the most value out of the used materials, collect accurate data, eliminate contamination, and prepare materials to be re-sold, the materials need to be separated at source, report stakeholders.

Circular building materials

In the circular built environment, there are a number of types of circular building materials. There are renewable products with low embodied carbon (the total carbon in the life cycle of a product), such as mass timber. There are products with Environmental Product Declarations (EPDs), a third-party verified ISO standard, that can help explain the environmental impact and toxicity. There are also prefabricated materials that can be disassembled, as well as reclaimed materials (e.g., clean wood) taken from existing buildings or materials with recycled content (CESS, 2021).

There is a significant overlap with circular materials. For instance, the embodied carbon of material can be derived from EPDs. EPDs can be further used to understand the toxicity of a product, which can help understand its overall sustainability. Reclaimed and recycled content materials can lower total embodied carbon and can form part of or all of the prefabricated materials.

Our Guelph-Wellington analysis looks more closely at recycled and reclaimed materials because of their importance in helping kick-start the secondary market for diverted CRD materials.

CRD waste diversion

Guelph-Wellington has an availability of recycling options for the vast majority of materials. The City of Guelph Waste Resource Innovation Centre accepts concrete and brick, gypsum drywall, asphalt shingles, and clean wood (no pressure treated or painted etc.).

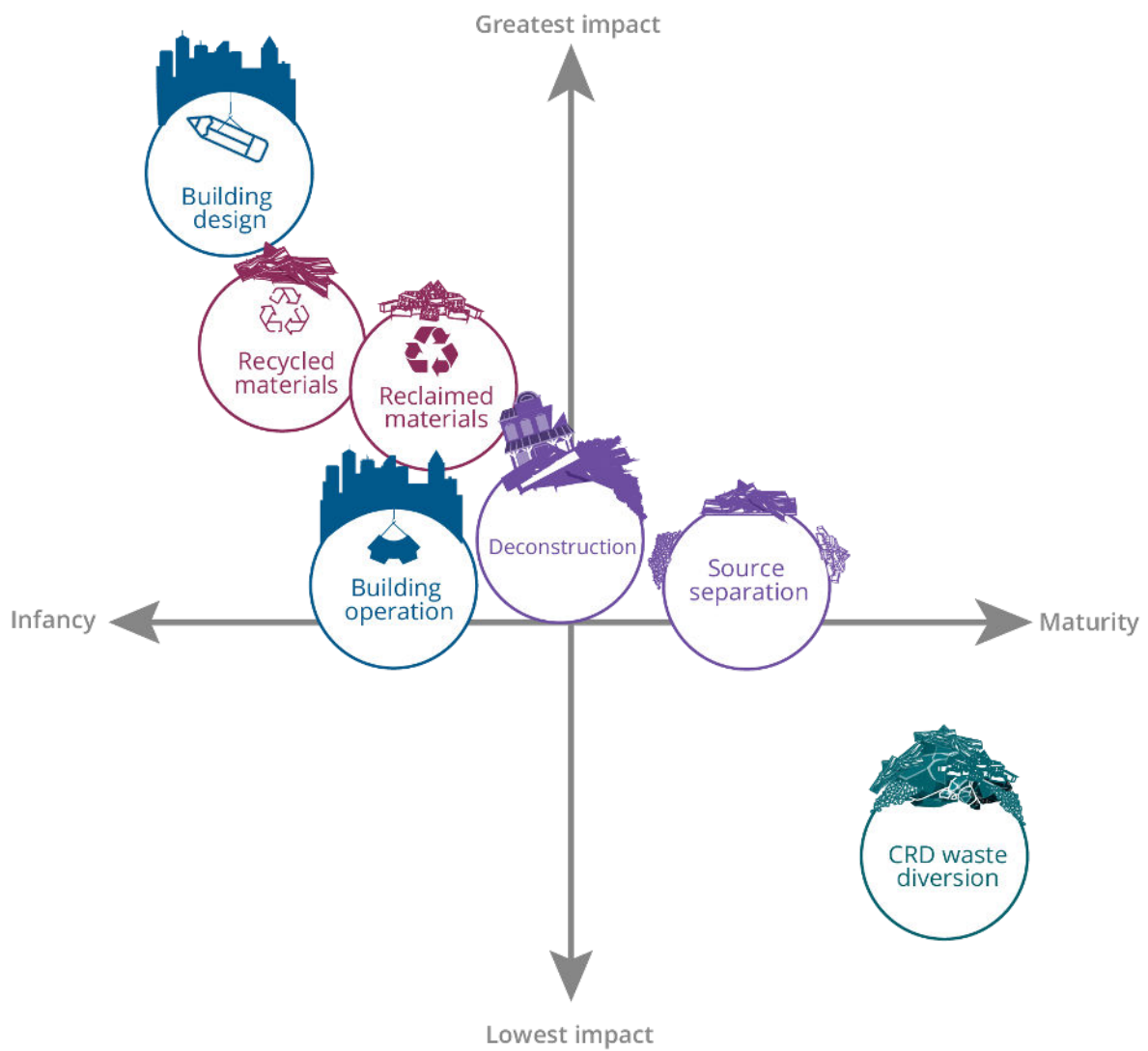


Figure 6. Maturity and impact of the circular built environment in Guelph-Wellington.

Pyramid of RePossibility: What materials have the most potential

Growing the reuse and recycled building materials market will fuel the economic promise of a circular built environment where buildings are material banks logistically deconstructed to match the just-in-time needs of new builds. Knocking down barriers to foster the reuse of concrete, wood, and gypsum would help to improve diversion rates and build the circular economy.

Metals have the largest economic opportunity because salvaging the metals returns on the investment in labour and transportation. Cardboard has a smaller economic opportunity/monetary value; however, there is a great volume of this material, especially within new construction. As materials are shown closer to the bottom of the pyramid, there is less financial opportunity for those materials and so they are diverted/recycled/reused less. Concrete is an example where economic opportunity exists due to its weight, which results in a high landfill tipping fee.

Certain materials can be reused in their current form, such as windows, doors, cabinets, plumbing and lighting fixtures, but the secondary market for these materials exists within a charitable model or online marketplace, which yields limited economic opportunity.

While opportunities exist for recycling, knocking down barriers to foster the reuse of some of the most voluminous items – concrete, wood, and gypsum – would help considerably to improve diversion rates, build the foundation of a reclaimed materials market, and get the region closer to the goal of a circular economy.



Figure 7. Pyramid of RePossibility: What Materials are of the most importance.

Why don't we build circular?

The current economic model, facilitated and bounded by regulation, has delivered unparalleled prosperity, but numerous crises – housing, climate, health – challenge our take-make-waste system. From surface-level events and trends to deep societal myths, the causal layered analysis begins to answer the question of “Why do we keep building this way?”

Please note: Any event or trend not discussed below but listed on the causal layered analysis graphic is expanded on in greater detail in later sections.

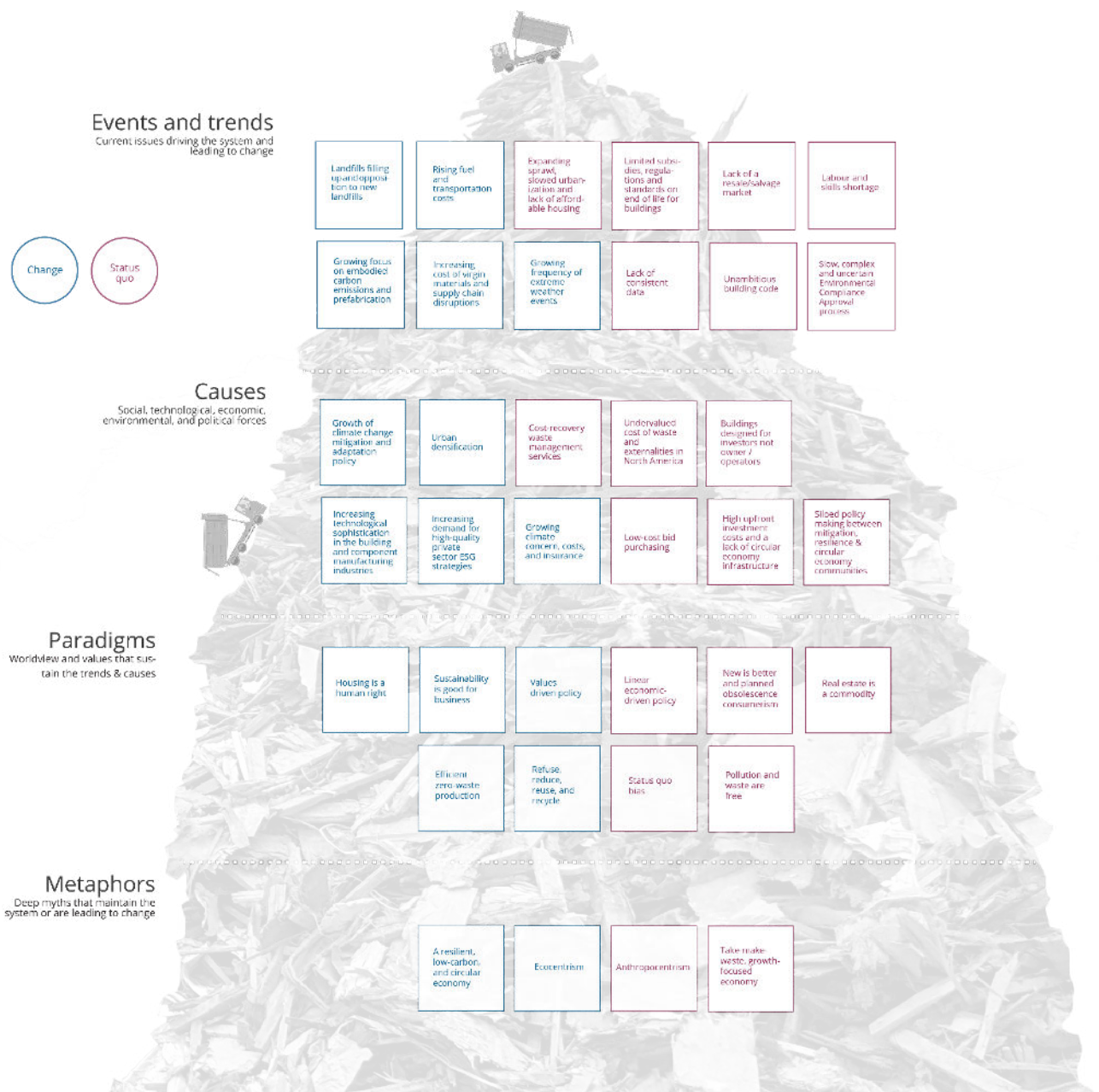


Figure 8: Why don't we build circular?

Events and trends ushering in change

Climate of change

Climate change is underpinning many of the drivers shifting the current system. The increasing frequency of extreme weather events is increasing the cost of insured damages and disrupting supply chains (IBC, 2022) (Evans, 2021).

Transportation and capacity

At the time of researching this report, gas prices were at an all-time high, and a number of stakeholders reported that the increased cost of gas was a major business disruption but was also spurring an increase in diversion.

“My trucking costs have gone up 25 percent with fuel surcharges just to go to landfill, so I do more work to pull out and recycle the aggregates,” said a veteran waste management professional.

Growing opposition to quarries

During the last provincial election, the group Reform Gravel Mining Now, a coalition of environmental groups backed by a number of community groups and 19 municipalities, called for a moratorium on new gravel mines. They said Ontario’s 6,000 mines and pits have enough materials to meet Ontario’s needs, and new operations are not needed, at least while a more sustainable strategy can be developed (Reform Gravel Mining Coalition, 2022).

Events and trends supporting the status quo

Affordable housing crisis

Faced with a significant shortage of housing supply in Ontario (and many parts of Canada), housing policy experts have called for an increase in housing supply to meet the growing demand. Ontario has 1.2 million homes, both rental and owned, short of the G7 average of housing units per population. Over the last ten years, housing prices in Ontario have shot up 180 percent while average incomes have only grown 38 percent (Ontario Housing Affordability Task Force, 2022).

At the centre of this issue is a fight to add density to existing urban and suburban single-family neighbourhoods, coupled with the increasing pressure to develop further into farm fields or the protected Greenbelt.

A number of municipalities are grappling with exclusionary zoning and planning rules that limit the development of multi-unit housing in single-family neighbourhoods. Exclusionary zoning policies reduce the supply of available units in neighbourhoods, inflate house prices for existing landowners, and squeeze out new residents, immigrants, and people of colour (Matthews-Hunter, K., Cancelli A., & Evenson, J. 2018). The City of Guelph has recently taken steps to develop a bylaw to update its zoning policies to tackle this issue (McNaughton, 2022).

As vast tracts of urban neighbourhoods remain unchanged, developers fight for the remaining available urban real estate while others stretch housing development further into rural and exurban areas. The suburbs are an economically and environmentally unsustainable but ubiquitous development model (Smart Prosperity Institute, 2013).

If exclusionary zoning is removed, municipalities may see an uptick in demolition as former single-family homes are removed to make way for triplexes and fourplexes.

Labour shortage plagues the industry

Compounding the housing supply problem is a major labour shortage in the construction industry. Add up the call for 1.5 million new homes over the next ten years with the need to retrofit millions of homes to meet climate targets, and the problem goes from bad to worse. In an accelerated retrofit scenario, energy efficiency improvements hold the potential to create over 2 million job-years by 2050, but labour shortages will disrupt that road (Delphi, 2022).

The next generation of workers want to work for responsible companies. Nine in ten Generation Z consumers believe companies have a responsibility to address environmental and social issues. And companies with a social or environmental focus are considered to be more sought-after employers (McKinsey, 2019). Companies with leading-edge business practices may benefit.

Industry resists change to building code

The unaffordability of the housing market leads the development industry to resist change to the existing way we build, saying it will increase costs and unaffordability (Lee, 2020).

High performance does not necessarily result in higher costs and can save costs over the life of the building, the high-performance building industry argues. Nevertheless, the federal government and provinces continue to release unambitious building codes that fail to get new buildings on the road to high performance, energy efficiency, climate resiliency or circularity (Ballard, 2022).

When changes to the building code are implemented, builders and tradespeople take courses to learn high-performance building techniques. After BC introduced its leading energy-efficient step code, a more diverse group of professionals signed up for Passive House Canada's courses.

"It used to be the converted taking courses," said the course instructor. "Now, you have people coming from all over because they see where the market is going."

Lack of consistent data

There is a limited amount of data on the character of new construction materials and what materials get recycled or landfilled in Guelph, Ontario and Canada more broadly. While, globally, there is a lack of consistent data that quantifies the value of adopting the circular economy (WBCSD, 2021).

An Auditor General of Ontario report found that the provincial government does not have good data on the waste generated by the industrial, commercial and institutional sectors; the ministry doesn't know how much, the type of waste or diversion or disposal rates (Auditor General, 2021).

Furthermore, there is a lack of measurement frameworks with indicators to account for environmental externalities in resource consumption and the benefits of resource efficiency (OECD, 2021).

Opportunity

- Collaborate with other municipalities and private-sector partners to explore how municipalities can improve data collection and usage in the built environment, especially for smaller and rural municipalities.
- Advocate to the provincial government to provide collected data from private waste facilities as part of the private facilities' Environmental Compliance Approval reporting requirements.

Causes for change

Climate sophistication of governments and businesses

Driving many of the events and trends is a growing climate concern among the public, the costs associated with extreme weather events and the resulting upswing in insurance premiums (Bell et al., 2021) (IBC, 2022). As concern has mounted, so has the sophistication of the climate mitigation and adaptation policy communities and the pressure on governments to enact more impactful policies. Looking towards the United States, the major piece of legislation to make it through both houses of Congress and the White House was the Inflation Reduction Act, a major piece of climate legislation.

As pressure has mounted on governments, the private sector (led by institutional and other first movers investors) is putting increased pressure on public companies to disclose decision-useful information about their climate risk and corporate climate strategy (Halper et al., 2021). This pressure to report climate risk may soon be felt by municipalities.

Increasing technological sophistication in the building industry

The building industry has generally been constructing buildings in a similar fashion for the last hundred years, but technology has begun to disrupt this model. In 2016, McKinsey ranked the construction industry second last to digitise (in terms of digital assets, digital usage, and digital workers), only ahead of agriculture (Gandhi, Ramaswamy & Khanna, 2016).

This trend is starting to shift. In 2019, venture capital investment in construction technology outpaced non-construction funding by a factor of 15. The industry is moving

to create multi-service platforms and expanding into 3-D printing, modularisation, robotics, digital-twin technology, artificial intelligence and analytics, and supply-chain optimisation (McKinsey, 2020).

Growing technological sophistication in the industry may help spur the circular economy by adopting more prefabrication and by capturing more up-front data. The data would be collected about the materials and components that make up new builds through building information modelling (BIM) applications and other tools (Delphi, 2021).

With a growing recognition that prefabrication can reduce labour costs, increase resource efficiency, cut carbon emissions, and speed up developments, DfD/A's principles may see more growth in "green" building circles in the near term (PHC, 2022).

Total revenue in the North American market for prefabrication and modular-construction real estate projects grew by a factor of 2.4 from 2015-2018, rising from \$2,040 million to \$4,940 million (McKinsey, 2020).

Causes maintaining the status quo

Externalities are not factored into the cost

The current economic system does not factor the true cost of materials and their waste into the price of materials. The development industry sells the building to an owner/operator, and therefore, there is limited direct incentive for the designers and builders to consider the longer-term impact, while the environmental impact of resource extraction is minimally accounted for and often subsidised (Delphi, 2021).

Regulatory captured building code process

The current federal model code process is a conservative and opaque process that is slow to innovate, and favours entrenched interests. It is set up to achieve incremental improvements that no longer align with Canada's climate goals or the speed at which codes need to be adjusted to meet the rapid onset of climate change, report climate mitigation and adaptation building experts.

Set up by the National Research Council, the Canadian Commission of Building and Fire Codes (CCBFC) — a volunteer-based decision-making body made up of over 400

members who participate in standing committees (SC), task groups and working groups—is responsible for the development of the national model codes. This process allows for in-camera vetoes of expert suggestions by the Executive Committee and Provincial/Territorial Policy Advisory Committee with limited accountability.

Furthermore, all the major materials associations—steel, wood, home builders, cement, etc—have stakeholder status, while many in the high-performance and resiliency building community do not (nor could they afford to fund volunteer experts to participate), report climate mitigation and adaptation building experts.

The end result is an unambitious building code that does result in high-performance, resilient, or circular buildings. The federal model code can then be further watered down when implemented by the provinces, such as in Ontario (Ballard, 2022).

With supportive direction from the top, British Columbia released the most stringent building code in Canada. Even BC's leading step code has come under fire for changes that limited its effectiveness by allowing compliance through a reference-model approach rather than only performance (Ferooshani, Bernhardt & Bernhardt 2022).

Vancouver is the only municipality to enact and enforce a building code. Through the Vancouver Charter, the City of Vancouver can regulate the design and construction of buildings.

Opportunity

- Participate in the process of developing building standards, guidelines and code changes to support the use of reclaimed and recycled content building materials.

Lost-cost bidding

The low-cost bidding procurement process in the construction industry rather than focusing on value is a major weakness of traditional procurement methods and has caused environmental degradation and can result in indirect costs for project owners (Ruparathna & Hewage, 2015).

One deconstruction expert said this problem leads to calls to his firm to come in after and fix the problems created by the low-cost bid contractor.

“We get calls after the fact to come in and fix what has been done and that's happened in my 8 years like 10 times,” said a deconstruction expert about cleaning up the mess created from contracts being awarded to the lowest-cost bid.

Increasingly, sophisticated owners and customers are demanding a focus on the total cost of building ownership to counter this persistent problem (McKinsey, 2020). For instance, Toronto Community Housing Corporation recently announced plans to shift to a quality-based selection for their \$1.5B capital plan (Toronto Community Housing Corporation, 2022).

Opportunity

- Leverage a quality-based selection process for the public procurement of architectural and engineering consulting services to create opportunities for high-performance and circular buildings in Guelph-Wellington.

Regulating the status quo?

Circularity in buildings faces a steeper hill to climb than other aspects of the green building industry, such as energy efficiency or resiliency. There are few incentives, regulations, or building standards related to deconstruction, material reuse, and circular building design and operation. Where policy levers do exist, they are not widely used or relatively new in implementation.

At the time of this report, the federal government has over a dozen major programs dedicated to increasing the energy efficiency of the built environment. A rough scan of the federal government's recently released discussion paper as part of the consultation for their Green Building Strategy mentions net zero 49 times and resilient 32 times (add resiliency and resilience, and there are 64 total mentions), but circular and waste are only mentioned once each (NRCAN, 2022).

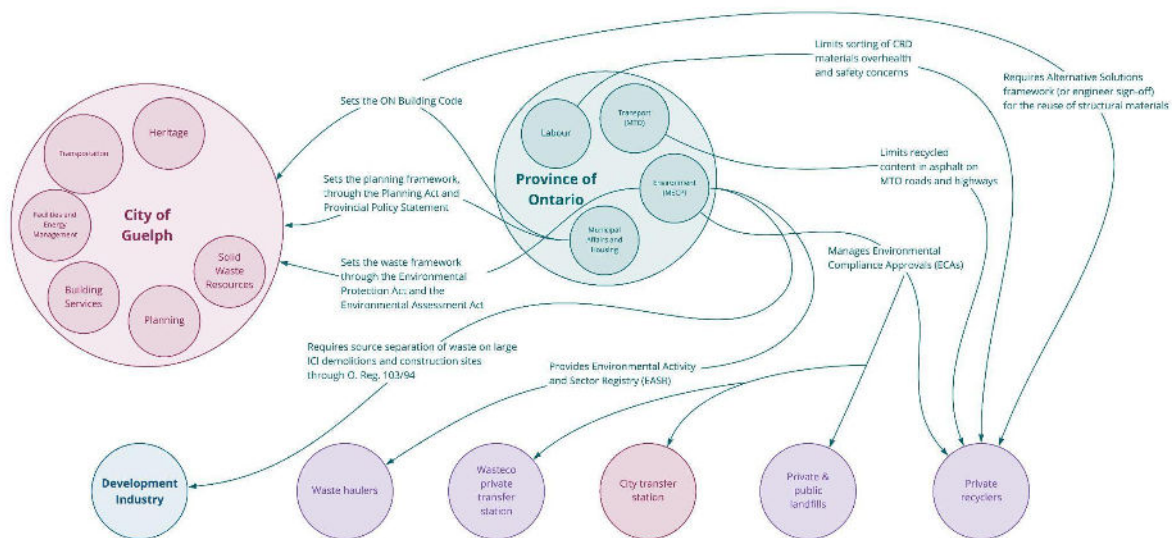


Figure 9: Provincial rules and regulations.

The province sets the planning and waste framework

In Canada, the provinces set the planning and waste frameworks. In Ontario, the province sets the planning framework through the *Planning Act* and the Provincial Policy Statement. They also set growth plans and the building code, but it's up to the municipality to prepare and enforce official plans, zoning, engineering standards and bylaws.

Through the *Environmental Protection Act*, the province sets the waste framework, including establishing or enlarging waste management systems or disposal sites, but it requires the consent of the municipality. Through the *Environmental Assessment Act*, the province sets the process to identify and resolve potential environmental problems.

In response to recent municipal opposition to new landfills, the Ontario government passed an amendment to the *Environmental Assessment Act* that gives local councils the ability to approve or reject new landfills that are up to 3.5 kilometres outside their municipal borders (Singh & Wesley, 2020).

Waste management/disposal sites must hold an approved Environmental Compliance Approval issued by the Ministry of Environment and Climate Change, which dictates the type of materials processed, operation conditions and environmental monitoring of the

site. There has been success in British Columbia with landfill bans on materials such as concrete, wood and gypsum, which have promoted the recycling and processing of these materials.

Opportunity

- Develop support for a landfill ban on clean wood, gypsum and concrete. Bans are used in other jurisdictions to increase the diversion and recycling of specific products.

Environmental Compliance Approvals

Under the EPA, new or site plan alterations of existing waste management and recycling operations need Environmental Compliance Approval. Seeking an ECA is a long, complex and uncertain process, reports stakeholders. There are no fast tracks for recycling operations.

“The approvals process is the same, they treat us just like a landfill or a transfer station; no incentives and for every tonne we are receiving we are competing with landfills,” said a veteran Ontario CRD recycler.

An approved site holding an existing ECA that wants to change its site plan in order to innovate or shift tactics to meet a changing market would need to get an updated ECA. Older ECAs are more flexible, stakeholders report, but new ECAs are much more specific and a harder process to go through.

“It’s a nightmare,” said a veteran private sector waste management professional.

“The up-front financial assurance is high and you don’t get it back until you shut down and if you want to change your operation or take on more tonnage, it could mean more up-front assurance money,” he added. The up-front capital dissuades risk-taking and innovation, he said.

Businesses that collect and transfer waste do not need an ECA, such as waste haulers. They, instead must provide information on their environmental activity through the provincial Environmental Activity and Sector Registry.

Source separation required for the ICI sector

In Ontario, source separation is required for large industrial, commercial, and institutional (ICI) buildings (a total floor area of at least 2,000 square metres) under O. Reg 103/94. Under the regulation, source separation is required, but where the material ends up is not. A review by the Auditor General of Ontario found ministry inspections of construction operations under the regulation resulted in a compliance rate of 86 percent but in ten years; the ministry had not inspected any demolition sites because of their short-term nature (Auditor General of Ontario, 2021).

Opportunity

- Collaborate with the provincial government to expand the reach and increase inspections of O.Reg 103/94 Industrial, Commercial And Institutional Source Separation Programs to include more sites and to require diversion. The regulation requires source separation (not diversion) of waste on a small number of large industrial, commercial and institutional demolition and construction sites.

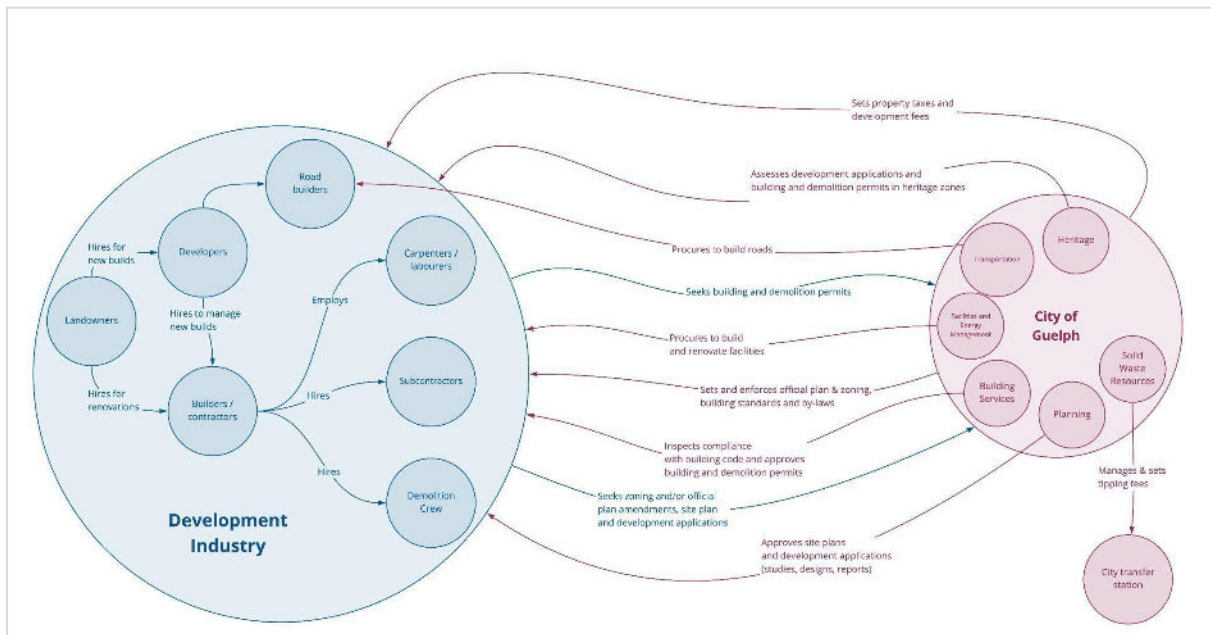


Figure 10: Municipal rules and regulation

Municipal touchpoints

Municipal governments are the front-line government to manage both the built environment and the waste system.

Front-line planning

Municipal permits are required for demolition or constructing new builds, site plan control is used to shape and evaluate development proposals (and can be used to enforce green building standards), zoning is used to determine what types of buildings go where, and there are also a number of other touchpoints through development fees and taxes, heritage preservation, road building, waste management and more. The multiple touch points can keep the status quo in place or help shape a more circular built environment.

For instance, a company that uses recycled brick in their green roof operation points to Toronto's green roof bylaw as something that has helped kick-start new businesses.

"It has essentially created several businesses both on the contracting and the supply side that probably wouldn't exist if there wasn't a bylaw. So if you asked me how that impacted the market, it was pretty substantial," said the business owner.

Recycled asphalt pilot

In 2018, the City of Richmond initiated a pilot to use recycled asphalt on municipal roads to build market confidence. After stakeholder engagement and the development of an assessment framework and a procurement tool, the municipality paved 800 metres of the road with asphalt containing 40 percent recycled asphalt. The pilot will be evaluated yearly for performance (Circular Innovation Council, 2021).

“There were a lot of concerns from the engineers and the consultants as well and by the end of it, they were all converted,” said a circular economy expert.

Opportunity

- Study engineering data from existing case studies to inform the piloting of procurement provisions for recycled content in municipal roads and buildings.
- Advocate for the updating of Ontario Ministry of Transportation highway specifications to increase the use of recycled asphalt and concrete aggregate.
- Identify opportunities to pilot other circular materials at a small scale in the municipal environment (e.g. carbon-negative concrete in built forms).

Deconstruction bylaw drives diversion

A number of West Coast municipalities – Portland, Vancouver, Victoria, and the District of North Vancouver – have enacted deconstruction bylaws that require the deconstruction, source separation, and diversion of building materials from buildings before a certain age (e.g., 1950). The age is set to capture the most value based on local building types, materials used and frequency of demolition. The municipalities leverage a combination of refundable fees, deconstruction certification, education, training, inspections, penalties, material harvest percentages, and completion reports to enforce compliance.

In Metro Vancouver, drywall and clean wood can’t be landfilled. The bans, coupled with a tax receipt leveraging an official appraiser for donated materials, make the deconstruction costs more competitive in projects not covered by the deconstruction bylaw, reports a west-coast deconstruction company owner.

Opportunity

- Explore updating the demolition bylaw to require or incentivise deconstruction, source separation, and diversion of building materials before a certain age (e.g., 1950). Leverage a combination of refundable fees, deconstruction certifications, education, training inspections, penalties, material harvest percentages, and completion reports to support compliance.

Green development standards can include circular

The City of Toronto's Toronto Green Standard, a development standard for new mid- and high-rise and city-owned developments managed by the planning department through site-plan approval, contains circular criteria in the upper tier of the standard. The top voluntary tier will become the baseline by 2028. The criteria include diverting at least

75 percent of total construction and demolition materials and reusing structural and non-structural elements for at least 30 percent of the projects completed floor area (City of Toronto, 2022, April). In an effort to incentivise uptake in the upper tiers of the standard, the city offers steep discounts on development fees, up to 50 percent, on Tier 3 projects (City of Toronto, 2022, August).

In Ontario, Toronto and Whitby have adopted tiered building standards. Markham, Brampton, Ajax, King, Vaughan and Halton Hills have developed green standards that require developers to meet a minimum threshold through a points system. Caledon, Mississauga, and Pickering are currently developing standards, reports the CEO of a municipal climate policy non-profit.

Guelph does not have a green development standard. New city buildings are built to CAGBC's net-zero building standard.

Opportunity

- Understand how various Ontario municipalities have implemented green building standards for new mid- and high-rise and city-owned developments and explore setting targets for diversion, deconstruction, design for durability/deconstruction, and the use of circular building products (e.g.,

reclaimed/recycled materials). Offer expedited planning approvals and reduced development fees for buildings targeting the top tiers of the standard.

Embodied carbon policies can boost circular

As efforts to increase efficiency in new buildings become more mature, policymakers and the development industry are turning their focus to reducing embodied carbon emissions. While embodied carbon emissions in buildings make up about 11 percent of total emissions, operational carbon still accounts for close to 30 percent of building emissions (UNEP, 2021). As operational carbon is reduced over time, embodied carbon will grow in importance. Policies to reduce embodied carbon can have a cascading effect on improving the circularity of buildings.

The Toronto Green Standard also requires buildings Tier Two or above to do an analysis of embodied carbon (but does not yet have a target builders have to reach).

“We see this kind of as that first step, starting to socialize this idea,” said a City of Toronto planner.

The City of Vancouver is leading Canada with a policy requiring a reduction of 40 percent of embodied carbon emissions in new builds by 2030 (City of Vancouver, 2022).

While there are many touchpoints, there are also constraints. Planning approval was frequently cited by stakeholders as something that was hindering development.

Planning delays

Over the years, planning departments have enacted policies to help solve resident concerns. Small checks on the development process have ensured that there is adequate sunlight, trees are protected, heritage is preserved, character is maintained, and more, but the small checks have created delays that continue to grow.

In 2020, Canada, with Toronto, used as the case study, ranked 67 out of 190 countries for ease of getting building permits, dropping from 54th in 2013 (World Bank Group, 2020; Duong & Amborski, 2017).

“The City of Guelph is very challenging to get things approved,” reported one home builder, echoing the sentiment of a number of interviewed stakeholders.

Opportunity

- Offer expedited planning approvals for buildings targeting the top tiers of a new Green Development Standard for new mid- and high-rise developments

Front-line managing waste

The City of Guelph's Waste Resource Innovation Centre has a CRD recycling system built off of the framework of the waste infrastructure. It is a self-service system that requires the source separation of CRD materials.

Unfortunately, there are no hauling businesses in the region that can consistently deliver this requirement.

"Source separating, I think it'd be pretty complicated to do it. To make it financially feasible for our customers, it would really heavily depend on what the funding was for that sort of thing," said one waste hauler.

Opportunity

- Provide supporting labour and infrastructure to encourage clean loads, such as piloting city-owned segregated CRD bins service. "Got a small reno, we'll pick it up!"

In jurisdictions where we found higher CRD diversion rates, the CRD loads were mixed, but those materials primarily ended up in boilers for greenhouses or as roads in landfills --- so the materials either end up inside the landfill or on top, but either way, it's landfilled.

The city contracts with a number of recyclers to process the separated CRD materials, but the majority of materials are downcycled into lower-quality products, except for gypsum (which gets turned back into drywall). With available but underused infrastructure in place, diverting more CRD from landfill is a clear low-hanging fruit in Guelph-Wellington.

Nevertheless, further locking the system into the current recycling system, which is primarily a system of downcycling, won't help build the circular built environment.

"if you start out with diversion-to-downcycling, then that's what the infrastructure is going to respond with, but If you start out with deconstruction, and highest and best

use, that's what the market is going to develop around," said a seasoned circular economy expert.

We also found limited awareness of the CRD recycling services (though our sample was small) and observed signage on-site promoting this service in need of an upgrade.

Opportunity

- Leverage behavioural analysis to redesign City Waste Resources Innovation Centre signage and advertising of CRD recycling. By putting human behaviour at the centre of the approach, it can help nudge the public and private sectors from information to action.

Cost recovery framework compared to waste?

The low cost of landfill impacts fees down the chain at transfer stations, keeping costs low. At the same time, fees for recycling materials are set based on the return those items yield in the open market and the cost to process those materials.

The City of Guelph's waste transfer station's tipping fees are as follows:

Mixed waste Public Drop-off	\$128 per metric tonne (unless you weigh in and out for each material type)
Clean fill, including stones, sod and topsoil	\$128 per metric tonne
Concrete, brick, rubble, toilets	\$74 per metric tonne
Drywall	\$86 per metric tonne
Mixed construction waste	\$140 per metric tonne
Shingles (clean, asphalt)	\$94 per metric tonne
Shingles (asphalt) with mixed construction waste	\$140 per metric tonne
Clean wood	\$84 per metric tonne
Hauler tipping fee to landfill	\$94 per metric tonne

Figure 11. City of Guelph waste drop-off fees.

The tipping fees for shingles are set below the cost to collect, process and ship to the recycler because “we see the benefit to not having them go to landfill,” said a veteran waste public management professional.

Despite the tax base covering 50 percent of all waste management services, the recycling costs of CRD materials at the City of Guelph are mostly focused on cost recovery. Meanwhile, the economic opportunity of fostering circular businesses, processes and products is not factored into the cost-recovery analysis. (City of Guelph,

Opportunity

- Re-examine a cost-recovery framework in municipal waste and planning to include a holistic analysis accounting for externalities and the economic potential of a regional circular economy.

Trying to add economic value to waste and build circular

Today, circularity is not being incorporated into building design and operation, and there is limited economic incentive for the private sector to add value to CRD waste. Cheap landfills, low-cost virgin materials, and limited policy support reinforce the status quo, but some innovators work under the constraints while others look for policy change before committing resources.

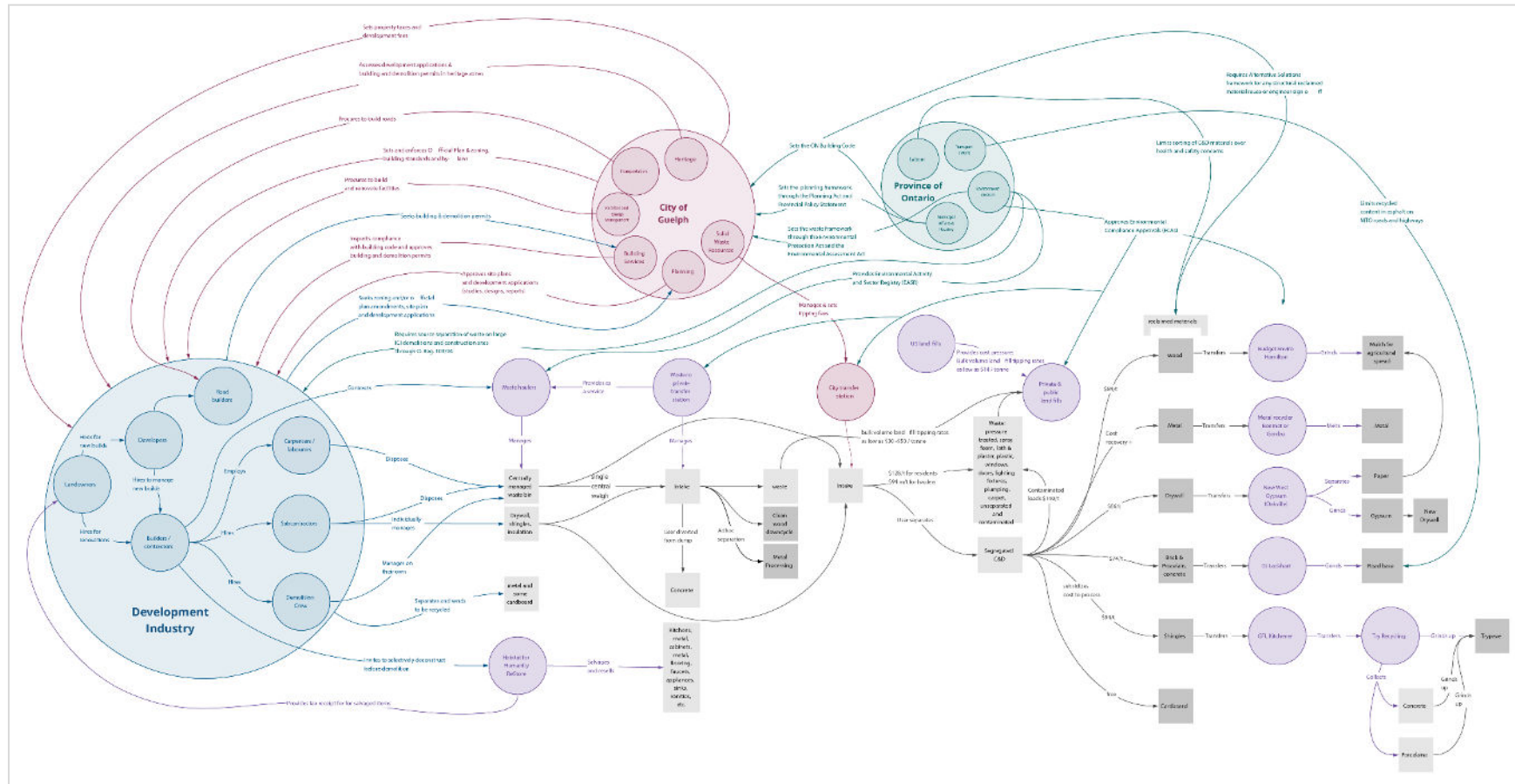


Figure 12: System map of building and waste industries and regulators.

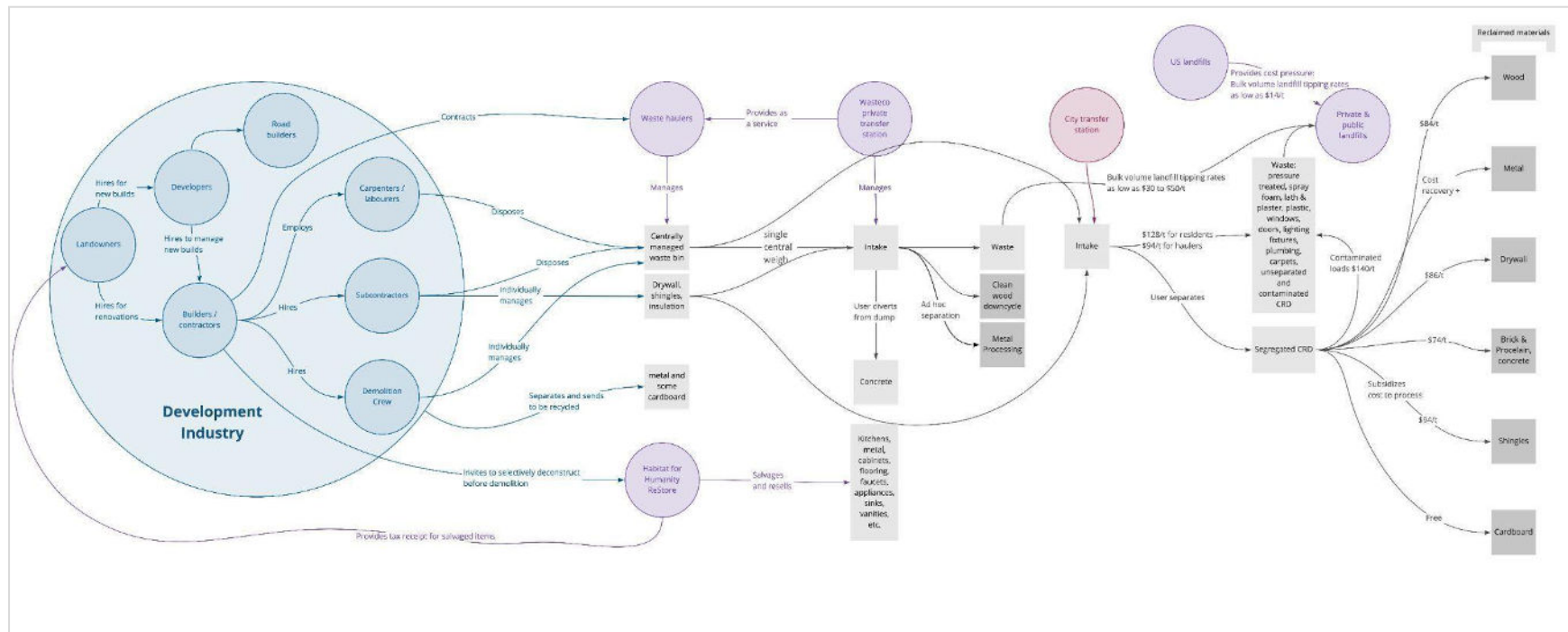


Figure 13: System map of building and waste industries.

Buildings are not being designed for circularity

Some of the first circular building design standards were drafted in Canada in the late 1990s and early 2000s, such as CSA S478:19 Durability in Buildings, Z782-06 Guideline for Design for Disassembly and Adaptability in Buildings, and Z783-12 (R2016) Deconstruction of Buildings and their Related Parts (CESS, 2021).

“The CSA Z782 Design for Disassembly guideline was ground-breaking when it was developed back in 2008 and it became the seed document for an ISO standard, but the problem was we didn’t use it in Canada,” reports one of the standard’s original authors.

There are some examples of Design for Disassembly and Adaptability (DfD/A) in Canada but the principles have not made it into the building code or penetrated the development community in Guelph-Wellington.

Material passports

In Europe, designing buildings for end-of-life reuse is more advanced. Since 2015, Project BAMB (Buildings As Material Banks), a partnership between 15 organisations from 7 European countries, has been piloting material passports and reverse building design techniques (BAMB, 2022).

A Dutch company, Madaster, provides material passport software to register all materials and products that are used in a building or infrastructure project. Leveraging data from a BIM (building information management) and other data sources, users can understand the materials in a project, track the embodied carbon emissions, and understand their reuse potential (Madaster, 2022).

Circular building certifications are nascent

Circularity in third-party managed green building standards is also nascent, but the certifications that do include elements of circularity have delivered results.

Data from 678 Leadership in Energy and Environmental Design (LEED) certified projects from across Canada reported an average diversion rate of 88 percent, an inverse of the average amount of CRD waste that is diverted today (Light House, 2020).

LEED is a point-based green building standard, and depending on the number of green activities across a number of environmental categories (location and transportation, sustainable site development, water savings, energy efficiency, materials selection, and

indoor environmental quality), buildings can be certified to tiered levels (certified, silver, gold, and platinum).

TRUE (Total Resource Use and Efficiency) is a circular economy certification for manufacturers to help develop zero-waste products. It encourages the design of products to facilitate reuse and zero-waste processes (CAGBC, 2022). A relatively new certification, TRUE, through the U.S. Green Building Certification Inc., began piloting TRUE Construction in the summer of 2022 to help support zero-waste practices in construction (GBCI, 2022).

Opportunity

- Building off of municipal leadership, develop a coalition of regional corporate leaders in the building industry to phase in zero waste in their operations, similar to Total Resource Use and Efficiency (TRUE) certification.
- Explore working with private sector building certification organisations to incorporate circular building design methodologies into existing certifications, training, and advocacy.

Deconstruction and source separation are minimal

The labour, logistics and transportation costs make deconstruction and separating the CRD waste uneconomical for the development industry relative to the return on investment from recycling.

“When we're doing renovation work, we're not deconstructing as much as I would like, or we're building new homes and taking down existing homes in their place. I haven't been able to find a way to make it economically viable, reports an environmentally conscious high-end and high-performance builder.

Deconstruction in small-scale residential projects is virtually non-existent (except in some kitchen renovations and other ad hoc situations). It exists in a few unique larger projects.

A number of stakeholders said that any source separation has to be closely monitored, and those labour costs add up.

"We did have a trial of four or five years ago, with a different general contractor and we received back not only insulation, but gypsum and shopping carts and so that's a real challenge," reports a professional from a high-performance insulation company.

The technology exists to process CRD materials, but it is expensive. An Ontario facility built to recover wood, drywall, concrete and metal from CRD waste went bankrupt after nine months (Auditor General of Ontario, 2021). There exists no automated process that can easily separate materials post-demolition and manual staffing is challenging, reports a veteran waste management professional.

An Ontario firm does deconstruct buildings but primarily in the ICI sector; they avoid residential projects because it is not financially feasible.

Metal, an item that earns a return on the labour associated with recycling, is pulled out of the waste stream at all steps along its journey from an existing building into the waste stream.

Cost signals work to divert materials.

Salvage and reuse is ad-hoc

A number of professionals in the renovation business will call Habitat for Humanity ReStore to salvage materials -- most often kitchens but other items as well -- before demolition and renovation. The process is driven more out of a desire to limit waste than an economic benefit of the materials or a tax receipt, report building industry professionals.

The ReStore is a volunteer-driven, not-for-profit organisation that uses the resale price for their tax receipts, while a deconstruction firm in Vancouver leverages an appraiser to set tax receipts at fair market value.

"There's just a benefit of having a third-party appraiser; you're going to get higher tax receipts, which incentivizes people further to deconstruct," reports the deconstruction expert.

Meanwhile, the local Guelph ReStore operation is running out of space, deconstructing 4-5 kitchens a week and, like many businesses struggles to maintain a steady pool of labourers (especially as volunteers).

“Right now for us, it's space, space for storage. We actually have a big sale right now because we've maxed out all our warehouse space,” said a Habitat for Humanity ReStore official. “Looking for storage in Guelph is very difficult right now, especially affordable.”

A reuse hub in Texas

A new Material Innovation Centre in Port San Antonio is offering training courses in the trades, a reclaimed material warehouse, venues for public workshops, and a community tool library. The centre receives, stores and conducts research on salvaged materials to support the local circular economy and reuse of building materials.

Opportunity

- Explore developing a city-supported upcycling and deconstruction hub. The hub would be space to process materials back into reusable building materials and upcycled into new products. It would be a one-stop-shop to cut down on private sector transportation costs while incubating new businesses, providing a place for experiential learning, and providing builders with access to ready-to-use reclaimed materials.

Early stage innovation

But just as much as there are constraints, there are businesses working under these tight margins and fostering new opportunities.

A Guelph builder started developing Energy Star, a low-energy building certification, and “people in Guelph were far more receptive to it,” reports the builder.

A B.C. shingle recycler said if they can secure 40,00 tonnes of stock per year, they’d set up a plant in Ontario.

A deconstruction firm in B.C. envisions setting up a reclaimed wood manufacturing hub in Ontario, but only if landfill tipping fees were higher and more CRD materials were banned from landfills.

An Ontario reclaimed materials re-seller wants to move more substantially into reclaimed wood reselling.

“We're going to kind of try to maximize our efforts towards selling the stack of lumber to the guy making the table or the architect building the building,” he said.

Shifting to circular behaviour

The human behaviour underpinning the current system is well-worn from many years of operation that keeps change at bay.

Landfills filling up & resources depleting

The fast demolish, build, and dump development process depends on easy access to low-cost virgin materials – materials that are often subsidised and do not account for environmental externalities or end-of-life management (Delphi, 2021).

Climate change is causing an increase in extreme weather events and disrupting supply chains. When historic floods swamped B.C. in 2021, all rail and truck traffic was halted out of the Lower Mainland (Evans, 2021). A stable climate is essential to keep global shipping lanes open to deliver the raw materials from the Canadian north or from international markets, something that may become less and less guaranteed in a future with more climatic shocks. Since the start of the pandemic, the Raw Materials Price Index has nearly doubled in price, largely from the rising cost of crude oil (Government of Canada, 2022).

Further, the development industry needs low-cost landfill space to keep costs down – a need facilitated by low Ontario (and even lower US) tipping fees (OMWA, 2021). The ability to cheaply send materials to landfill (including low-cost transportation options) makes the more expensive deconstruction less viable in the market compared to demolition.

Only when either becomes untenable because of policy or economic change will this system significantly deviate from its current take-make-waste process.

Nails need to be removed from clean wood; mortar needs to be removed from bricks; concrete needs to be ground down to reusable aggregate; shingles need to be separated from nails and then ground down; gypsum needs to be separated from paper, and so on. All these steps increase the cost.

Next, the materials need to be stored or immediately shipped to be reused in future projects. A number of structural materials need to earn engineering approval or pass through the OBC's Alternative Solutions framework and be approved by municipal building services departments, a cost-recovery process that further adds more expenses to a project.

"The Alternative Solutions framework has made it more expensive and harder to use because building departments require the process to be cost neutral," said a high-performance home builder. "Basically, they've created a financial impediment to non-traditional proposals."

Further, reclaimed building materials are under-appreciated because they are largely under-incentivised by government policy or promoted in third-party building standards. Reclaimed materials are mainly used by boutique builders in expensive custom projects. As a result, the majority of CRD waste materials go to landfill and a robust reclaimed materials market remains out of reach.

Punishing contamination reducing diversion

In an effort to increase diversion, Solid Waste Resources put a fee on contaminated loads to incentivise clean loads (and increased the cost to dump), but the added risk, cost and time on haulers are sending them to private transfer stations. As a result, more CRD loads have ended up in landfill.

"We added 50 percent to our fee and if you bring us mixed C&D, it's going to cost you that much money. Some companies have identified hey, you know, we can go to a different operation," said a veteran public waste management professional.

General contractors and trades are motivated by customer satisfaction, avoiding risk and fostering networks. Customer satisfaction is important because their industry depends on word-of-mouth referrals. They avoid risk because many are small

businesses and need to work within estimated costs and with clear timescales. Trusted networks help the installers when they are looking for a partner from a different trade, passing on or receiving jobs from close contacts, purchasing equipment for jobs, or when customers share their experience in their broader social networks (Owen, 2015).

As one hauler said about the contamination fee: "It's just not worth the risk. You don't know what's in the bin all the time and you don't want that surprise and neither does the customer."

Opportunity

- Explore reducing the tipping fee for clean, segregated CRD materials and eliminating the contamination penalty. Increasing the cost of municipal solid waste (MSW) and penalising contamination can drive waste to other lower-cost locations.
- Offer free promotion through municipal channels (e.g., section on building permit application portal) for CRD businesses that support zero-waste construction objectives (e.g., waste haulers that source separate).

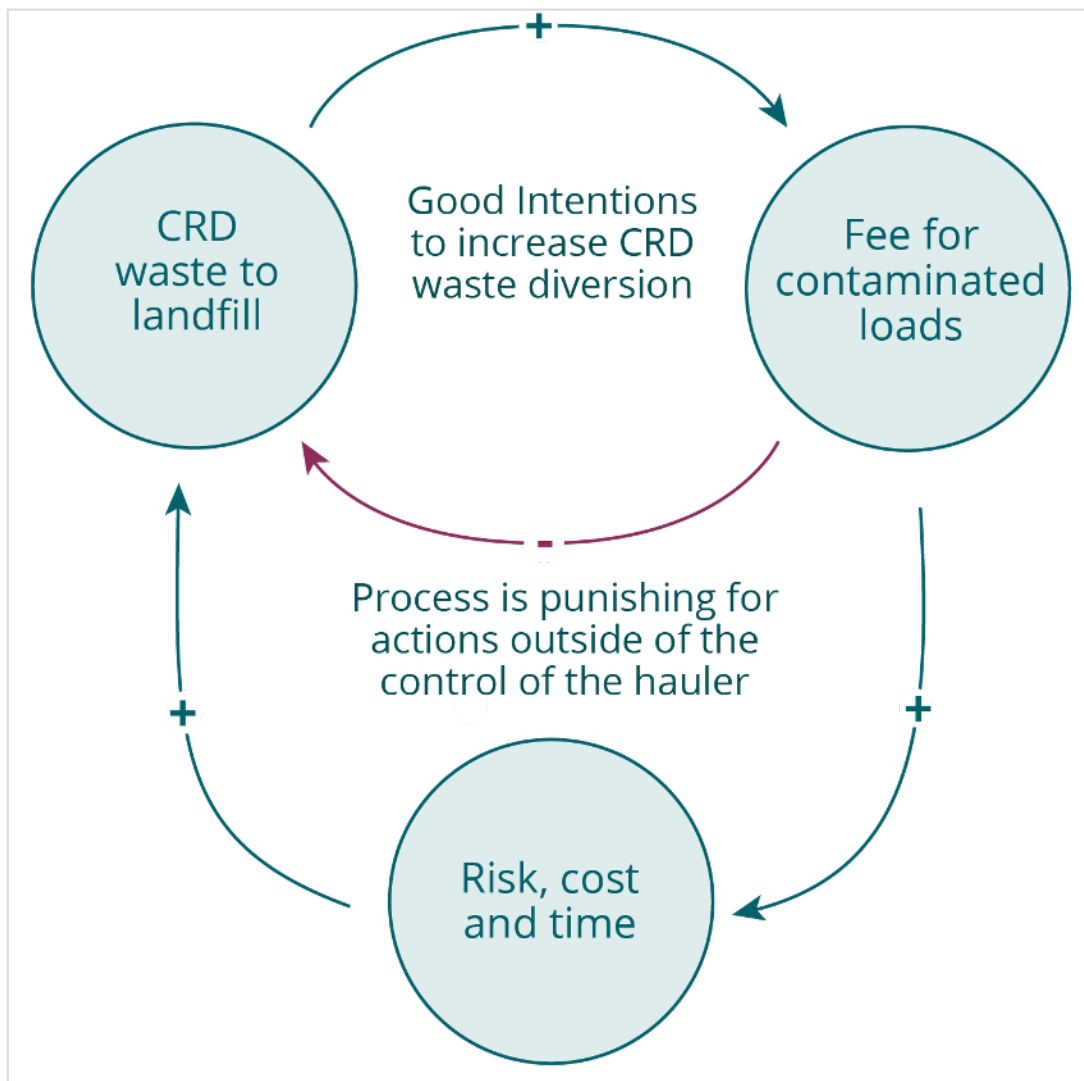


Figure 12: Behaviour system loop of Guelph CRD recycling.

Catalysing information to action

Homeowners face a number of barriers to turning information about upgrading their home to reduce their environmental impact into action. Looking at energy efficiency, where upgrades can help save homeowners money, there is a gap in program uptake. Various market and behavioural failures deter homeowners from making efficiency improvements. Homeowners have imperfect information, concerns about contractor reliability, fears related to the complexity and the hassle, and discount the future energy

savings, while landlords make tenants pay the cost for inefficient homes (Gillingham & Palmer, 2013) (Wilson, Crane & Chryssochoidis, 2015).

Homeowners, more often than not, turn to their trusted contractors to support their decisions.

"I think most homeowners are going to rely on their contractors; you know, we're hiring people to do these things, because we trust them with their knowledge and to do the right thing," said a Guelph homeowner. "If I were looking for information on how to recycle my shingles, I would ask my roofing contractor, what are you doing with the shingles?"

Homeowner motivations to conduct energy retrofits can vary. They include attitudes towards energy use and environmentalism, government incentives, age of homes, positive social interactions (more than expert advice), household events like when a boiler breaks down, life events such as when a homeowner is moving, retiring, or having a child, or household characteristics like size or socio-demographics (Wilson, Crane & Chryssochoidis, 2015).

More broadly, changing behaviour to adopt new technology and services face a number of barriers. Providing consumers with information to help break down barriers can help, but it is not enough to motivate action. Looking at the adoption of another innovation, electric vehicles provide clues about the complexity and potential solutions. The diffusion of innovation (DOI) framework uses five factors to examine innovation adoption. Is the innovation better than the current product? Is it compatible with the values, experiences and needs of consumers? Is it complex to adopt? Can it be trialled before adoption? And, can the innovation be observed by others? (Rezvani, Jansson, & Bodin, 2015). For example, the non-profit Plug-n-Drive supports expanding EV adoption by "providing an experiential learning environment for electric vehicles" (About Plug'n Drive, n.d.).

The City of Guelph is in the process of developing the Property Assessed Clean Energy (PACE) program to assist homeowners with energy-efficient property improvements. The PACE program allows homeowners to borrow money from the City to pay for the capital of these improvements.

Opportunity

- Pilot grants and loans to support home renovation waste diversion in heritage zones as part of proposed city-run energy efficiency PACE programs.
- Offer residents lawn signs indicating to neighbours that they're committed to a "Low Carbon, Zero Waste Renovation" as part of development approvals that meet particular diversion requirements.
- Explore issuing a Zero Waste Construction Guide for residents that highlights CRD companies committed to low-waste construction practices.

Conclusion

Demand for raw materials is expected to grow significantly, the majority of CRD materials end up in landfill, and Ontario is expected to run out of landfill space to put it all. The circular built environment in Guelph-Wellington is nascent. Diversion options are available, but most of the materials get downcycled, deconstruction is ad hoc and used in some larger projects, reclaimed and recycled materials are costly and used sparingly, and circular building design and operation are largely unused. Metal is widely recycled, while concrete, wood and gypsum hold significant potential to increase diversion and reuse.

Provincial leadership would have a system-wide impact, while local governments have many front-line opportunities to shape more circular development and waste systems. Overall, there are a few policies boosting deconstruction, material reuse, and circular building design and operation. Materials salvage is leveraged in an effort to cut waste, not to save money. Some innovators work to add value to waste where possible, while others look for a more favourable policy environment. Low-cost landfills and raw materials, policies and limited reclaimed materials infrastructure send most CRD to landfill. There are many potential interventions that can help grow the circular built-environment in Guelph-Wellington

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