SIDEWALK LABS

October 17, 2017

Since its inception, Sidewalk Labs has been conducting a thought experiment with leading urbanists and technologists about what the city of the future might look like—and scouring the globe for a place to bring it to life.

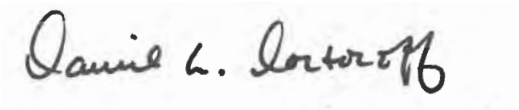
In March 2017, Waterfront Toronto issued Request for Proposals No. 2017-13, a call for an innovation and funding partner for Toronto's Eastern Waterfront. After all of our searching, we knew this was the perfect place, and the perfect partner.

Our response to Waterfront Toronto's RFP represented a snapshot in time of our ideas about how to create a place that deployed emerging technology and people-first design innovations to address the challenges that face growing cities—and how we might realize this vision on Toronto's Eastern Waterfront.

We've decided to release the vision we laid out in our response, both in the interest of transparency and to start what promises to be a history-making public conversation. We hope all Torontonians—and city-lovers far and wide—will join in. Which urban challenges are most urgent? Where can technology prove useful in finding solutions, and where is it not the right tool? Which of our ideas are great, which are crazy, and what did we miss?

We need your ideas, your aspirations, your critiques, your concerns. We hope you'll email us, call us, tweet at us, and, if possible, join us in person at a series of public conversations, beginning with a Community Town Hall in early November.

We couldn't be more honored to have been selected by Waterfront Toronto to do something historic on the shore of Lake Ontario. And we couldn't be more excited than to do it together in partnership with you.



— Daniel L. Doctoroff
CEO, Sidewalk Labs


A.
Project Vision
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SILO DOOR & YELLOW POLE ON CHERRY STREET
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ROGERS
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BILLY BISHOP TORONTO CITY AIRPORT FERRY
HEART IN THE DISTILLERY DISTRICT
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PLANT IN TORONTO EATON CENTRE
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THREE TIRES IN THE WATER AT CHERRY STREET
BARREL IN THE DISTILLERY DISTRICT
BOAT ON QUEENS QUAY EAST AND SMALL
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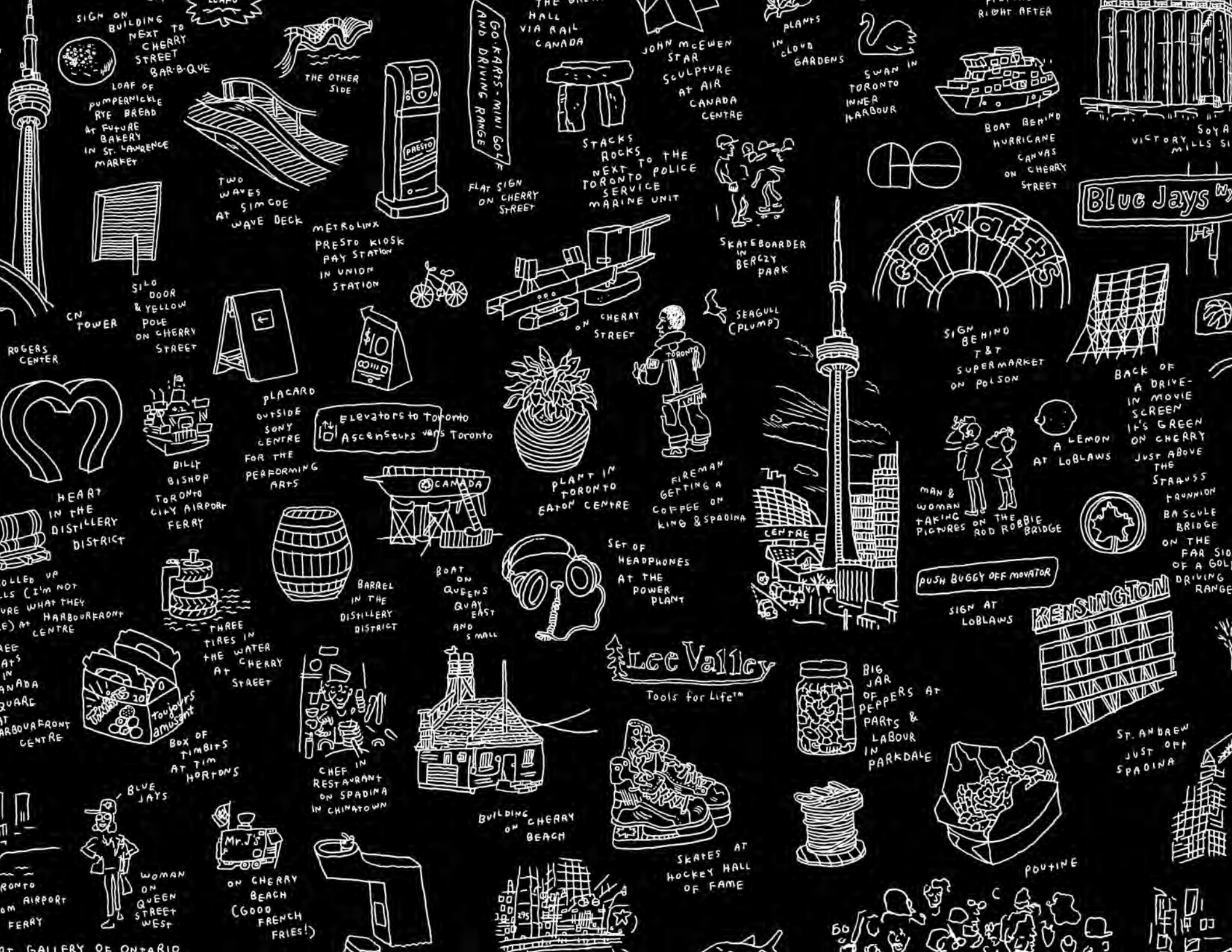
SIGN ON BUILDING NEXT TO CHERRY STREET BAR-B-QUE
LOAF OF PUMPERNICKEL RYE BREAD AT FUTURE BAKERY IN ST. LAWRENCE MARKET
THE OTHER SIDE
TWO WAVES AT SIMCOE WAVE DECK
METROLINX PRESTO KIOSK PAY STATION IN UNION STATION
GO-KARTS - MINI GOLF AND DRIVING RANGE
FLAT SIGN ON CHERRY STREET
HALL VIA RAIL CANADA
JOHN McEWEN STAR SCULPTURE AT AIR CANADA CENTRE
STACKS ROCKS NEXT TO THE TORONTO POLICE SERVICE MARINE UNIT
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BOAT BEHIND HURRICANE CANVAS ON CHERRY STREET
RIGHT AFTER
SOYA
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Blue Jays Way
CN TOWER
SILO DOOR & YELLOW POLE ON CHERRY STREET
ROGERS CENTER
SKATEBOARDER IN BERCZY PARK
ON CHERRY STREET
SEAGULL (PLUMP)
GO-KARTS
SIGN BEHIND T&T SUPERMARKET ON POLSON
BACK OF A DRIVE-IN MOVIE SCREEN IT'S GREEN ON CHERRY JUST ABOVE THE STRAUSS MANNION
PLACARD OUTSIDE SONY CENTRE FOR THE PERFORMING ARTS
Elevators to Toronto
Ascenseurs vers Toronto
PLANT IN TORONTO EATON CENTRE
FIREMAN GETTING A COFFEE ON KING & SPADINA
A LEMON AT LOBLAWS
MAN & WOMAN TAKING PICTURES ON THE ROD ROBBIE BRIDGE
BASCULE BRIDGE ON THE FAR SIDE OF A GOLF DRIVING RANGE
HEART IN THE DISTILLERY DISTRICT
BILLY BISHOP TORONTO CITY AIRPORT FERRY
CANADA
BARREL IN THE DISTILLERY DISTRICT
BOAT ON QUEENS QUAY EAST AND SMALL
SET OF HEADPHONES AT THE POWER PLANT
CENTRE
PUSH BUGGY OFF MOVATOR
SIGN AT LOBLAWS
KENSINGTON
THREE TIRES IN THE WATER AT CHERRY STREET
Lee Valley
Tools for Life™
BIG JAR OF PEPPERS AT PARTS & LABOUR IN PARKDALE
ST. ANDREW JUST OFF SPADINA
Box of TIMBITS AT TIM HORTONS
CHEF IN RESTAURANT ON SPADINA IN CHINATOWN
BUILDING ON CHERRY BEACH
SKATES AT HOCKEY HALL OF FAME
POUTINE
BLUE JAYS
WOMAN ON QUEEN STREET WEST
Mr. J's
ON CHERRY BEACH (GOOD FRENCH FRIES!)
FERRY
GALLERY OF ONTARIO

A1

Vision

A1-a VISION

i. A new type of place. Toronto is a city of neighbourhoods at heart, and the Eastern Waterfront is its next frontier—a great undeveloped outlet that can set a new standard for downtown communities and help relieve the pressures of the city's remarkable growth. In Quayside, Waterfront Toronto has the opportunity to create a neighbourhood that lives up to the city's planning principles of livability, connectivity, prosperity, and resilience. As the innovation and funding partner for Quayside, Sidewalk Labs, an Alphabet subsidiary and sibling company to Google, will accelerate these plans for inclusive growth by merging the physical and digital realms, creating a blueprint for the 21st-century urban neighbourhood.

Quayside will celebrate the waterfront's shipping heritage, its remaining industrial icons, and its origins as a public promenade. It will be a truly complete community, blending work, home, and play throughout the neighbourhood, within every building, and even on the water. Instead of orienting the built environment around cars and condos, Quayside's public realm will centre on bike paths and pedestrian laneways. The neighbourhood will prioritize placemaking, with an adaptable mix of building uses and amenities that stay active at all hours of every day.

Quayside will feel like no other neighbourhood in Toronto—or, indeed, the world. The neighbourhood will be a bustling digital and civic workshop open to all, and its streets will be filled with exploration. When people look around Quayside, they might see a retail shop turning into artist housing as part of a flexible building pilot. Or a self-driving shuttle dropping off passengers during a test ride. Or a community group using a digital kiosk to provide feedback on a local planning discussion. Or a new urban innovation institute, home to a campus of entrepreneurs itching to solve the toughest problems facing cities.

Welcome to Quayside, the world's first neighbourhood built from the internet up.

Quayside will be a new type of place, with connectivity designed into its very foundation. It will blend human-centred urban design with cutting-edge digital technology, cleantech, and advanced building materials. It will be a global testbed where people can use data about how the neighbourhood works to make it work better. It will serve as connective tissue—going above, below, and around the Gardiner Expressway to improve access to Toronto's waterfront. And it will reflect the city's exceptional diversity.

But what happens in Quayside will not stay in Quayside. The ideas first tested there will take on new life when deployed at scale across the Eastern Waterfront district. Modular housing piloted in Quayside can produce whole neighbourhoods of lower-cost, quicker-to-build housing, enabling the market to meet burgeoning demand. A self-driving shuttle can bloom into a next-generation transit system that provides point-to-point convenience without the safety risks and high costs of private cars. A thermal grid pilot can become the foundation of a district-wide energy system that sets a global example for climate-positive living.

Integrating new technology into the urban environment is hard. The technologists who produce ambitious solutions do not speak the same language as the urbanists who must find ways to implement them. Today no single city stands as a model for a brighter urban future.

In Quayside, the physical and the digital will converge into a platform for urban innovation, accelerating the pace of solutions. As this platform scales across the Eastern Waterfront, it will catalyze an industry at the intersection of cities and technology that exists nowhere else in the world. Just as Silicon Valley is the centre for digital technology and New York is the centre for finance, the Eastern Waterfront can help make Toronto the global hub for urban innovation. This ecosystem will build off Toronto's natural strengths: its diversity, strong public institutions and universities, and rising tech presence, bolstered by recent investments in artificial intelligence.

The moment is right for a vision of historic sweep. The world sits on the cusp of a revolution in urban life every bit as transformative as the arrival of the steam engine or electricity, powered by a new set of digital and design breakthroughs. With Quayside as its launchpad, the Eastern Waterfront will be a place where people and companies come to engineer solutions to tough urban growth challenges, and to export the ideas sparked in Toronto far beyond the mouth of the Don River.

ii-iii. Partnering to achieve it. Sidewalk was formed to lead an urban innovation project of great consequence. Alphabet (then Google) launched Sidewalk with the belief that emerging technology—if truly integrated into the physical environment—can help cities address seemingly intractable challenges. Sidewalk has spent the past two years studying more than 100 efforts to create urban innovation districts and

producing a comprehensive vision on building a city in the internet era.

As an innovation partner to Waterfront Toronto, Sidewalk will contribute a unique combination of technology, urban development expertise, and flexible funding approaches. Sidewalk will seek from Waterfront Toronto and its team the expertise gained from years of successful waterfront planning and development; coordination of city, province, and federal support; sourcing of local partners and expertise; and a joint approach to master planning consistent with Toronto's long-term development objectives.

Sidewalk envisions a phased governance structure (described further in **A5-a**) that ensures close collaboration with Waterfront Toronto and the opportunity for community engagement in defining the project vision, while preserving the flexibility to collaborate with market-leading partners for specific implementations. During the initial phase, joint approval of a master development plan will be a key governance principle to ensure that the visions of Sidewalk and Waterfront Toronto are aligned. Sidewalk and Waterfront Toronto will form a senior working group to make key decisions, consulting with local stakeholders and an advisory board to be highly responsive to the community.

iv. Why Sidewalk is unique. As the marriage of Google engineers and government leaders who changed the face of New York City, Sidewalk is the only urban innovation company built expressly to bridge the divide that exists between urbanists and technologists. Sidewalk merges the iterative thinking and challenges to convention that brilliant technologists do so well with the placemaking know-how and local sensitivity that savvy urbanists bring to the table.

As an Alphabet subsidiary, Sidewalk will deliver its parent company's unparalleled expertise and reputation to spark a new industry around urban innovation in Toronto. No one else has envisioned the integration of technology into the physical environment that will give rise to an urban innovation platform and inspire a new generation of creative minds to invent tools for city living. Sidewalk's presence will signal to aspiring engineers, urban designers, and entrepreneurs that a career helping cities meet their challenges is possible along the Eastern Waterfront.

Most critically, Sidewalk's vision puts people at the heart of its objectives. Technology is never the end goal, but rather a tool that empowers people to improve quality of life. The world does not need another plan that falls into the trap of treating the city as a high-tech island. A new neighbourhood or district must be cheaper to live in, cleaner to breathe in, safer to travel in, easier to find work in. Otherwise, why build it?

Waterfront Toronto and Sidewalk share the goal of turning the Eastern Waterfront into the most innovative urban district in the world. Implementing this vision together can help Toronto address its growth challenges; ignite an urban innovation cluster where new industries thrive, new skills are learned, and small businesses scale; and create a replicable model for the world.

A1-b URBAN CHALLENGES

i. Growing pains. Many of Toronto's most pressing challenges are the result of its success. High-demand cities around the world, from New York to London, struggle to maintain the character of their neighbourhoods and the socioeconomic diversity of their people as housing prices, congestion, and costs of living soar, and Toronto is no exception. At the same time, the global threat of climate change has put the spotlight on cities in search of solutions, with Toronto becoming a respected leader in this urgent pursuit.

The cities that emerge stronger from these challenges will be those that manage growth equitably, affordably, and sustainably. Toronto is on the right track with its plan for the city centre that prioritizes dense, mixed-use building, investment in transportation and infrastructure, and climate-sensitive development. But it has to move faster to achieve inclusive growth. Chief Planner Jennifer Keesmaat articulated the balancing act required in Toronto's official plan: "Our choice is not whether we grow, but how well we grow."

Of course, many challenges in Toronto go beyond growth. Condos along the waterfront alone cannot explain the startling rise in single-family home prices; that is also a problem of housing supply being unresponsive to demand. Likewise, while rising costs exacerbate income inequality, the greater force at work is a global economy that has stopped providing the middle-class job opportunities and wage growth it has delivered in the past.

These challenges impact Torontonians every day in the form of reduced quality of life and opportunity. It is the Ryerson graduate who cannot afford to get her own place, the service worker who spends hours of his life sitting in traffic on the Gardiner, the family that cannot find enough space to live

comfortably downtown. To live up to its billing as "the city that works," Toronto must work for everyone.

ii. Overcoming challenges. It would be unrealistic to propose solving all the challenges facing Toronto, let alone its peer cities around the world, in Quayside. But the opportunity presented by Waterfront Toronto provides the chance to demonstrate how emerging technologies can make cities more affordable, easier to travel within, and more environmentally sustainable, in ways that urban planners could not have imagined just a decade ago.

As new concepts get built, tested, and refined in Quayside, they can begin to show the path forward on the toughest growth challenges. The experiments undertaken in Quayside will convince people to look at pressing problems in new ways. If pilots around new construction methods such as prefabricated modular or tall timber show an ability to reduce building costs, for example, then developers and housing providers across Toronto will have another tool to help them meet market demand and improve affordability.

Piloted in isolation, concepts explored in Quayside can demonstrate capabilities for improving quality of life, and start to deliver neighbourhood improvements. But it is only when the project expands to district scale in the Eastern Waterfront that new capabilities and applications can reach escape velocity and help Toronto—along with other high-demand cities—achieve inclusive growth.

iii. Global significance. Several things will make this project globally significant. First, the firsts: the things that have never been done. The Eastern Waterfront will be the first district where the only vehicles are shared and self-driving, where buildings have no static use, where streets are never dug up.

Second: the integration of innovation, both physical and digital, across every aspect of urban life. Nowhere else will mobility innovation meet streets designed for it. Nowhere else will housing be more affordable based not on policy alone but on how things are built. And nowhere else will all this innovation exist in a single place.

Third: the capacity for iteration. The Eastern Waterfront will be a place where people have the tools to develop bold ideas—a place that not only accommodates innovation but demands it. What Sidewalk envisions today for Quayside and the Eastern Waterfront is just the first chapter; it is what cannot yet be imagined that will change the world.

iv. Success metrics. The most imaginative urban innovation only succeeds when it improves people's lives. To assess success in Quayside and the Eastern Waterfront, Sidewalk has identified 25 metrics that cut across all aspects of quality of life in cities, including cost of living (with 11 subsets around rent, transportation, and more), carbon emissions, walkability, park access, job growth, civic participation, and time saved commuting.

Sidewalk has conducted rigorous feasibility studies applying the urban innovation concepts described in **A1-c** to large-scale districts reasonably comparable to Toronto's Eastern Waterfront. Based on these studies, Sidewalk expects to see incremental quality-of-life improvements on all metrics in Quayside when compared with the surrounding metro area, and transformative gains when innovations are deployed at scale across the Eastern Waterfront. For example, Sidewalk's feasibility studies projected cost of living reductions of 14 percent (largely through lower rents and transportation costs), job growth that outpaced the rest of the region, and climate footprints among the lowest in the world. (These feasibility studies, and their findings, are described in further detail in **A4-b**.)

A1-c
PURPOSEFUL SOLUTIONS

You can never truly plan a neighbourhood with every solution laid out from the start. Instead, you can give people the tools to create and experiment. This vision of Quayside as a platform for urban innovation is at the heart of Sidewalk's approach.

The world's great cities are all hubs of growth and innovation because they leveraged platforms put in place by visionary leaders. Rome had aqueducts, London the Underground, Manhattan the street grid. The creators of these physical platforms, along with digital ones like the web or Linux, spurred innovations by a diverse group of entrepreneurs and urban planners. An Android phone changes with every new downloaded app; the original street grid of Toronto changed with every streetcar track placed on top.

Sidewalk's platform concept integrates **digital, physical, and standards layers** to form the baseline conditions for urban innovation.

Sidewalk is actively developing a digital layer with four essential components. A Sense component knits together

a distributed network of sensors to collect real-time data about the surrounding environment, enabling people to measure, understand, and improve it. A Map component collects location-based information about the infrastructure, buildings, and shared resources in the public realm. An Account component provides a highly secure, personalized portal through which residents can access public and private services. A Model component (in development by Sidewalk's Model Lab) can simulate "what if" scenarios for city operations to inform long-term planning decisions.

The physical layer is essentially the core infrastructure that frames any city: utility channels to carry wires, waste, and water; a street grid to direct movement; a public realm to provide an array of parks and amenities. Sidewalk's approach to the physical layer is designed to be adaptable. For instance, unlike traditional utility networks, which are buried in roads and therefore disruptive and costly to change, flexible utility channels will be easily accessible and reserve space for new connections, saving time and money on upgrades and installation. The physical and digital layers will connect via sensors to generate a shared repository of data on the neighbourhood that is critical not only for day-to-day operations but also for public agencies and third parties working to improve services—empowering people to build solutions faster than is possible in cities today.

The platform's standards layer defines the rules for residents, administrators, and developers using and building atop the platform. Good platforms encourage the most innovation and collaboration with the fewest barriers to entry. The platform must attract participants by being open, and it must connect producers of new goods and services with consumers. The platform must have clear data standards and well-supported application programming interfaces (APIs) to accelerate development. And the platform must have an uncompromising and transparent approach to data and privacy protection.

To jumpstart the urban innovation platform, Sidewalk is developing a series of concepts noted below. These ideas should not be seen as rigid solutions but rather approaches to urban growth challenges that provide an initial demonstration of the platform's capabilities, and that are open to refinement through partnership with Waterfront Toronto.

The next frontier of global sustainability. Toronto's sustainability trends around transportation and electricity consumption are encouraging, with electric vehicle ownership rising and great strides being made on cleaner electricity. But as the Quayside Draft Vision Document points out, there is still a lot of progress to be made reducing emissions that come from building energy, waste, and water use.

As the centrepiece of a new approach to building energy in Quayside, Sidewalk will pilot a thermal grid that taps multiple existing sources of energy for circulation and reuse, making it possible to heat and cool buildings without fossil fuels. Sidewalk will also capture enough renewable energy through an advanced microgrid to meet Waterfront Toronto's goals for onsite power generation. And Sidewalk will adopt Passive House building standards that go beyond LEED to manage the thermal load that is the largest cause of energy demand in buildings.

Sidewalk will complement these efforts with a suite of innovations that target reductions in waste and water use. To reduce construction waste, Sidewalk will experiment with more eco-friendly building materials, such as tall timber. Sidewalk will seek to pilot a smart disposal chain in multifamily buildings that consists of sensor-enabled waste separation for recycling and onsite anaerobic digestion for composting, dramatically reducing landfill waste. And an intuitive purple-pipe pilot will help tenants reuse greywater.

These components can help make Quayside a zero-emissions neighbourhood and introduce the next generation of sustainable buildings.

Real estate that is flexible and far more affordable. Housing is the single biggest expense facing Toronto families, and the toughest barrier to inclusivity. To make Quayside a complete community, Sidewalk has developed several tools that help achieve affordability—from technology that lowers construction costs to innovative financing and partnerships with government.

In Quayside, Sidewalk plans to deliver **modular** buildings using advanced manufacturing to save time and money during construction. Sidewalk will also demonstrate a flexible building typology, Loft, with a strong shell and minimalistic interior that makes it quick and easy to convert building uses. To enable adaptable buildings while ensuring good standards, Sidewalk will test outcome-based codes, using embedded sensors to monitor for negative impacts such as noise or pollution. Sidewalk will also explore new occupancy models that rely on

shared space, such as co-housing, to further lower housing costs.

Drawing on its long history developing affordable housing in New York City, the Sidewalk team will pursue innovative financing approaches in Quayside. Sometimes the best fit will be a partial homeownership program; other cases may require a rental subsidy. Critically, affordable housing in Quayside will not be relegated to separate buildings; Sidewalk's approach will be for residential facilities throughout the neighborhood to house residents with a range of incomes.

These strategies can make housing more efficient and affordable and encourage socioeconomic diversity.

A mobility system as convenient as private cars at much lower cost. The biggest challenge to sustainable mobility in Toronto is finding ways for transit to compete with the private car in terms of convenience for daily trips—a struggle exacerbated by limited transit funding. In Quayside, Sidewalk plans to use both traditional transit and digital mobility tools to offer efficient alternatives to driving, all at lower cost than owning a car.

Sidewalk's approach begins by restricting conventional vehicles (non-emergency) from a large portion of the neigbourhood after a transition zone. But that is not enough. For trips within Quayside, Sidewalk will provide a robust walking and biking infrastructure, including expansions of Bike Share Toronto. Working with Waterfront Toronto and the city, Sidewalk hopes to extend transit links to the waterfront—specifically, the 501 and 514 streetcar routes. Sidewalk will also pilot a self-driving transit shuttle, a strategy identified in the Quayside Draft Vision Document.

For trips outside Quayside, Sidewalk's approach is to reduce the need for private cars, or manage their impact when transit is not convenient. An adaptive traffic light pilot (being incubated by Sidewalk's Semaphore Lab) will use sensing technology to detect pedestrians and cyclists and prioritize their safe movement through congested intersections. A managed parking pilot (being developed by Sidewalk's portfolio company Flow) will direct cars to available parking, reducing the emissions and congestion caused by circling. A mobility-as-a-service platform will help users take advantage of all mobility options, and will facilitate an on-demand shared ride system. Finally, Sidewalk will create an urban freight transit system, using robots to make deliveries via utility channels.

These initiatives will help make Quayside one of the least auto-dependent neighbourhoods in Toronto, saving families thousands of dollars a year in car-ownership costs.

A public realm that is vibrant and usable year-round. Toronto's Jane Jacobs spent her life encouraging cities to improve their shared spaces, because ultimately the public realm defines a neighbourhood. But bad weather can deter people from gathering outdoors, and limited insight into usage patterns and conditions makes public spaces hard to maintain.

Sidewalk's approach to the public realm centres on returning it to pedestrians and making it more usable more often. Awnings set out in bad weather are as old as the souk, but emerging capabilities and technologies, such as durable plastics like ETFE, enable new approaches to weather mitigation and all-season infrastructure that can draw people outdoors. In Quayside, Sidewalk will pilot retractable canopies in public spaces and heated bike and pedestrian paths to melt snow.

Sidewalk also will pilot a public realm management system, enabled by sensor arrays, that monitors air quality, asset conditions, and usage, helping managers respond quickly to emerging needs, from broken benches to overflowing waste bins. This system will enable tests of reservable outdoor spaces for short-term uses, such as pop-up shops. Using flexible building structures, Sidewalk is exploring a next-gen bazaar, a tech-enabled makerspace with activity stalls that can be refreshed quickly.

These capabilities can help make public space more usable for as much of the year as possible—and as familiar and comfortable as a living room or a backyard.

A close-knit community that uses data to improve city services. Social cohesion and civic engagement are an ongoing challenge in growing cities, but new data and digital tools can be put to work for a stronger community. Sidewalk portfolio company Intersection is at the forefront of connected communities: its LinkNYC system is the world's largest free public Wi-Fi network, and its connected program at Hudson Yards in New York City enables a vast array of neighbourhood experiences, including amenity reservations and digital feedback channels.

In Quayside, Sidewalk will pilot a neighbourhood assistant tool to facilitate social cooperation and

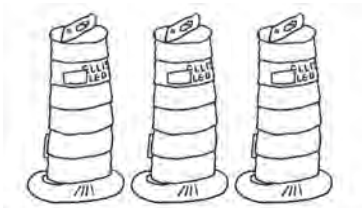
public feedback. This tool will enable Quayside residents to form new neighbourhood groups, crowd-source community needs, and access a peer-to-peer marketplace. Toronto has excellent 311, but the neighbourhood assistant can be another portal through which residents communicate feedback to officials, addressing the need for digital tools that gauge community well-being, as noted in the Quayside Draft Vision Document.

Building off Ontario's Community Hubs program, Sidewalk will work with Waterfront Toronto and government partners to bring a robust set of community services into single locations that are more accessible to residents. By connecting these hubs with better data, Sidewalk will enable service providers to deliver more personalized services to the local community. Sidewalk's Care Lab is actively developing digital tools to integrate primary care and social services for city residents.

All told, Sidewalk will work to make Quayside a thriving community where data-driven services make life easier, healthier, and more productive.

A1-d
BARRIERS /DEPENDENCIES

Cities are notoriously difficult to change. Risk aversion, funding limitations, vested interests, and other barriers stifle bold action. By combining their respective expertise creating positive urban change, Waterfront Toronto and Sidewalk have the rare opportunity to build something transformational that truly integrates digital technology into the physical and social environment. The Eastern Waterfront itself supports this effort: a site at the heart of a great city that is large enough to host the district of the future and yet largely undeveloped.



Of course, there are good reasons why urban change is hard. In a great city, a rich diversity of people and places create a unique fabric to be treasured and protected. In the case of Toronto, Sidewalk is still getting familiar with this fabric, but it brings a deep love of cities and a commitment to solving the challenges they face. Sidewalk has engaged best-in-class, Toronto-based consultants with decades of collective experience guiding, safeguarding, improving, and growing Toronto. Sidewalk has also started to reach out to civic leaders, business leaders, academics, former public officials, and community activists to serve as an advisory board that will help guide plans for Toronto's newest neighbourhood.

There are more practical barriers and dependencies for the project. Sweeping innovation may require more up-front investment, as well as massive infrastructure work on a short timetable, and deliver less immediate return. Thus Sidewalk must be innovative when it comes to financing, as well. The Sidewalk team is led by recognized leaders in creating new structures to fund housing and infrastructure investment—from America's largest ever tax increment financing district, to America's largest ever affordable housing program, to the redevelopment of Lower Manhattan after September 11. They will bring that experience to bear on the Eastern Waterfront.

Another barrier is that there is no way to set a global standard for innovation without meaningful change to outmoded regulation. Achieving Sidewalk's vision for adaptable buildings that reduce costs, for example, will require a new paradigm in the building code that provides both flexibility and safety. Likewise, opportunities for innovation in the areas of transportation and energy may require substantial forbearances from existing laws and regulations, as well as the willingness of provincial and municipal governments to partner with Waterfront Toronto and Sidewalk in ways that take full advantage of the project's technological capabilities and urban design.

Finally, building on the excellent work Waterfront Toronto has done on community engagement, Sidewalk will establish an unparalleled level of trust around data use by engaging with independent privacy experts and community stakeholders to advise on protections, transparency, and controls. For example, Ann Cavoukian, former Ontario Information and Privacy Commissioner and now Executive Director of the Privacy and Big Data Institute at Ryerson University, has agreed to serve on an advisory board if Sidewalk is selected for Quayside.

A1-e
BROADER EASTERN WATERFRONT REVITALIZATION

On the Eastern Waterfront, the ideas imagined and tested in Quayside can achieve the scale necessary to redefine cities, positioning Toronto and Canada as a world leader in urban innovation, and delivering step-change improvements in quality of life. Four themes drive Sidewalk's belief that a revitalized Eastern Waterfront can become a living laboratory of global significance: place, scale, impact, and opportunity.

First are the unique properties of the Eastern Waterfront itself. It is close enough to feed on the energy of Toronto's booming core, but still removed enough to function as a place of experimentation. Add to that its size, sparse population, and guidance from Waterfront Toronto, and the Eastern Waterfront provides a singular canvas on which to apply the concept of an urban innovation platform.

The site is large enough to support a dozen or more distinct neighbourhoods—a system of "networked neighbourhoods." Across the waterfront, the streets will restrict conventional vehicles, with a mobility network primarily serving pedestrians, cyclists, and taxibot transit. A free-flowing public realm will emphasize flexible pavilions and radical mixed-use, bringing home, work, and play closer together. A green ribbon of parks will surround the district, and a series of blue "water rooms"—from floating theatres to homes—will create new life on the lake.

Second is the scale of impact that can be achieved by innovation on a site of hundreds of hectares. A Loft pilot at Quayside can create radical mixed-use for hundreds of people; this same concept, applied across the Eastern Waterfront, means transforming the speed at which the built environment evolves for tens of thousands of Torontonians. A smart disposal chain deployed in Quayside will make it easy to bring composting to multifamily buildings; this same concept, applied across the Eastern Waterfront, becomes a robotic sorting system that diverts more than 90 percent of waste without the hassle of manual separation. A cluster of Passive House buildings at Quayside will climb the learning curve and make it possible for the Eastern Waterfront to be entirely Passive House at no incremental cost.

Third is the combined impact that occurs when boundless innovation comes together in cross-cutting ways. When a mobility-as-a-service pilot in Quayside scales across the Eastern Waterfront, it not only enables families to abandon auto-ownership without sacrificing convenience, it also combines with self-driving shuttles to turn every corner into a transit stop. By eliminating the need for parking, this new mobility system further combines with flexible Loft structures and programmable public space to repurpose land for whatever the community needs most, from affordable housing to cultural institutions. And the system combines with the advanced microgrid to fuel electric vehicles with renewable energy and off-peak power, keeping the air cleaner.

The examples go on. The public realm is enhanced by utility channels that put an end to disruptive street work and enable robots to transport solid waste underground and out of sight. Flexible buildings are supported by an outcome-based code that, at full scale, prevents nuisances and safety risks while dramatically reducing the restrictions on how indoor spaces are used. The microgrid is complemented by a thermal grid that can tap vast sources of waste heat and natural cooling, enabling the Eastern Waterfront to export clean thermal energy to downtown neighbourhoods and achieve Waterfront Toronto's climate-positive ambition.

In this way, the networked neighbourhoods of the Eastern Waterfront will begin to operate at a system scale, like the internet, generating advantages that increase with each new node. Whereas a neighbourhood of a few thousand people will produce a modest market opportunity to attract third parties to the platform, a district of networked neighbourhoods will be powerful enough to draw companies and entrepreneurs from all over to take part in Toronto's new ecosystem.

Which leads to the fourth and final theme: the opportunity for people to create things that no one can yet imagine. Some of these things will be digital applications built on top of the platform. When the internet first emerged as a small network of researchers, who envisioned that it would one day transform the way people navigate city streets? And cities themselves will change in unknowable ways once the traditional rules of urban planning disappear. When planners no longer need to orient streets around cars, developers no longer need to distinguish land uses, and communities no longer need to choose between an affordable home and a reasonable commute, the physical environment becomes an extension of human creativity, rather than a barrier to it.

For more detail on how innovations applied in Quayside will have a transformative impact across the Eastern Waterfront, see **Appendix A**.

A1-f TRANSFERABILITY

Sidewalk's approach for Quayside is designed to achieve both a successful urban development project and to maximize transferability of the solutions that emerge on a global scale. Everything will have a dual purpose: inclusive growth for Toronto, and a demonstration project for cities everywhere to look to and learn from.

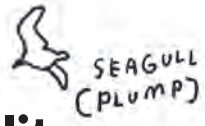
As local laboratories of innovation, cities have always copied the best practices of other cities. Sidewalk leaders learned that lesson time and again during their tenure in city government. New York City's

High Line inspired dozens of cities to create similar projects with abandoned infrastructure. The PlaNYC sustainability initiative set a new standard for managing growth while protecting the climate. C40 cities institutionalize this practice to help each other implement ideas systematically.

Of course, before cities and developers copy ideas, they must see that a new concept has worked. Sidewalk expects Quayside to become the most measurable community in the world. Nowhere else will researchers have access to a well-supported, standardized data platform, and models that enables rapid urban innovation—a "city with an API." At a new urban innovation institution in Quayside (described more in **A4-a**), researchers will be able to analyze data to demonstrate which concepts being tested in the living laboratory are improving quality of life, and which are not. As innovations show their promise, their usage will transfer outward—first to Toronto, then beyond.

As more concepts prove their success, and more cities copy them, more urban innovators will come to Quayside to pursue their own ideas. This positive feedback loop for Toronto will catalyze an innovation marketplace in Toronto, consistent with recent recommendations from Canada's Advisory Council on Economic Growth.

A2



Sustainability and Innovation

Sidewalk's approach to sustainability in Quayside is to pilot and scale different kinds of innovation to tackle the thorniest problems in environmental performance. Despite tremendous strides on climate action in Toronto, the state of the art today is insufficient to achieve the levels of greenhouse gas reductions the planet needs, let alone realize Waterfront Toronto's vision of a climate positive community. Achieving that high bar requires aggressive innovation around mobility (detailed in **A3-b**) and electricity, but Sidewalk sees an opportunity in Toronto to make the biggest impact on resource consumption around building energy. Through a sustainability strategy centring on thermal energy capture, Quayside has the potential to be nearly climate positive in its early phases, and the Eastern Waterfront can achieve climate-positive status.

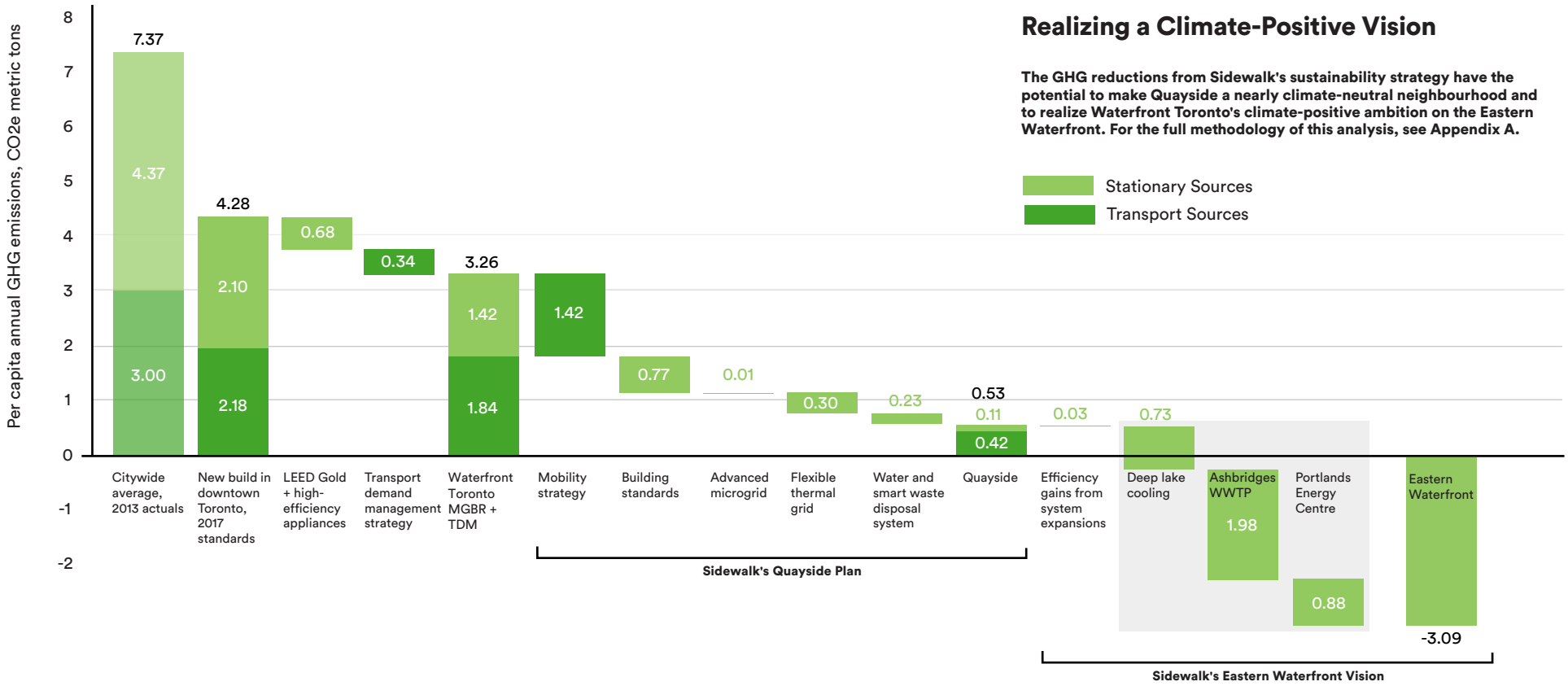
A2-a APPROACH TO BUILDING-LEVEL SOLUTIONS

Flexible buildings that reduce energy demand. A critical aspect of Sidewalk's vision for buildings is incorporating flexibility and mix of uses into each structure. This approach has many benefits, including future-proofing structures to reduce construction and demolition waste, and enabling dense, mixed-use developments that encourage walking and cycling. Different building uses also generate complementary thermal demands, which makes thermal exchange systems more effective.

In Quayside, Sidewalk also sees the opportunity to experiment with new construction techniques and designs that will eliminate the waste that occurs from building construction and demolition, including modular housing and flexible construction. Sidewalk has also been experimenting with more sustainable building materials, including mycelium insulation and tall timber skeletons, and intends to pilot such structures in Quayside as a first step to adoption in the Eastern Waterfront.

The MGBR and beyond. Waterfront Toronto's Minimum Green Building Requirements set an admirable baseline, but Sidewalk is eager to go beyond them. For overall energy consumption, Sidewalk plans to use the Passive House standard as a baseline. With a cluster of Passive House–inspired buildings, Quayside will serve as a laboratory for the refinement of this standard as it applies to North American multifamily buildings. Further, Sidewalk seeks to explore the effectiveness of different types of building controls, which are among the most potent ways to reduce energy consumption, but which still lack standardization and scale. Sidewalk also sees an opportunity to realize Waterfront Toronto's target of 10 percent onsite power generation using roof and façade photovoltaics, as well as battery storage. Between these efforts, Sidewalk expects to reduce draw from the Toronto Hydro electric grid by 75 percent per capita versus existing conditions.

Sidewalk also sees the opportunity to improve upon the MGBR in waste and water. In Quayside, Sidewalk will deploy a digitally enabled smart chute system that will help pay-as-you-throw waste regimes succeed in multifamily buildings by making it possible to differentiate between recyclables and trash. Sidewalk will also handle organic waste through a separate system culminating in an onsite anaerobic digester. Such a system will require minimal additional effort from users but will achieve vastly better outcomes—at a minimum, a 90 percent landfill diversion in household waste. Similarly, Sidewalk will go beyond the MGBR and use nonpotable water indoors as well as outdoors, through a complete purple-pipe system, so residents and workers become familiar with the idea of not using drinking water for all domestic purposes.



A2-b
APPROACH TO DISTRICT-LEVEL SOLUTIONS

Sidewalk will seek to make use of the density that Waterfront Toronto hopes to achieve in both Quayside and the Eastern Waterfront to create a set of solutions that are flexible and shared. Many of these systems can begin at the neighbourhood level in Quayside but demonstrate their full potential when applied at district scale across the Eastern Waterfront.

Utility channels. A key investment at district scale will be to create a system of utility channels to accommodate all networked utilities. These will provide space for electric wires, telecom conduits, and water and district heating pipes, as well as space for small-scale robots to travel between building basements and under walkable streets. The channels will enable the fast provision of new types of utilities as they emerge, and will make it easy to maintain systems without disruptive utility work. Finally, the robot lanes provide the network that will allow a new type of urban freight system to emerge, beginning with solid waste handling.

Energy. Despite the reductions in thermal load that Passive House buildings can provide, buildings will still need a high thermal load in Toronto's seasonal climate. To address this challenge, Sidewalk will seek to pilot in Quayside, and scale up across the Eastern Waterfront, a multi-source district heating and cooling system called the thermal grid. Unlike systems that only rely on a single source, the thermal grid will tap and export multiple sources of waste or free heat and cool in the area: geothermal, waste heat from sewers and the Portlands Energy Centre, deep lake cooling, and the capture and reuse of waste heat and cool from within the buildings themselves.

Capturing all of these sources will far exceed the thermal demands of the efficient buildings. As a result, the

thermal grid will be the primary path for the Eastern Waterfront to realize its climate-positive ambition, according to Sidewalk's analysis (shown on the previous page). Further, there is so much excess heat that even if some sources were unavailable in the future, the system would still achieve climate-positive performance. Sidewalk will pilot a thermal grid in Quayside using waste heat from building and ground sources, but tapping the large sources of waste heat and Lake Ontario cooling will require the scale of the Eastern Waterfront to be economical.

Waste and water. Sidewalk sees a similar opportunity for district-scale solutions for both solid waste and water. While the Quayside Draft Vision Document has identified a vacuum system as a promising solution, Sidewalk sees even greater benefit in using industrial robots to move solid waste to a central point through utility channels. By putting waste into standardized containers that robots can move, neighbourhoods can adhere to the current three-bin approach (organics, recyclables, and landfill) while accommodating any change in the sorting regime. In Quayside, an anaerobic digester at the central point will consume the neighbourhood's organic waste, while landfill and recyclables will likely be shipped offsite. At the scale of the Eastern Waterfront, Sidewalk will seek an onsite material recovery facility for the remainder.

As mentioned, Sidewalk plans to incorporate a purple-pipe nonpotable water feed into each building's system. While Sidewalk will explore onsite rainwater capture and treatment for potable uses, the Ashbridges Bay Wastewater Treatment Plant could easily supply the entire Eastern Waterfront (including Quayside) with nonpotable water, which would greatly simplify the water supply system and eliminate large amounts of energy-consuming treatment equipment at the building scale.

Telecommunications. Digital communications are critical to the operation of a district. Connectivity will be ubiquitous in Quayside, consisting of high-speed wired communications over fibre and copper; high bandwidth wireless communications over Wi-Fi and cellular technologies; and long-range, low-bandwidth connectivity using low-power wide-area network technologies. The latter is especially appropriate for sensors in the public realm and within buildings as part of the outcome-based code, which will report environmental metrics such as temperature, carbon monoxide levels, noise, and vibration.

Incorporating these networks from the beginning, in such a way that they can be upgraded as new technologies emerge, will make sensing easier and cheaper to deploy on an unprecedented scale and density. Knowing that technology will keep improving over time, Quayside and the Eastern Waterfront will be designed to minimize the cost of hardware upgrades, and to avoid them as much as possible by enabling the infrastructure to be software-upgradable. In the same way that water and power are provided by a district-owned system, the provision of a district-level communications backbone and access points will reduce the expense and maintenance overhead of duplicate infrastructure from multiple providers.

A2-c BARRIERS /DEPENDENCIES

The two main types of barriers and dependencies to the full realization of Quayside's potential are economics and coordination.

Economics and scale. In many cases, the cost of implementing new innovations is hard to know, even if the benefits are relatively easy to predict. For example, the costs associated with implementing Passive House standards across a site the size of Quayside are not entirely clear. Similarly, while the costs of robots and other advanced technology systems are falling, the point at which costs fall far enough to enable the systems Sidewalk imagines is also not yet clear.

Most importantly, the overall scale of the development may prove a limiting factor. Some of the most impactful innovations are major capital projects that will require large volumes of reliable offtake to be financeable, including the thermal grid and the containerized waste system. Sidewalk may find that many of these concepts are feasible at the scale of the Eastern Waterfront but not of Quayside, and will work with Waterfront Toronto to discuss scaling back innovations in Quayside when the economics do not make sense, or finding innovative ways to expand the service areas of such projects whenever possible.

Coordination. Other dependencies relate to the coordination needed with other entities that control key aspects of the infrastructure that Sidewalk will plan to connect to or build upon, as well as the regulatory environment that will shape the site. For example, if the city determines that it is impossible to tap waste heat from the Ashbridges Bay Wastewater Treatment Plant, this decision will

affect the expected performance of the planned thermal grid; however, Sidewalk's thermal energy plan identifies several sources so the loss of any one will not undermine the climate-positive objective. Similarly, Sidewalk will rely on Waterfront Toronto's delivery of its Intelligent Communities Initiative; should that project get delayed or altered, Sidewalk's concepts for connectivity will need to be amended.

In all cases, the best strategy is to start conversations early and recognize the perspectives and interests of potential partners. Sidewalk will work with these entities to develop approaches that meet their fundamental needs while also creating the flexibility necessary to innovate.

A2-d
ECONOMIC AND TECHNICAL FEASIBILITY

Sidewalk has reviewed the Quayside Draft Vision Document in detail, and offers a specific assessment of each target and strategy in the Technical Appendix of **Appendix A**. Overall, the document establishes highly ambitious, though realistic, approaches that Sidewalk will be excited to implement. But Sidewalk's review identified several areas of focus consistent throughout the recommendations that may unnecessarily raise costs or difficulty, including an overemphasis on building-scale and single-purpose solutions, and an underemphasis on space constraints.

A bias towards building-scale solutions. In several areas, including potable water treatment, material recovery, waste-to-gas, and sewage heat capture, the Quayside Draft Vision Document specifies building-scale solutions as its objective. While digital technology enables many tools to be miniaturized, and building-level systems may be easier to replicate in other cities, the benefits of urban density are often best realized when economies of scale are leveraged.

A focus on highly specific solutions. Similarly, in several cases, the document identifies a specific technological solution when alternatives may prove better or have broader applications. For example, the document recommends a vacuum system for solid waste, as found in Roosevelt Island (New York City) and Hammarby Sjöstad (Stockholm). But that system has seen limited replication in its 35 years of operation because it is a dedicated, single-purpose system that must cover all of its costs based on waste-related savings alone. And while power-to-gas storage is a promising concept, it is not yet clear that such systems are better than traditional chemical batteries that may be more versatile.

No focus on space constraints. Many targets established in the Quayside Draft Vision Document involve commitments for the allocation of space, but the document does not explore how those allocations add up to compete with other desirable uses, including new residential and commercial space. For example, the goal of greater than 50 percent tree canopy and two acres of land for urban farming may prove difficult to reconcile with the goals for 10 percent onsite power generation, abundant open space for public activities, and affordable housing.

As Waterfront Toronto's innovation partner, Sidewalk will help address these challenges through several alternative strategies and tools. Sidewalk believes several solutions noted in the Quayside Draft Vision Document should be evaluated at a range of scales, such as wastewater heat recovery, which may work better at the neighbourhood scale than at the building scale. Sidewalk also believes different technologies should be evaluated when highly precise approaches have been specified; a robot-powered containerized waste system, for instance, could deliver the same benefits of a vacuum waste system while accommodating additional uses. And Sidewalk will identify an innovative approach to space constraints that still achieves important targets, such as obtaining the benefits of tree canopy coverage through a mix of other types of greenery, physical shading, and stormwater management.

In these cases and others, Sidewalk is eager to work with Waterfront Toronto and its team to evaluate the feasibility of potential solutions.

A3

Complete Communities

Sidewalk's vision of a complete community starts with a place that builds on Toronto's social, cultural, and economic diversity. It means a place that is inclusive, one that welcomes all comers to contribute to the fabric of urban life. It means a place that is adaptable, one in which buildings and spaces can change to address the evolving needs of the populations they serve. It means a place that is accessible in every dimension: welcoming, pedestrian-friendly, participatory, easy to get to, and easy to move around in. Most importantly, it means a place that is affordable.

A3-a
MIXED-INCOME HOUSING

A complete community starts with housing affordability. Allocating a

significant percentage of housing units as affordable is an integral part of any solution, but it falls short of a comprehensive strategy to deliver mixed-income housing. Sidewalk will tackle the challenge in multiple ways: using technology to lower building costs, designing buildings that can adapt to changing needs, and innovating on financing.

Quayside will pilot innovations that advance this strategy to achieve greater affordability across five different concepts. These efforts will enable Quayside to experiment with capabilities in the built environment that produce more useable, efficient, and affordable space, in a way that is replicable across Toronto and around the world.

New construction methodologies. There is enormous opportunity to drive down the cost of new construction by applying standardization and industrial approaches, such as assembling buildings from prefabricated components manufactured offsite, and employing standard and reusable product catalogues.

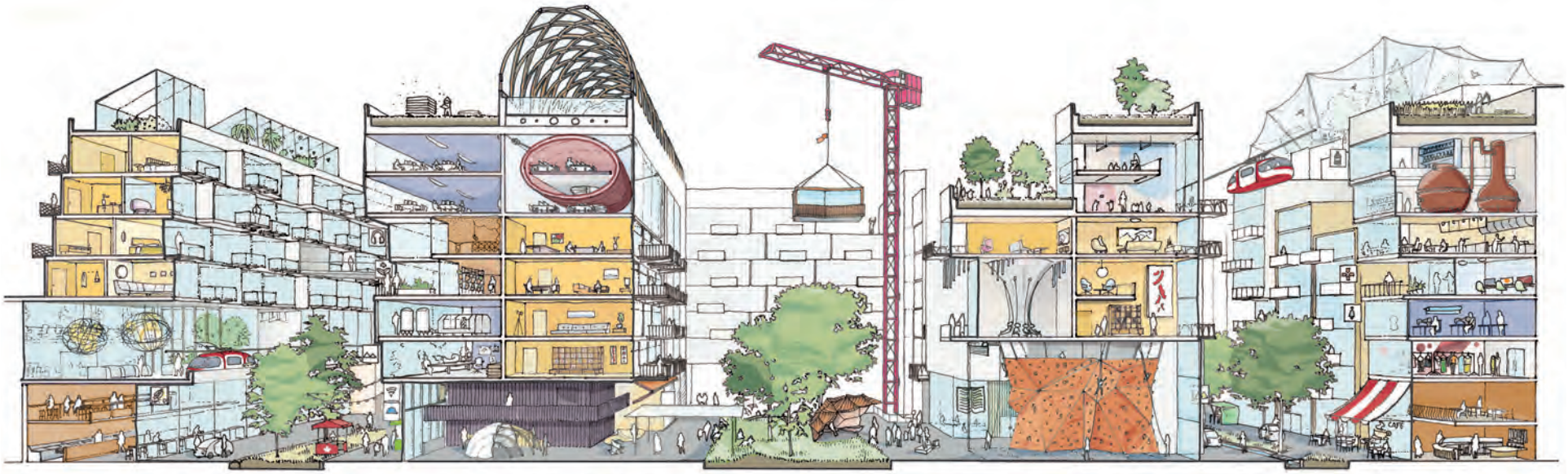
When these innovations are applied at scale, they enable the flexibility to deliver a remarkable range of customized structures and compelling architecture. These structures consist of a base set of modules that can be configured into different unit and building sizes, and finished with a variety of façade types—fully responsive to unique site conditions and needs. This approach will decrease construction, maintenance, and renovation costs, as well as expedite delivery timelines, all while maintaining high standards of urban design.

Specifically, Sidewalk proposes dedicated parcels in Quayside for both modular and tall timber construction. These building pilots will lay the groundwork for greater adoption in the Eastern Waterfront.

New building typologies. Sidewalk will also prototype building typologies in Quayside that demonstrate new levels of adaptability in the built environment.

The first is a concept Sidewalk is developing called Loft (conceptualized below). In many cities, structures built for manufacturing epitomize urban rejuvenation because they have proven adept at accommodating a wide variety of changing uses. The Loft

A Flexible Loft for the Future City



The Loft structure is designed with a strong skeleton and a flexible interior to accommodate changing building and market needs, enabling radical mixed-use development to occur more quickly and at lower cost than it does today.

concept improves upon traditional loft buildings by planning explicitly for ongoing and frequent interior changes around a strong skeletal structure. Its structure will remain flexible over the course of its lifecycle, accommodating a radical mix of uses (such as residential, retail, making, office, hospitality, and parking) that can respond quickly to market demand. This flexibility will reduce transactional costs, enabling the built environment to grow and evolve with the community.

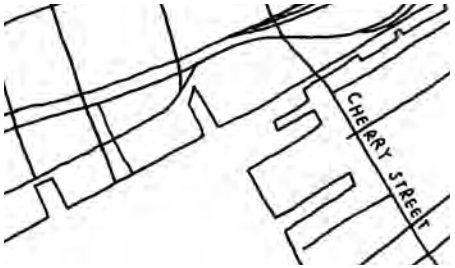
Specifically, Sidewalk proposes to hold an international design competition around Loft in Quayside. In its Quayside iteration, a Loft pilot could contain parking space that transitions to other uses once shared mobility reduces private car use.

New regulatory frameworks. New building typologies require an innovative approach to the building codes and zoning ordinances that govern the built environment. In the first half of the 20th century, prescriptive measures were necessary to protect human health, ensure safe buildings, and manage negative externalities. Today, cities can achieve those same goals without the inefficiency that comes with inflexible zoning and static building codes.

New predictive modelling techniques and real-time monitoring can enable a shift to an outcome-based building code. The outcome-based system will require buildings in an area (regardless of use) to conform to a series of safety and quality-of-place metrics that will be measured in real-time: structural integrity, daylight access, air quality, noise levels, energy usage, and more. This system will reward good performance and incentivize sustainable infrastructure, enable buildings to adapt their uses to market demand (including housing), and reflect the increased value of a truly mixed-use neighbourhood—one that is activated with varying uses throughout the day and can support a complete community.

Specifically, Sidewalk proposes to outfit buildings in Quayside with the sensors necessary to measure the data needed to craft the outcome-based code system before implementing it in the Eastern Waterfront. To ensure safety, Sidewalk will work with municipal and provincial agencies to design informative pilots within existing regulatory frameworks.

New occupancy models. A recent shift towards innovative commercial and residential occupancy models offers new formats, flexibilities, and opportunities for sharing. Start-ups have created co-working spaces and are exploring co-housing models, in which residents self-organize to share a greater proportion of amenities to reduce cost and enhance community. Sidewalk imagines these spaces to be a microcosm of a complete community: multigenerational, mixed-income, and diverse. Quayside can serve as the testbed for innovations that can accelerate this shift and broaden the appeal of alternative occupancy models.



New financing models. The Sidewalk team has a long history of developing innovative approaches to housing affordability. Several members played key roles in the development and implementation of New York City's New Housing Marketplace Plan, which created and preserved more than 165,000 affordable housing units. Some of its most effective components included dedicated revenue streams (the NYC Housing Trust Fund) and an expanded Housing Development Corporation (the city's housing bank) to dramatically increase housing options. The plan also implemented New York City's first exploration of inclusionary housing.

To achieve 20- to 30-percent affordability across the site will require new forms of public-private partnership. The levers available for delivering affordability will vary based on the full range of housing typologies (social housing, private rentals, subsidized rentals, home ownership) and the tenures of residents occupying them. A partial homeownership program might be a perfect fit for a family looking to settle down, whereas a retiree on a fixed income may require a rental subsidy. Sidewalk proposes to make Quayside a living laboratory for housing policy innovation that delivers a mixed-occupancy community that mirrors Toronto's socioeconomic diversity.

A3-b
SUSTAINABLE TRANSIT

A sustainable transit strategy for the Eastern Waterfront must compete with private vehicles even at a site with excellent highway access and nearby parking options. To realize this objective, Sidewalk will deploy private car restrictions, traditional transit, and digital mobility tools to provide the most effective choices at lower cost for trips in and around Quayside, and usher in a new era of urban mobility in the Eastern Waterfront anchored around shared, electric, self-driving transit.

Mobility within Quayside. Sidewalk's vision for mobility within Quayside begins with dedicating a large

portion of the site as a pedestrian area barring conventional (non-emergency) vehicles. On Queen's Quay and Cherry Street, which must carry regular traffic, Sidewalk will pilot a new type of adaptive traffic light that can hold signals to prioritize safety for cyclists and pedestrians. Sidewalk will work to include an abundance of Bike Share Toronto stations in the area. Finally, Sidewalk will encourage a diverse mix of retailers in Quayside to help people meet all daily needs by foot. These initiatives will create an extremely walkable neighbourhood where most trips are made by walking or cycling.

To encourage the most use of public space for the greatest number of days, Sidewalk will pilot new approaches to weather mitigation and asset management in Quayside. Bad weather affects pedestrians and cyclists more than drivers, pulling Torontonians off the streets and into the underground PATH system, or nudging them into cars. To encourage walking and cycling trips in all weather conditions, Sidewalk will test retractable canopies over walkways, and a heated pavement system beneath sidewalks and bike paths to melt snow. Sidewalk's analysis suggests that managing wind, sun, and precipitation can double the number of daylight hours when it is comfortable to be outside (see inset graphic).

Sidewalk will also build tools to ensure that the public realm is attractive and inviting. In Quayside, Sidewalk will pilot a system that tracks usage patterns and asset conditions through sensors, without tracking individuals. This system enables site managers to understand pedestrian and cycling flows, locate bottlenecks, and proactively identify repair needs. To demonstrate this capability, Sidewalk will pilot flexible space allocations using embedded LED lights, enabling a temporary bike lane to become a pedestrian laneway on demand, for instance.

Links to the city. For trips between Quayside and downtown, Sidewalk wants to implement the city's concept of "The Stitch"—improving waterfront connectivity via sidewalks and bike lanes. Incremental changes can make the Parliament and Cherry Street underpasses more attractive, but Sidewalk also envisions a significant investment to create a visible, attractive, and iconic link to the waterfront.

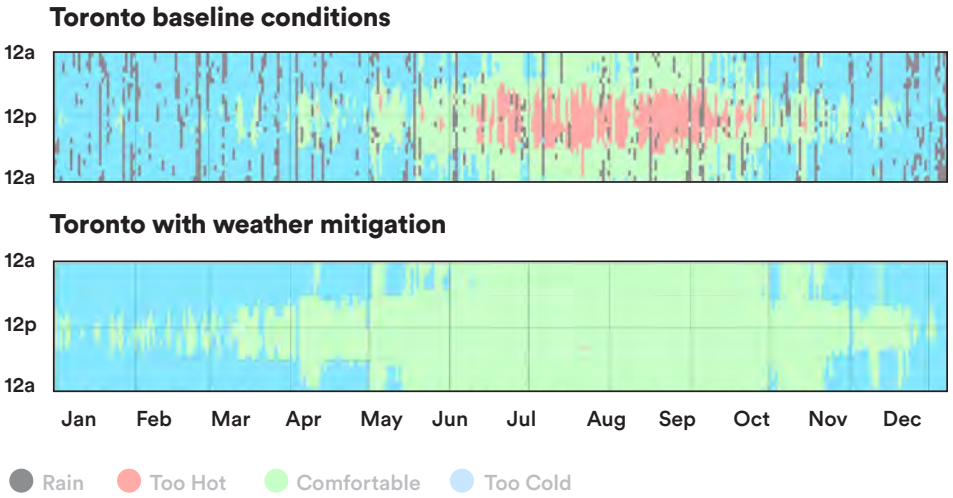
The most effective approach to serving trips into downtown will be to extend the 501 and 514 streetcar routes, an idea that Sidewalk will seek to explore in collaboration with the Toronto Transit Commission. This upgrade will provide frequent and fast service to King Street and along Queen's Quay, linking Quayside to Union Station. Sidewalk will also work with TTC to extend the Route 65 bus to serve Quayside, providing a direct connection to the Bloor-Danforth line.

For trips outside Quayside that cannot be made conveniently by walking, cycling, or transit, Sidewalk envisions concepts that will mitigate the negative impacts of car trips. Shared-ride taxi services can provide quality service while encouraging high vehicle occupancy. Electric shared vehicles (using the Zipcar or Car2Go models) can facilitate car trips while reducing auto ownership. For visitors who have no good driving alternative, Sidewalk is developing parking technology to make fast curbside drop-offs and pick-ups easy. In all cases, adaptive traffic lights will use sensors to detect pedestrians and cyclists and ensure they get priority at the intersection.

Critical to these strategies is ensuring that people have easy access to all of their mobility options, a concept known as mobility-as-a-service. Sidewalk plans to incorporate all Quayside-specific services into an API that can surface these options in a variety of navigation apps, such as Google Maps and Transit App.

Through these efforts, Sidewalk expects Quayside to achieve a world-class level of car-free urban mobility, with ownership rates of less than 20

Weather Mitigation: Doubling Outdoor Hours



These grids show outdoor comfort conditions every hour of every day over an average year in Toronto. Sidewalk's approach to weather mitigation can create an additional 2,767 total comfortable outdoor hours a year for the waterfront—doubling the current amount—by reducing the impact of wind, increasing shade on sunny days, and blocking rain.

percent among Quayside residents—lower than most of downtown Toronto. That rate will save families thousands of dollars a year, reduce the neighbourhood's carbon footprint, and cut the number of necessary parking spaces in half, opening more space for the critical elements of a complete community: affordable housing, the public realm, and local amenities.

The future of urban mobility. The most exciting part of Sidewalk's mobility strategy for Quayside is that it serves as a testing ground for advanced deployment in the Eastern Waterfront, which offers the space and scale to reinvent urban mobility using the most revolutionary technology development in transportation since the jet engine: the self-driving vehicle.

Sidewalk believes self-driving vehicles will feel and function more like transit than like the private automobile. A shared-ride taxibot network can offer the advantages of point-to-point service with space and fuel economies approaching that of the city bus, replacing private cars while supporting transit enhancements such as further streetcar extensions, the planned new Metrolinx station at East Harbour, potential ferry connections, and the Relief Line. Such a system will benefit the public realm dramatically: on a street where all vehicles yield the right of way to people, pedestrian safety comes first.

Sidewalk will explore partnerships, including with its sibling company Waymo, to test multiple types of self-driving vehicles on the Eastern Waterfront. These could include a small van of six-to-twelve seats, which would be appropriate for low-density transit routes. Another option is a personal vehicle more like a bike than a car in size. In the near term, Sidewalk also sees the opportunity to use these vehicles to serve the public during the summer months as a shuttle between the Cherry Beach and the Distillery District, filling a transportation need while introducing Torontonians to this technology. Some single-person self-driving vehicles might eventually be integrated into an elevated transport system, such as a gondola. Of course, all tests of self-driving technology will require close coordination with Ontario policymakers and regulators.

Sidewalk also envisions a new urban traffic system for the Eastern Waterfront called the Ground Traffic Control System. Building on the adaptive traffic signals and parking technology tested in Quayside, as well as onboard navigation in self-driving vehicles, GTCS will optimize routes to balance individual and system efficiency, dramatically enhancing the performance of urban streets.

Freight transit. Sidewalk's approach to urban freight also involves self-driving technology. In Quayside, Sidewalk will pilot an internal robot delivery system via its utility channels. Robotic delivery is in its infancy and requires exploring trade-offs in terms of cost, delivery time, and convenience. Sidewalk envisions offering an internal delivery system to all businesses and residents in Quayside, and will seek to expand a successful system to the entire Eastern Waterfront.

A3-c
RETAIL, CULTURAL, AND COMMUNITY AMENITIES

Developers have traditionally treated retail, cultural, and community amenities as a matter of simple curation, but the digital transformation of these areas enables a different approach to their delivery. Online sales have upended brick-and-mortar retail; artists are experimenting across media and collaborating across disciplines; more and more public services are being driven by data. Food trucks notwithstanding, ideas for providing these amenities are stuck on the standard 10-year retail lease, the purpose-built concert hall, and the static clinic.

In Quayside, Sidewalk will work closely with Waterfront Toronto and local partners to enable a dynamic range of local, independent, and diverse amenities to activate the public realm, support residents and workers, attract visitors, and contribute to high-quality placemaking. Key to Sidewalk's approach is to provide radical flexibility at much lower cost, attracting the most innovative amenity concepts from across Toronto and North America. Critically, it will lower the barrier for new entrants and enable the community gathering places that have become increasingly important in the digital age.

The flexible built environment. Retail is fundamentally changing, with on-demand delivery requiring smaller, more specialized stores and flexible stock. One concept Sidewalk will seek to develop in Quayside is the idea of the highly flexible storefront. Sidewalk's flexible Loft concept will enable retail spaces to expand or collapse quickly, and at low costs, as the population grows and retail trends change. Loft also enables interior spaces to be reconfigured to meet retailer needs and market demands.

Sidewalk seeks to make Quayside the desired location of innovative retail concepts merging the physical shopping experience with the digital, such as Amazon Go, a brick-and-mortar supermarket that automatically

bills shoppers for their cart contents without the need for a checkout line. Sidewalk is also exploring the concept of a "next-gen bazaar"—a flexible makerspace filled with dozens of easily removable stalls that can house a dynamic range of retail and cultural activities. Flexible space can also support new approaches to community services such as health and education, from urgent-care clinics that pop-up during a flu outbreak to temporary classrooms that can relieve pressure on school buildings.

The programmable public realm. Cities thrive on public activity and dynamism. The most exciting ways to activate the public realm are often a mix of traditional uses in flexible spaces: the cafe that puts tables on the sidewalk, the teacher who uses a park for nature lessons, the artist who turns a street corner into a stage. Building on a robust system of asset monitoring, Sidewalk can make areas of the public realm reservable for a wide range of temporary uses without impinging on the public's overall needs. Sidewalk plans to design into the public realm a set of outdoor "rooms" that would be conducive to the needs of performers, craft sellers, and other innovators.

The nimble cultural institute. Visual and performing artists are increasingly working across disciplines, and presenters around the world need to look beyond traditional facilities to showcase work and build audiences. An auditorium may not be the right venue for an interactive performance, nor a gallery the right space for a multimedia exhibition. In New York City, a new institution, The Shed, is dedicated to the notion that technology enables new types of artistic collaboration and dynamic performances; its telescoping shell can expand or contract via rails to accommodate an ever-changing mix of performance, music, and visual art. That principle of radical flexibility can be extended across Quayside, allowing a permeability of temporary and permanent culture and public art anticipated to exceed the 30,000-square-foot arts and culture requirement outlined in the Quayside Draft Vision Document.

Data-driven social services. In addition to retail and cultural amenities, a complete community requires a robust set of local services, including schools and libraries, primary healthcare facilities, and child-care providers. In Quayside, the digital layer of Sidewalk's urban innovation platform can help these services become more flexible and responsive to individual needs. Sidewalk's Care Lab, for example, is exploring ways to integrate primary care and social services data to deliver more proactive healthcare to city residents. This delivery model can enhance Ontario's Community Hubs program, which brings together multiple services in one location; in Quayside, Sidewalk will work with local providers to build a digital social service tool that can enable more personalized care.

Encouraging mutual assistance. A flexible community is also one that makes it easy for neighbours to collaborate with each other, and for residents to communicate with local officials. In Quayside, Sidewalk will pilot a neighbourhood assistant tool to facilitate social cooperation and civic engagement. The tool will provide a one-stop access point for a variety of service requests—working toward the next generation of 311. Quayside residents will be able to use the neighbourhood assistant for maintenance or sanitation requests, for instance, or to report an issue with their local playground.

Through its close collaboration with Waterfront Toronto, Sidewalk will work to ensure that public feedback plays a core role in its approach to retail, cultural, and community amenities in Quayside.

A4

Economic Development and Prosperity

A4-a JOB CREATION CAPACITY

A cluster is a geographic concentration of companies, institutions, and entrepreneurs working in a specific field. Successful clusters increase productivity, give rise to new businesses, and accelerate innovation through a density of talent, the ability to recruit newcomers, and heightened competition. Initial job anchors can ignite a cluster, with an inner ring of professional jobs drawn to strong talent, and an outer ring of indirect jobs and multipliers serving the ecosystem. Silicon Valley is a perfect example: the combination of Stanford research and military funding catalyzed what is now the world's foremost digital technology cluster.

Toronto has all the raw materials necessary to spark an urban innovation hub, including a diverse community, an openness to global talent, and an attractive lifestyle. It is home to a highly educated workforce surrounded by great institutes of higher learning. There is a burgeoning tech presence, boosted by proximity to the software industry in Kitchener-Waterloo. And

there is a motivated public sector with an active interest in innovation. The new Vector Institute for artificial intelligence, to which Alphabet has committed 5 million CAD, is a microcosm of what happens when all these threads start to weave a new cluster.

To catalyze a cluster around the urban innovation platform in Quayside, Sidewalk will provide an initial anchor through a commitment from Alphabet to move Google's Canadian headquarters to the Eastern Waterfront. Google's presence will lend the neighbourhood commercial and innovation credibility. In other locations, Google has created a multiplier impact, generating additional job growth or relocation.

As a secondary anchor, Sidewalk will work with local institutions such as the University of Toronto and Ryerson University to establish an urban innovation institute, bringing together academia, industry, government, and entrepreneurs to address the growth challenges facing cities. This applied research institute can create a talent pipeline and a real-time knowledge-exchange with pioneering companies, just as Stanford does with digital startups in Silicon Valley, and Cornell Tech does with engineers in New York.

As new questions, problems, barriers, and opportunities emerge daily in the living laboratory of Quayside, the institute will provide a collaborative arena to explore, innovate, test, and create new products and technologies. Cleantech firms developing building controls can work with behavioural scientists to understand habit formation. Hardware startups developing self-driving vehicle sensors can work with crowd researchers to predict movement patterns on busy streets. As urban innovations succeed, other cities will implement the technologies incubated in Quayside, creating a positive feedback loop that draws in yet more entrepreneurs, and turning the institute into a global hub for the study of urban life.

To further catalyze a cluster around these anchors, Sidewalk will seek to foster a collaborative environment for startups and other young companies (discussed more in **A4-c**). Sidewalk expects the platform's fundamental conditions to be attractive to all types of digital-economy companies, with particularly high levels of interest from Toronto-based startups exploring cleantech and building materials innovations, and Kitchener-Waterloo ventures focusing on robot manufacturing and artificial intelligence.

The breadth of disciplines and business types that emerge in Quayside will reflect just how many fields touch on urban life. Take mobility as one area of focus. A car manufacturer might want to locate a research-and-development facility for self-driving vehicles in the area to be close to test sites. A ride-sharing company may choose to pilot new services. But the cluster will extend beyond core mobility products. New companies in areas like financial services, operations, infrastructure, technology, and energy will gather or emerge to provide related services. Insurance companies might use the data-rich environment to explore new underwriting models. Cleantech companies might deploy new types of charging stations for self-driving electric vehicles.

Placemaking and planning in Quayside itself will also drive the innovation cluster. The same neighbourhood qualities that will make Quayside so compelling to future residents will make it attractive to best-in-class employers and knowledge-economy workers: an active public realm, an ever-changing mix of retail and cultural amenities, a robust walking and cycling infrastructure, and a culture of innovation. This growing economic activity will create additional jobs necessary to support the population, including service jobs.

Part of growing an inclusive urban innovation cluster means making sure that the opportunities it creates are accessible to all Torontonians. To build upon Toronto's existing talent base, Sidewalk will partner with large tech employers and local institutions to establish an advanced skills training program—a target identified in the recent federal budget—where workers can develop high-demand skillsets for the digital economy. Sidewalk will work with the Waterfront Toronto Employment Initiative to identify talent from the surrounding neighbourhoods for technology training programs, as well as broader employment opportunities created by the cluster. And by offering programs geared toward school children, the training effort can inspire the next generation of technology entrepreneurs in addition to training today's workforce.

At its peak, Quayside can become the anchor of Toronto's innovation ecosystem. But once this living laboratory expands to the scale of the Eastern Waterfront, Toronto will become the urban innovation anchor for the world, generating new economic activity from unexpected places. The film industry in Toronto shows how public-sector vision can catalyze a cluster, producing direct jobs (such as film crews and special effects artists) and indirect jobs (such as carpenters and caterers). That example offers only a glimpse of what is possible in an urban innovation cluster that cuts across many, many more disciplines. In time, the Eastern Waterfront will become a fully diversified economic engine—capable

of driving Canada into a new frontier of growth in the 21st-century economy.

Sidewalk estimates that, at full build, the Quayside neighborhood will house more than 5,500 jobs and generate more than 50 million CAD of annual property taxes. And depending on the scope of the development program agreed upon by Sidewalk and Waterfront Toronto for the Eastern Waterfront, its impact on jobs and tax generation when fully built could be ten times that of Quayside.

A4-b
PROSPERITY

Waterfront Toronto and Sidewalk share ambitions of turning the Eastern Waterfront into the most innovative urban district in the world. But if these innovations do not lead to substantial quality-of-life improvements for residents, workers, and visitors, the endeavour will have failed.

Of course, it is hard to know how urban innovations will impact quality of life in a real-world environment, since no place in the world truly integrates cutting-edge urban design with state-of-the-art technology. To explore how its urban innovation platform and concepts would perform in different settings, Sidewalk conducted rigorous feasibility studies on three American locations, representing distinct urban archetypes, including a Tier 1 city with conditions reasonably comparable to Toronto. For each location, Sidewalk examined platform conditions and launch concepts similar to those proposed in **A1-c** on a site comparable in size to the Eastern Waterfront. Using these feasibility studies, Sidewalk developed detailed projections on a comprehensive set of quality-of-life measures, including cost of living, job growth, carbon emissions, walkability, green space, and commute time savings. In all three study locations, Sidewalk's urban innovation platform enabled a significant improvement on quality of life compared with the surrounding metropolitan area.

Based on those feasibility studies, Sidewalk expects to see incremental improvements on quality of life during the Quayside neighbourhood pilot, and transformative gains across every dimension when coordinated solutions are deployed at scale across the Eastern Waterfront.

Cost of living. In the feasibility study of a district-scale site comparable to the Eastern Waterfront, Sidewalk projected a 14 percent cost of living reduction for a family of four compared with the surrounding metro area, a savings of more than 17,700 USD per year. These savings came primarily through lower rents (more efficient buildings allow residents to live just as comfortably with less space), lower transportation costs (walkable urban design, radical mixed-use, and shared mobility reduce the need for car-ownership), lower-cost utilities (pay-per-usage systems incentivize lower consumption while decreasing cost), and lower general cost of living. Based on its feasibility studies, Sidewalk expects Torontonians to reduce cost of living by 10 percent or more in a revitalized Eastern Waterfront, with a large share of savings coming from the 1,400 CAD per month families spend on transportation.

Environment and climate. In its district-scale feasibility study, Sidewalk projected a 73 percent reduction in greenhouse gas emissions per capita compared to the surrounding metro area. In Toronto, deploying similar innovations, Sidewalk believes it is feasible for Quayside to approach carbon-neutrality, and for the Eastern Waterfront to realize Waterfront Toronto's climate-positive goal. The greatest reductions stem from energy efficiency and the flexible thermal grid; with these savings, Quayside buildings can be virtually carbon-neutral, reflecting a 95 percent reduction in greenhouse gas emissions, even against Waterfront Toronto's aggressive MGBR baseline. Beyond greenhouse gases, Sidewalk expects to achieve significant reductions in other environmental impacts, including a 65 percent reduction in the consumption of potable water and a 90 percent reduction in landfill waste generation, relative to Toronto's current measures. The scale of the Eastern Waterfront makes it possible to incorporate massive sources of heat and cool into the system, exporting significant thermal energy to the rest of the city and achieving climate-positive performance.

Convenience and transport. In Sidewalk's feasibility study of large-scale innovation sites, the combination of radical mixed-use (bringing jobs closer to homes) and a public realm conducive to walking and biking encouraged far more active transportation and decreased the amount of time spent in daily travel. The study projected that residents would be 10 times more likely to take walking trips in a district comparable to the Eastern Waterfront than in the surrounding city, and would save one full hour on daily travel, primarily through shorter commutes. On the Eastern Waterfront, Sidewalk estimates a substantial increase from the 10 percent of trips taken by foot or bike in Toronto today, and a sizeable reduction in the city's 66-minute average daily commute.

Green space. In large-scale sites comparable to the Eastern Waterfront, Sidewalk's urban innovation platform led to the projected creation of two to five times more green space than in surrounding metropolitan areas, primarily because on-demand, self-driving mobility enables a community to repurpose land once used for roads and parking as green space. Similar achievements in the Eastern Waterfront would put all residents within a five-minute walk of a park. Sidewalk believes the Eastern Waterfront can aspire toward the 51 percent green space coverage found in one feasibility study site—though even half that would represent a significant improvement over the 13 percent of land currently dedicated to green space in greater Toronto.

Business opportunity. In a large-scale site comparable to Toronto's Eastern Waterfront, Sidewalk's urban innovation platform drove a projected 10 percent bump in labour force participation and doubled the number of freelancers, primarily through a greater prevalence of non-traditional, flexible working arrangements. From a business perspective, flexible building design and modular construction methodologies reduced barriers to entering a market, with 12.5 percent savings on commercial fit-out costs. In Toronto, the urban innovation platform will create the conditions for an innovation marketplace that attracts an increasing share of Toronto residents and entrepreneurs. Ubiquitous connectivity across the waterfront will improve digital inclusivity, and a commitment to training residents for the tech jobs of tomorrow provides more access to opportunities.

Health. In Sidewalk's feasibility studies, the proposed built environment integrated health and well-being into everyday life. Sidewalk achieved a projected 100 Walkability score, enabled largely by radical mixed-use, creating a public realm conducive to active transportation. Walking, cycling, and shared electric vehicles cut harmful transportation emissions by a projected 67 percent compared with the surrounding metro area. Advances in telehealth and the expansion of hyper-local pop-up clinics made access to healthcare more convenient. The combined effect was a more active, healthy pool of residents, resulting in improved outcomes and lower costs for the system. Sidewalk expects similar targets to be achievable on the Eastern Waterfront, putting its goal of becoming a WELL-certified community within reach.

Civic engagement. Sidewalk's feasibility study estimated that residents in a large-scale district comparable to the Eastern Waterfront would show increased rates of volunteering and neighbourhood engagement compared with the surrounding metro area. These increases were rooted in the neighbourhood's more convenient mobility systems, its more flexible public spaces (decreasing barriers to finding volunteer opportunities), and a neighbourhood assistant tool to facilitate community interactions. When similar initiatives are implemented along the waterfront, Sidewalk expects to meaningfully increase volunteer rates over the Toronto average.

A4-c SUPPORT FOR INNOVATION

Toronto is home to thousands of tech startups, many of which will be eager to seize upon the opportunities in Quayside created by the urban innovation platform. Sidewalk's approach to engaging early-stage companies centres around keeping the platform as open as possible to encourage the most creation and collaboration with the fewest barriers to entry.

Open principles. As the first urban neighbourhood in the world to integrate digital and physical infrastructure, the Quayside development will make it easy for early-stage companies to experiment with new concepts that can address urban growth challenges. The platform's digital layer, which collects data on the urban environment via sensors, will be governed by open standards, providing well-designed, well-documented, and well-supported APIs to third-party developers. Platform components and applications will be published under open-source licences where doing so results in significant additional value to the ecosystem as a whole. The platform's flexible physical layer will be an asset, too, given how hard it can be to test innovations that involve utilities or the built environment in traditional cities. The establishment of strong job anchors such as Google will further entice entrepreneurs, providing employment options to fall back on if a venture fails, as many inevitably do.

Early-stage support. In addition to establishing the urban innovation platform, Sidewalk has explored a series of approaches to attract entrepreneurs, early-stage companies, and complementary professionals and institutions. For instance, Sidewalk will explore ways for early-stage companies to deploy innovations to "alpha" communities of early adopters who opt in, leading to faster testing and iteration of new urban innovations. Sidewalk will also look to provide early-

stage companies with makerspace to test new materials or manufacturing capabilities—perhaps through the urban innovation institute. Critically, these capabilities will give creators the ability to build, decorate, and furnish the neighbourhood, and to generate revenue along the way.

Additional programs will seek to increase the workspace options available to young companies. One approach might be to provide free or low-cost co-working space for qualified startups for a limited period, perhaps 12 to 24 months. Another might be to pursue live-work and mixed-use buildings that can further reduce rental (and commuting) cost for companies and their employees. A third possibility might involve collaborating with industry and service-provider partners critical to early-stage company formation, such as legal or accounting services, likely in partnership with the urban innovation institute.

VC investments. A key barrier to the success of early-stage companies in Toronto is access to leadership talent and growth capital. Sidewalk will create opportunities for marquee North American VCs (and their talent networks) to participate directly in the funding of innovations.

In Quayside, Sidewalk's team will scan the marketplace and engage relevant early-stage companies. An initial scan identified many Canadian companies with products and services relevant to Waterfront Toronto's goals for the Eastern Waterfront that may be worth early investment consideration. These include Toronto-based companies focused on sustainability innovations around energy-efficient lighting and energy storage. This list also includes several Kitchener-based companies exploring data-driven tools with relevance to the urban environment, including explorations around indoor mapping, robot manufacturing, traffic data, and health sensors.

As early-stage companies launch and scale in Quayside, they will complement the initial economic anchors and help jumpstart Toronto's urban innovation cluster.

Appendix

A Neighbourhood from the Internet Up

1.
Introduction

Sidewalk Labs has included this appendix to share more detail on its close study of waterfront history, its approach toward digital and physical innovation in Quayside, and its theory on why these applications will transform urban life once deployed across the Eastern Waterfront.

Specifically, this appendix shows more of the work underpinning the innovation concepts and conclusions described in Section A1-c ("Purposeful Solutions"), including roadmaps to their further development in partnership with Waterfront Toronto.

This appendix also includes a Technical Appendix further responding to the prompt in Section A2-d requesting an economic and technical feasibility review of the Quayside Draft Vision Document ("Toward a Regenerative Waterfront").

Toronto: A Dynamic City Stepping Ahead

TO LIVE IN TORONTO TODAY IS TO EXPECT CHANGE. The city is in the midst of a transformation that is not only intensifying its urban centre but linking it to an entire region spanning the shores of Lake Ontario. As its neighbourhoods become denser and towers grow taller, Toronto is straining against its aging infrastructure and the traditionally sluggish pace of urban change.

But the conditions are right for Toronto to overcome these challenges and gain wide recognition as the great global hub that its heavily immigrant population already knows it to be. A metamorphosis is underway, and it is palpable throughout the city. New people with new talents are bringing new ideas. New energy is being channeled into change.

Any local will tell you that the next decade is pivotal. The best ending to this story is not Toronto becoming the next New York or San Francisco. It is Toronto becoming a better version of what it has always strived to be: a city that works—for everyone.

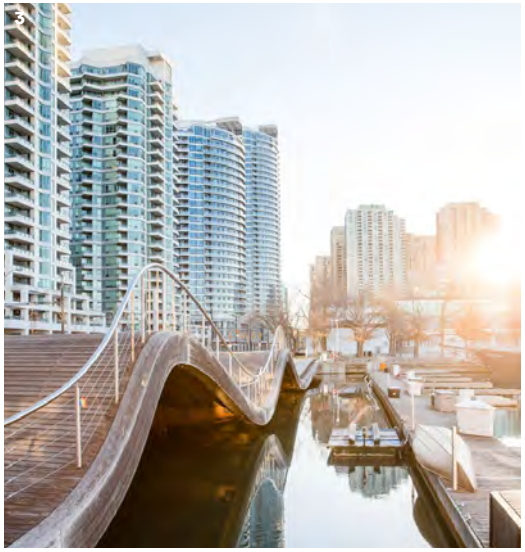
The pressures pushing against this ideal of inclusive growth are mounting, but so, too, is an appreciation for what makes the city special. People are rediscovering its waterfront and ravines—the twin topographies that shape the city. They are pushing for a pedestrian realm that encourages social cohesion and a transit system that does not require life with a car. They are celebrating the city's excellent public schools and libraries and institutes of higher education as a key driver of upward mobility. And they are clamoring for a city style that is dense and energized, mixed and messy, civil yet inspiring.

Toronto is a city of neighbourhoods, and if it hopes to meet its growth challenges—with several million people expected to join the metro area in the next 25 years—it will need new ones that meet these aspirations. That means turning to the Eastern Waterfront as the city's next great neighbourhood frontier.

New communities will need to emerge along the water. These communities will need to be forward-looking, incorporating the best traditional urban forms with the latest planning designs and digital technology. Fortunately these communities will not have to look far for inspiration. They can borrow from the street-level variety of Leslieville and Riverdale, the sustainability and vibrancy of the Canary District, the mixed-housing and public space of St. Lawrence Market.

The waterfront has all the assets to achieve its goals.

What it needs now is a jump start.



1. Harbourfront Centre meets Queens Quay West.
2. Air Canada Centre.
3. The Wavedecks at the foot of Simcoe Street.
4. Entice Culinary Lounge nestled in West Queen West.
5. Spadina Avenue, Chinatown.
6. Tank House Lane.

Credit: Mark Wickens

Sidewalk Labs: Where the Physical Place Meets a New Approach

SIDEWALK LABS WAS FORMED TO HELP FAST-GROWING CITIES meet the very challenges that Toronto is facing today. Its mission is to take the great principles of urban planning—the same ones Toronto has outlined in its growth plan for the core, such as affordability, inclusivity, and sustainability—and accelerate them into the digital age.

Over the past 200 years, the greatest leaps forward in urban life have occurred at the intersection of new technology and the physical environment. The steam engine, electricity, and the automobile all transformed how people live in cities today. These advances were not without their drawbacks, of course, but they fundamentally changed the capabilities of cities.

The world is on the cusp of a fourth revolution in urban technology every bit as powerful as the previous ones, driven by ubiquitous connectivity, machine learning, and new advances in design and digital fabrication. But as Toronto knows, cities do not have time to wait for transportation to become cleaner and more convenient, for housing prices to decline, for job opportunities to grow. The pace of urban change is too slow.

To overcome this challenge, Sidewalk started with a question: What could today's cities look like if they were built from scratch in the internet age? What emerged from this thought experiment was not a series of answers: there are no simple solutions to the problems of urban growth. Instead it is a new approach that sees cities as platforms for urban innovation that create the conditions for people to build, test, and refine new ideas that can improve quality of life.

Building new neighbourhoods from the internet up is a remarkable opportunity to embed emerging digital capabilities into core infrastructure from the start. Physical spaces like buildings, streets, and parks can be designed for the opportunities that technology present, rather than forced to retrofit new advances very slowly and at great cost. By merging the physical and the digital into a neighbourhood's foundation, people are empowered with the tools to adapt to future problems no one can anticipate.

Such a place quickly becomes a living laboratory for urban innovation. Given the speed of technological change, cities will only meet their growth challenges if they support innovation not right now but 10, 20, and 50 years ahead. To do so requires designing for radical flexibility, enabling the best ideas to be refined in real time and creating a cycle of ongoing improvement driven by the feedback of residents and the energy of entrepreneurs, rather than prescribed by planners and designers.

Of course, the objective is not to showcase technology for its own sake. Instead, it is to enable what is best about cities—direct human interaction—without imposing the barriers that prevent people from connecting and limit their access to the city's many resources. Technology can help create complete communities that are highly interactive and accessible to all, freeing residents from the constraints imposed by the heavy infrastructure and spatial hierarchies of the last century.

In that sense, Sidewalk's mission is not to create a city of the future at all. It is to create the future of cities.

The Eastern Waterfront is the ideal location to demonstrate the power of forward-thinking urban design and technological innovation.

Credit: Mark Wickens

2.
A New Kind of Neighbourhood

A neighbourhood from the internet up combines the advantages of a global city with a close-knit community. It leverages innovation to achieve the benefits of urban density and vibrancy without the negative frictions that traditionally come with urban growth, from traffic congestion to housing costs to environmental impacts.

This new kind of neighbourhood will be a complete community: socially and economically diverse, radically mixed-use, empowered by technology and data to make things work better, and oriented around a pedestrian-centred public realm made possible by self-driving vehicles.

Innovation at the Physical and Digital Layers

AT THE HEART OF SIDEWALK'S APPROACH to building a neighbourhood from the internet up is viewing it as a platform that integrates the physical environment with digital technology, creating the core conditions for urban innovation.

Traditionally, the physical components of a city have been fixed into place from the start, constraining new development as they become outdated and costly to upgrade. A growing city must have built-in flexibility to support ongoing innovation, and the ability to adjust as technology, market cycles, and urban lifestyles move in new directions.

Sidewalk envisions a physical layer that is far more adaptable and open to change than what is found in cities today. The four key components to this layer—flexible buildings, people-first streets, an adaptable public realm, and open utility infrastructure—are explored in greater detail in this section.

Threaded through all these components is the platform's digital layer—a new and transformative element. Distributed throughout the neighbourhood via sensors and other connected technology, the digital layer provides an unprecedented degree of insight into the physical environment. And with heightened ability to measure the neighbourhood comes better ways to manage it.

This capacity to evolve in response to new thinking will help Toronto meet the unforeseen challenges of the future.

Digital Layer

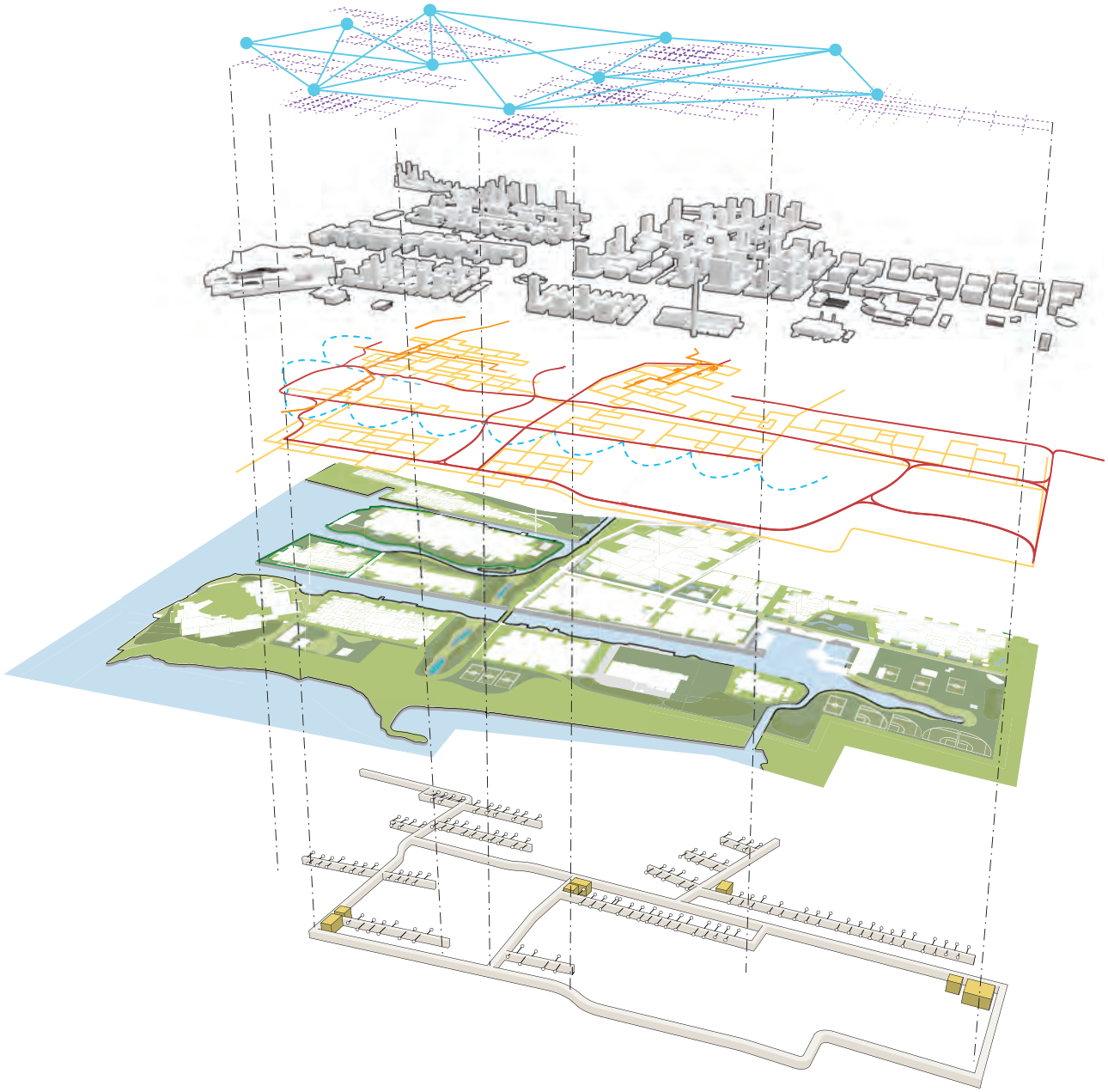
PHYSICAL LAYER

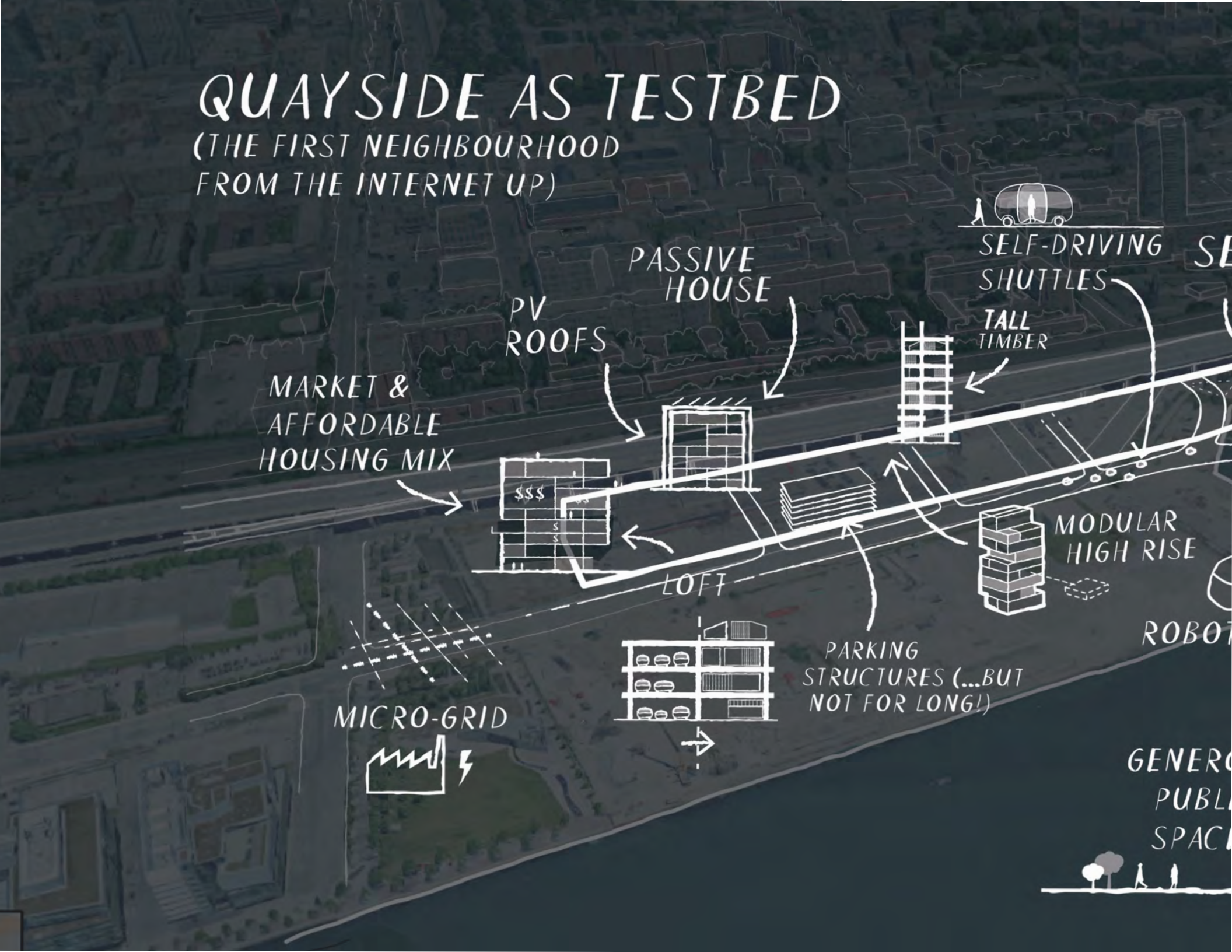
Buildings

Mobility

Public Realm

Infrastructure




QUAYSIDE AS TESTBED
(THE FIRST NEIGHBOURHOOD FROM THE INTERNET UP)
SELF-DRIVING SHUTTLES
PASSIVE HOUSE
PV ROOFS
TALL TIMBER
MARKET & AFFORDABLE HOUSING MIX
$$$
MODULAR HIGH RISE
LOFT
PARKING STRUCTURES (...BUT NOT FOR LONG!)
MICRO-GRID


PEOPLE FIRST STREETS
QUEEN'S QUAY EXTENSION
WEATHER MITIGATION
STREETCAR (AND NO CONVENTIONAL VEHICLES)
SILO
MAP
PEDESTRIAN & BIKE BRIDGE OVER THE WATER
UTILITY CHANNEL
URBAN INNOVATION INSTITUTE

What Makes This Neighbourhood Different? Streets That Put People First

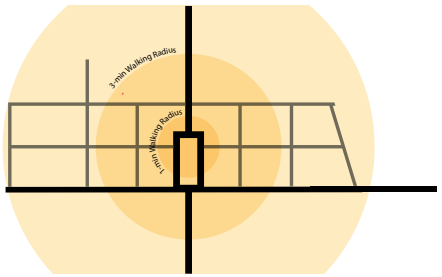
STREETS ARE A NEIGHBOURHOOD'S MOST IMPORTANT SPACES.

Roads shape the character and identity of any neighbourhood, but since the invention of the automobile, street networks have put cars first. Sidewalk believes in designing streets with people at the forefront, and self-driving mobility makes this paradigm shift possible.

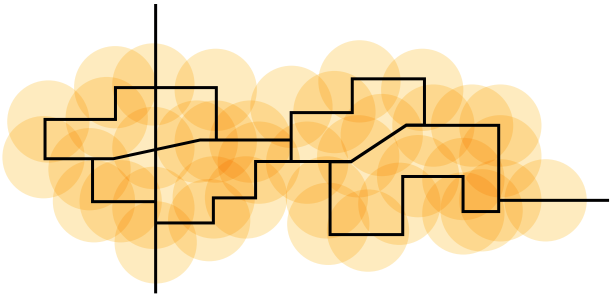
Self-driving vehicles can be accessed at any location, making it possible for the neighbourhood to have a non-hierarchical, decentralized form where many activities can happen in many places, untethered from the traditional central transit hub. In short, they turn every corner into a bus stop. Their operation also ensures a dramatic change in pedestrian safety, via collective efficiency and constant sensor-enabled monitoring of the environment.

At the same time, pedestrians and cyclists will have a freer, more accessible environment because the entire street system is no longer designed around controlling the behaviour of human-operated cars. Instead, land once used for parking and road separation can go toward greater space for biking and walking, and reducing the distances between destinations. Bike highways will connect across and between neighbourhoods, providing pleasant and scenic express routes that incorporate weather protection against rain and snow.

This new type of neighbourhood reimagines the historic walking city as a healthy and welcoming streetscape where self-driving vehicles navigate safely in a shared space with pedestrians. Each street type (explained at right) will reflect a human orientation in its scale and speed—large enough not to be crowded but small enough not to be alienating. Together, they can be arranged in a variety of ways to ensure that mobility remains convenient into, out of, and within the neighbourhood, while enhancing the public realm for everyone.



Traditional Transit Oriented Development Mobility



New Neighbourhood Mobility

Avenues

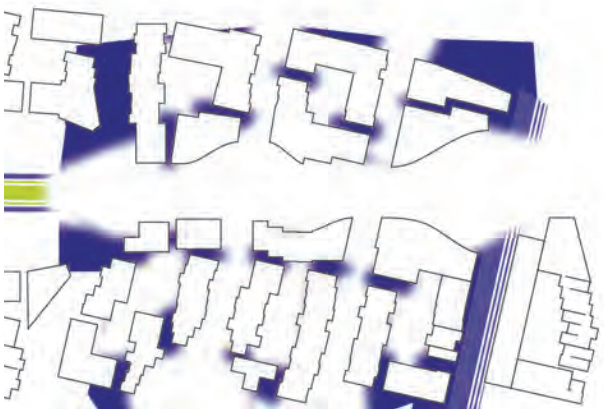
As the most grand of the neighbourhood's streets, avenues create easily traversable but active boundaries between areas. They are spaces of transition—from vehicle to foot, from building to outdoors.

Laneways

Laneways will be where the bulk of people spend their time, and their bustling mix of uses—mobility, commerce, and recreation—will reflect their central role in the life of neighbourhood residents, workers, and visitors.

Promenades

As the most intimate street type, promenades provide places for play, relaxation, and connections to homes and small multi-functional spaces. Over time, through personalization by locals, they take on their own distinct appeal.



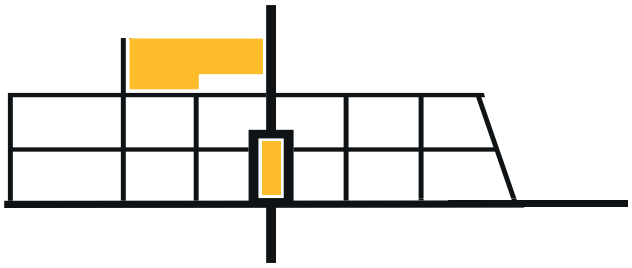
What Makes This Neighbourhood Different? Adaptable and Integrated Public Realm

A NEW SYSTEM OF HIERARCHICAL STREETS makes it possible to think about the public realm differently. Rather than open space acting as an escape from the neighbourhood, the public realm will be a core element—integrated, not divorced, from the daily activity of residents. This shared public space will be interwoven into both the urban form and the surrounding area: flexible and always close at hand.

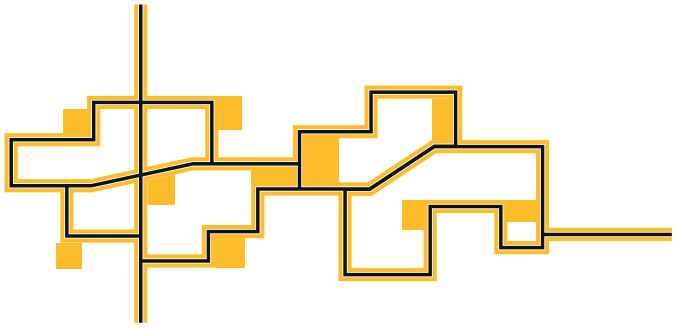
First and foremost, the public realm will prioritize pedestrians. The barriers and inhibitions created by the width and design of conventional streets, the rows of parked cars, and the noise and pollution of traffic will give way to a shared common space that becomes a canvas for community life.

In this way, the public realm in a neighbourhood from the internet up will be a throwback to cities past. A stroll through an Italian hill town, a medieval city core, or a Moroccan souk reminds us how cities were designed before the automobile—based around the speed of the pedestrian, an intimate human scale, and the ability to interact with friends, neighbours, and merchants.

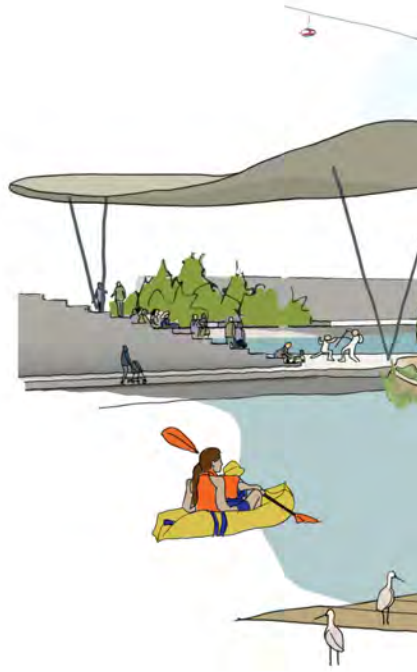
Technology enables greater flexibility in these new spaces, encouraging greater and more varied use of public space. Actively managed and reservable outdoor spaces will be available for pop-ups, food trucks, performances, exhibitions, and individuals alike. Customizable stalls that evoke the bazaars of an earlier time will showcase a range of retail or cultural experiences that might not fit cleanly into the above categories.

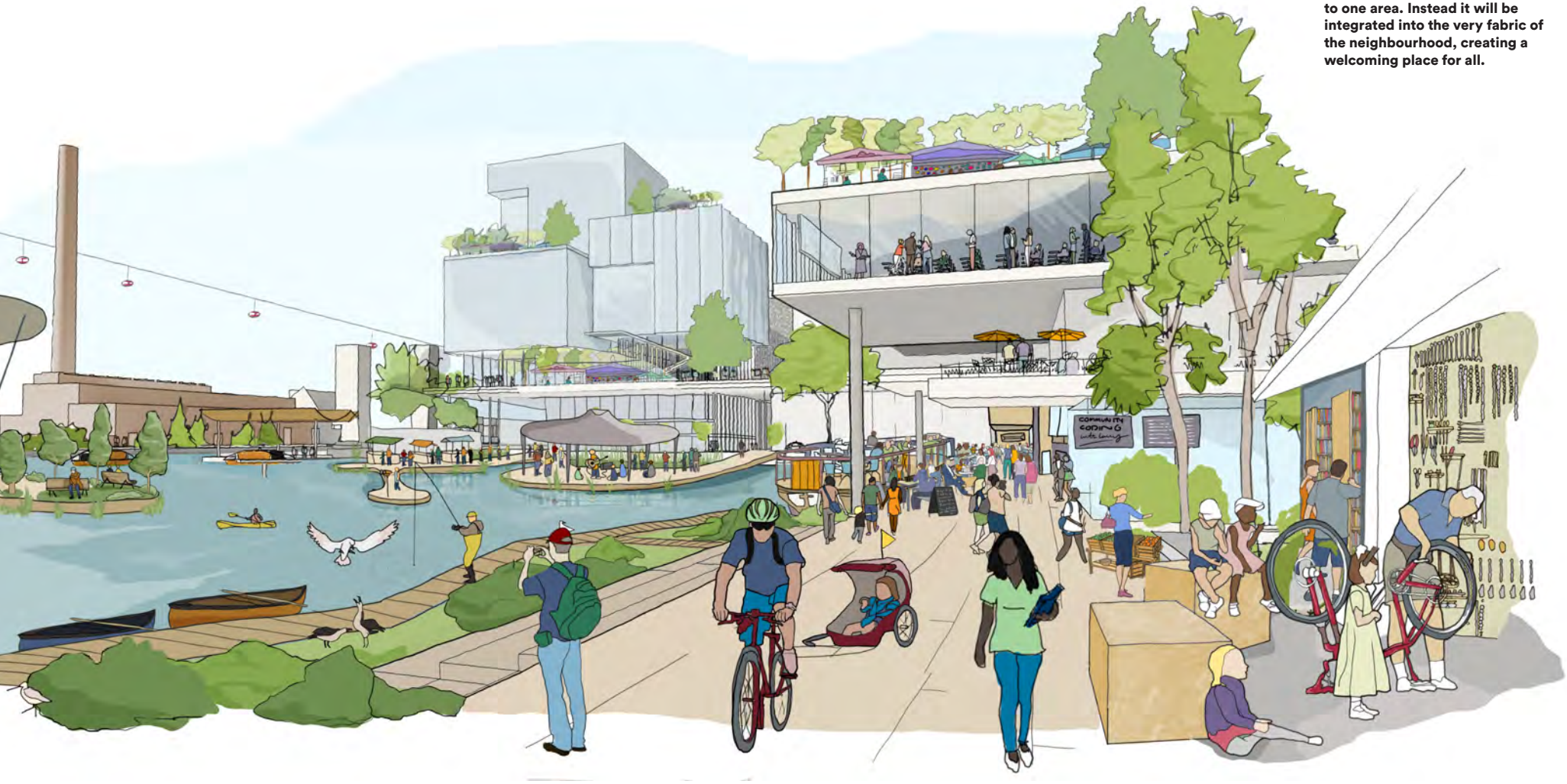


Traditional Neighbourhood



New Neighbourhood





The public realm in a neighbourhood from the internet up will not be confined to one area. Instead it will be integrated into the very fabric of the neighbourhood, creating a welcoming place for all.

What Makes This Neighbourhood Different? Radical Mixed-use Space

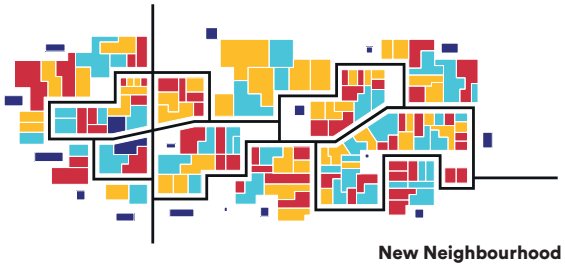
THE BUILDING BLOCKS OF THE NEIGHBOURHOOD will be a system of flexible-use spaces, operating from the scale of the sidewalk to the neighbourhood, enabling variety in both individual buildings and the overall urban form.

Contemporary urban life is defined by a culture of individual and community entrepreneurship, and a knowledge economy accelerating at rapid pace. People increasingly define their own careers, working independently or creating new ventures. Small businesses find opportunities in large flexible spaces, allowing rapid evolution through design, prototyping, and production. Communities seek a greater level of control over their environment, with more say over how the city is designed and managed, better access to information, and the ability to draw on their diversity to self-organize and plan cultural and civic activities.

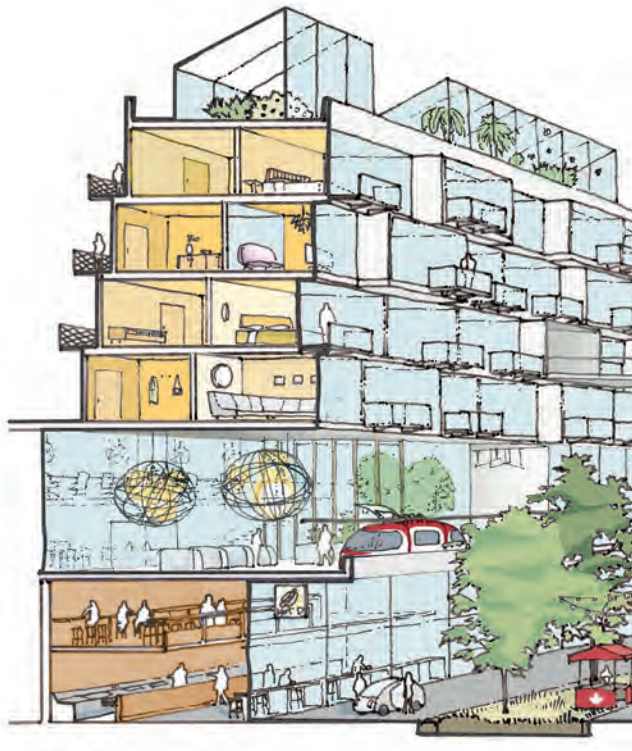
Radical mixed-use space is defined by user needs at a wide range of scales—from flexible market stalls allowing a maker to produce and sell a product at street level, to reconfigurable "Loft" workspaces that can be shared by multiple companies and re-sized on demand, to apartments that can be enlarged with additional modules as a family grows.

These malleable spaces, and the ability to mix them in new ways, will invert the normal hierarchies and separations of a purpose-designed urban development. But they are only possible with the integration of technology that enables efficient monitoring and safety standards, high space utilization, ease of access, and low transactional costs.

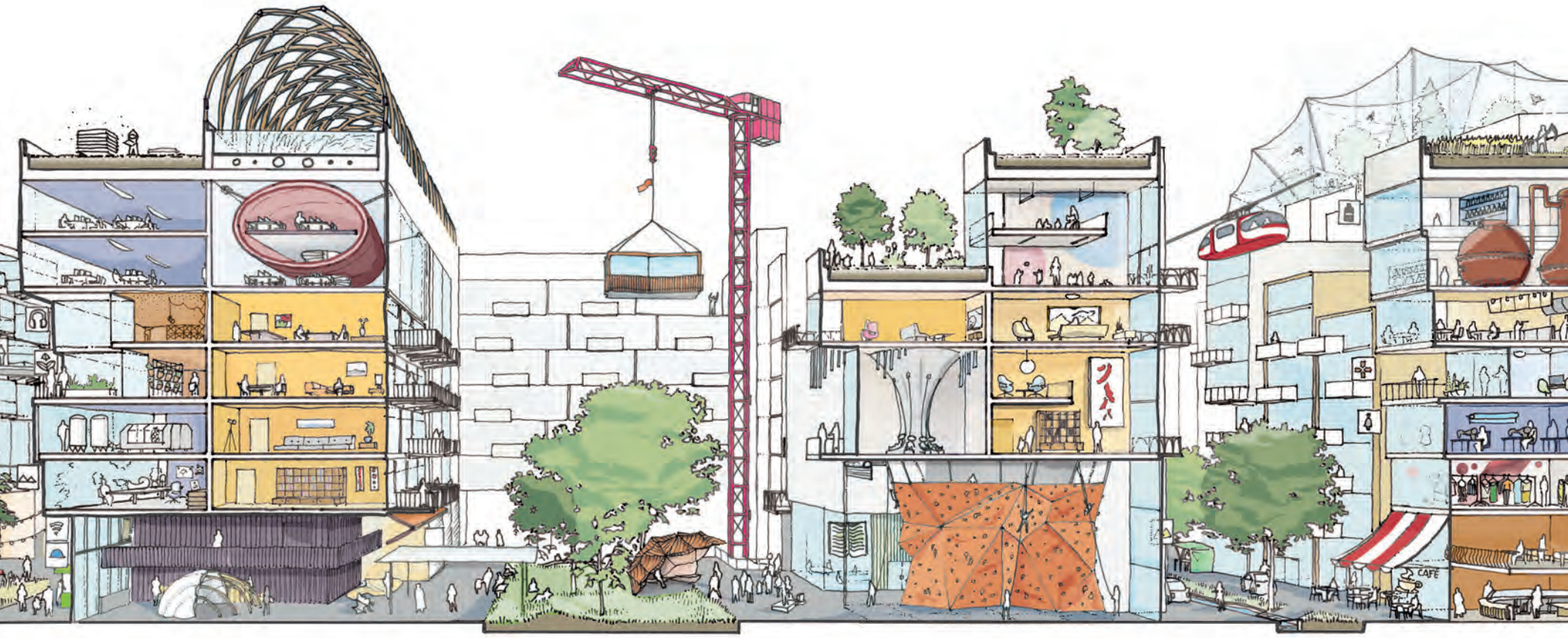
Traditional Neighbourhood



New Neighbourhood



A radical mixed-use environment means that the neighbourhood is always in flux, creating a dynamic community and enabling needs to be met at a much quicker pace.



What Makes This Neighbourhood Different? Dedicated Space for Utilities

UTILITIES IN A NEIGHBOURHOOD FROM THE INTERNET UP will be off the streets and easily accessible, housed in a system of utility channels that prevent old infrastructure and messy road work from impeding innovation.

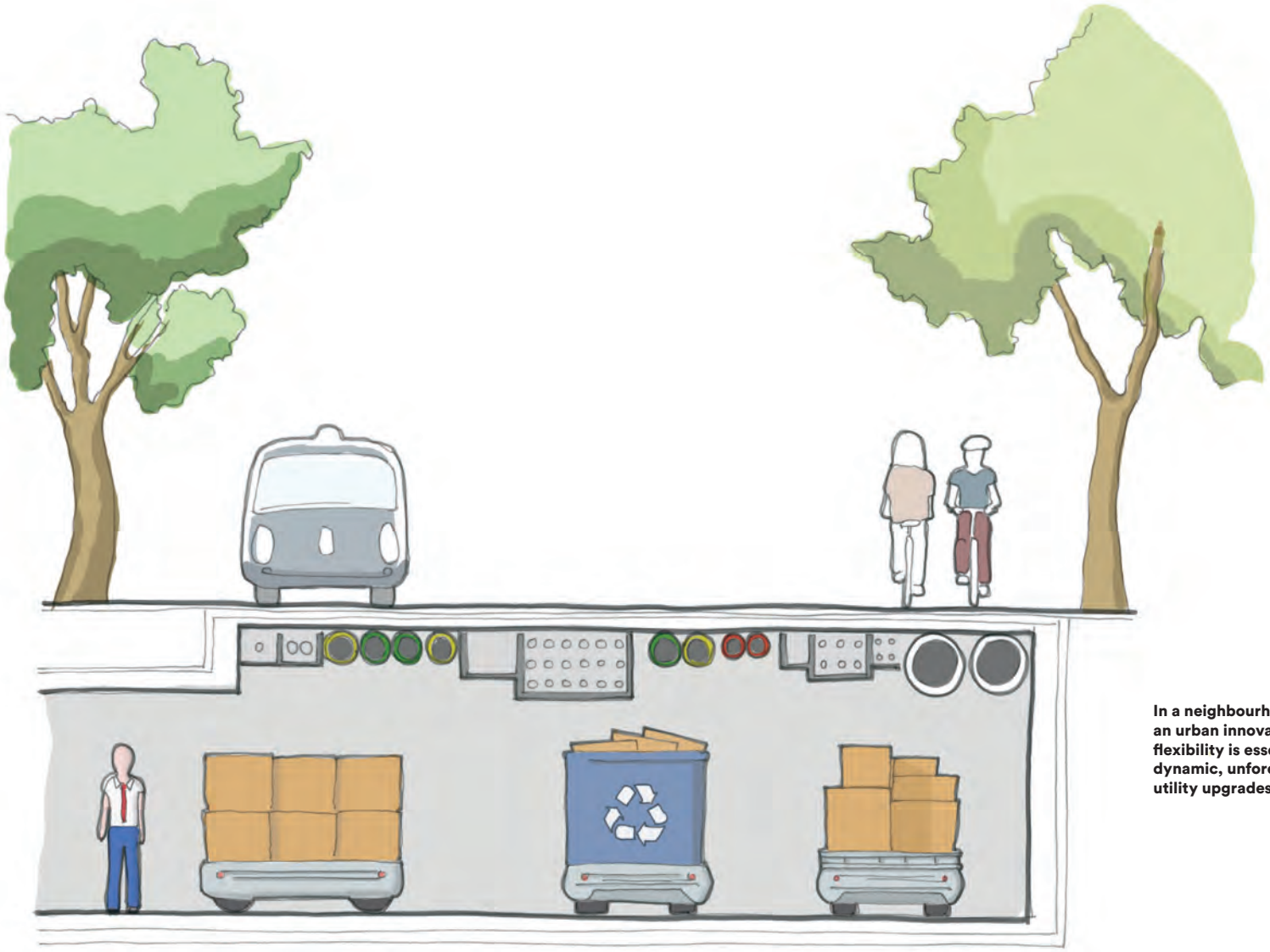
People tend to notice utilities only when they interfere with their lives. This happens when they fail, like during a blackout, or when utility work blocks traffic because it requires roads to be torn up. Both examples emphasize a critical aspect of utility services. People depend on them, and they are not designed for easy access.

There are also moments when existing infrastructure impedes access to new services. Over the last century, a series of new network utilities have emerged: natural gas provided the first central source of lighting, electricity began as an in-building system for the wealthy but became a networked utility for the masses, and telephones became a basic utility of life. In the past three decades, cable television and fibre-optic communication lines have become basic needs for both business and homes. In each case, the creation of these networks took longer than it should have. Those who were late to receive new services found themselves at a disadvantage.

New neighbourhoods will provide space for utilities in a network of shared, easily accessible utility channels that exist beneath the public realm and reach into every floor on every building. By enabling utility upgrades that are easy and cheap for incumbents and new entrants alike, utility channels will ensure that the neighbourhood is open for innovation and equipped with the most advanced urban infrastructure at the lowest cost to users.

This underground infrastructure will create space for electrical infrastructure, water pipes, district level heating and cooling infrastructure, and telecommunications infrastructure, eliminating the need for excavation every time a new conduit needs to be installed and preventing the need to destroy road surfaces every time a line needs to be accessed for repair. It will also give workers easier access to those parts of the system that require the most frequent visits: where main lines are tapped to serve buildings, where meters and valves must be checked, and where optical switches need to be upgraded to process faster fiber-optic signals.

Utility channels will spur a renaissance of innovation by providing a new, easily accessed network connecting an entire neighbourhood. The channels will provide an invisible conduit for waste logistics and be useful as corridors for robotic deliveries of parcels. This new upgradeable network will be coupled with the operating systems in the digital layer of the neighbourhood platform, providing a path for cost effective, continual improvements.



In a neighbourhood built as an urban innovation platform, flexibility is essential for dynamic, unforeseeable utility upgrades.

3. Reimagining the Eastern Waterfront

The Eastern Waterfront is an ideal place to create this new type of neighbourhood.

Sidewalk has begun to imagine what this place might be like, beginning with Phase One: Quayside. The pages here reflect the initial work Sidewalk has done to understand the site's unique qualities of place and extraordinary potential.

The ideas that follow are only the starting point of a journey that Sidewalk will take together with Waterfront Toronto to unlock the full potential of the Eastern Waterfront.

Born of a Pleasant Promenade

AT THE FOUNDING OF THE TOWN OF YORK IN 1793, the water's edge was reserved for the public. It was described as a "pleasant promenade, on which the burghers and their families should take the air and disport themselves generally"—an agreeable walk known as the "Esplanade." And agreeable it remained until the industrial revolution.

In the 19th century, railway companies saw the opportunity of a publicly owned corridor across the Toronto waterfront and converted the area into a right-of-way that formed a continuous wall of rail lines, cutting off the growing city from its lake. At the same time, new wharves and bulkheads pushed the shoreline southward to accommodate larger and larger ships. The waterfront became the city's first industrial zone.

Soon that early promenade had transformed into a site for factories that produced all manner of goods. Stockyards and tanneries, metal and wood works, a vast distillery, cold storage capitalizing on an abundant supply of winter ice from the lake: almost every category of manufacturer could be found gathered up against the water's edge. A vibrant Great Lakes shipping industry saw the daily passage of people and cargo—a trade that only increased in the early and mid-20th centuries with the completion of the Welland and St. Lawrence canals.

Logistics and storage facilities proliferated to serve bulk cargo traffic by rail and water. Parts of the waterfront became massive holding areas, leaving a trail of heritage structures originally designed for storage of goods in transit, including the grain, coal, and gravel silos that remain as the iconic totems of the Eastern Waterfront.

A different story unfolded to the east, where the Don River Valley met the lake, forming Ashbridges Bay, the largest natural marshland in the Great Lakes. The river delta long stymied use of this area for shipping, as silt deposits formed a less navigable slip of wetlands and sandbars, but industry's loss was the city's gain. The most lasting sandbar—the precursor to what today is Cherry Street—allowed residents to walk across the surface of the lake to Fisherman's Island. It became a popular destination for the type of simple outdoor enjoyment Toronto's founders had tried to reserve for the city from the start.

Cherry Street Bridge, 1898.

The Ashbridges Bay wetland gradually became a dystopian stew of municipal trash, raw sewage from the growing city, and toxic pollution from upriver stockyards mixed in a flood-prone area the size of downtown. Recognizing these conditions as a hazard to public health, the city's engineering department resolved to control the natural forces that had created it, filling the vast marsh and dredging and confining the Don River in a narrow channel. Completed between the wars, this new expanse of artificial land was envisioned as the locus for the next great wave of industrial expansion.

That wave never materialized. The frenetic growth of industry and manufacturing on the waterfront was on the wane. Instead, the Eastern Waterfront became home to vast open stockpiles of raw materials awaiting barge transport, and an attractive site for municipal utilities that could not be accommodated in the city's dense interior: the Ashbridges Wastewater Treatment Plant and the Hearn Power Station among them.

When the postwar craze for urban highways arrived, Toronto's waterfront was an obvious location. The creation of the Gardiner Expressway was a bold stroke of modernism, threading a high-speed auto route atop much of the city's most polluted and blighted land. Only a generation later, as manufacturers moved north beyond the city's limits, did the folly of the city's waterfront expressway start to become clear.

Today, the Gardiner stands in need of billions in repairs, but even as it gets rebuilt, the expressway's status as a much-maligned parapet is shrinking by the day. Of course, many Torontonians wish the city would just bury or collapse it, leaving a grand boulevard in its place. But something else is happening: new condos are crowding up against it as people clamor to live closer to downtown, and a new linear park is set to be built beneath it—an exceptional act of imagination that might just make one of the city's most maligned structures among its most treasured.

That the Gardiner could yet become one of the city's great assets could be a surprise finish to the latest chapter in the development of the city's waterfront.

The Hearn Power Station, opened in 1951, was the site of Canada's first 100 MW steam turbo-generator set.

Credit: Mark Wickens

Rediscovering the Waterfront

NOW SOMETHING DIFFERENT IS HAPPENING.

Waterfront Toronto has spearheaded this revitalization. In 1999, waterfront revival was deemed a matter of national importance, and all three levels of government came together to create Waterfront Toronto to lead this important mission. Since then, the Central Waterfront has taken shape and Downtown Toronto has recovered its lakefront as a public amenity—the city's welcoming "front porch." Now that progress is extending eastward.

The Eastern Waterfront is at another scale from Central Waterfront development; it is a district of some 300 hectares comparable in size to Toronto's entire downtown. Transforming the Eastern Waterfront will complete a long historical arc, as the city's lakeshore was shaped first by the desire for public access, then for 150 years by the imperatives of industry and shipping, and now back again to people.

Toronto's lakefront, with all of its contradictions and conflicts, is a powerful opportunity for new and innovative thinking. Already the Distillery District has become an all-season magnet, drawing Torontonians to its pedestrianized, brick-paved streets. Next door, the Canary District is a handsome showcase for a new, playful, and inviting urbanism. The waterfront is lighting up and the energy surrounding it will soon overcome the barriers that historically contributed to its neglect.

In time, the Eastern Waterfront will be Toronto's newest neighbourhood—or, more likely, a diverse set of neighbourhoods with their own unique personalities—and home to tens of thousands of Torontonians. The most exciting thing Toronto can do is to build more of what makes so many of its neighbourhoods beloved, and to give a modern, ambitious, and generous form to the elements that make the city a success.

Located adjacent to the Redpath Sugar Factory, Sugar Beach Park and its iconic umbrellas welcome visitors to East Bayfront.

Credit: Mark Wickens

View from Simcoe Wavedeck, as cyclists pass along the Martin Goodman Trail

Credit: Mark Wickens

Kids play on one of Toronto's Waterfront Wavedecks, new public spaces designed to reflect the beauty of Lake Ontario.

Credit: Mark Wickens

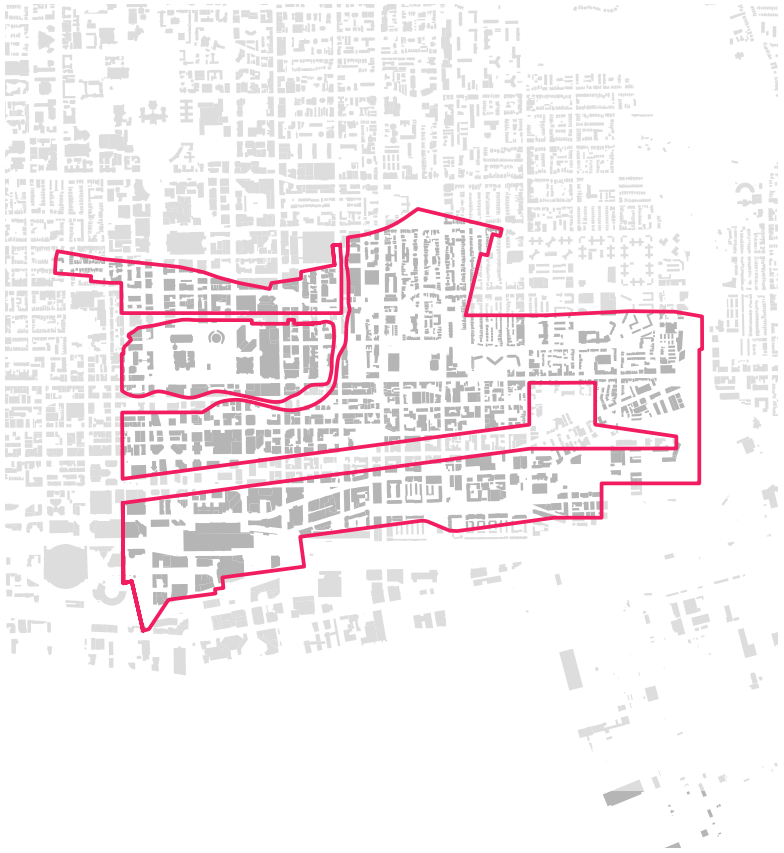
Building at Scale

WITH HUNDREDS OF HECTARES OF LAND and years of effort building momentum and capacity, Waterfront Toronto has created an incredible opportunity for the city. The expanse of the Eastern Waterfront is large enough to absorb a meaningful share of the projected growth for Toronto, and to realize technological and urban design innovations at a system scale with implications for cities worldwide.

The best way to get a sense of the scale of urban life possible on the Eastern Waterfront is to compare it to areas comparable in size within Toronto and other well-known cities.

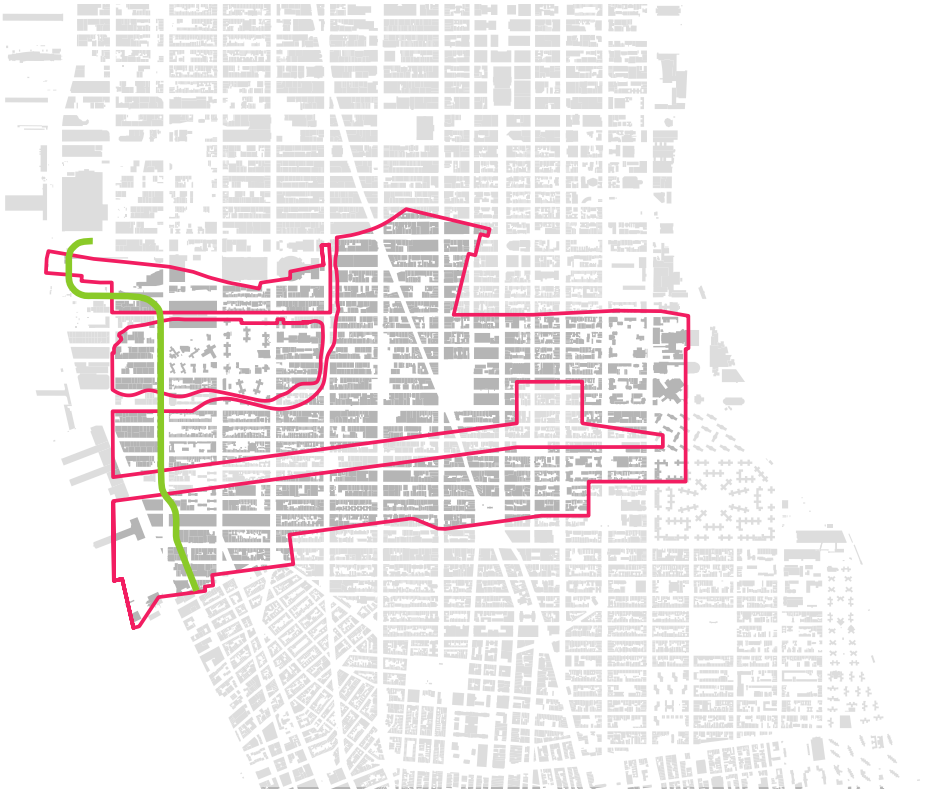
Toronto

Placed within Toronto, the Eastern Waterfront would span east-west from the Fashion District to the Distillery District, and north-south from City Hall to the lakefront, containing an area almost as large as Downtown itself.



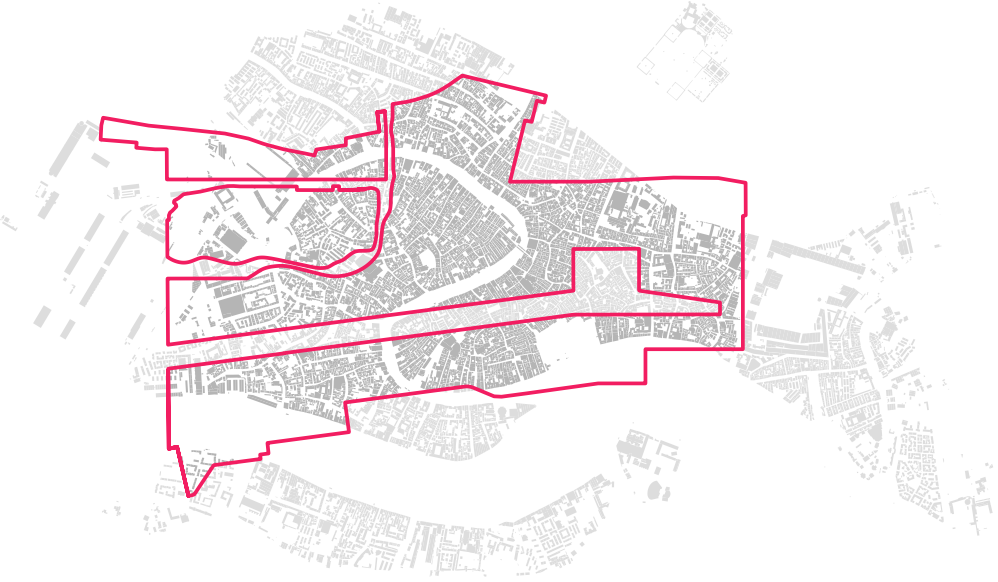
New York City

Placed within New York City, the Eastern Waterfront would span east-west from East River to Hudson River, and the full length of Manhattan's High Line from north to south—an area containing at least seven distinct neighbourhoods, each with their own individual character.



Venice

As a point of comparison with another city built entirely on the water, the Eastern Waterfront would just about encompass the entire city of Venice.



A Staged Approach Beginning at Quayside

PHASED DEVELOPMENT ALLOWS FOR THE CYCLE OF IDEATION, prototyping, and scaling that reflects the innovation process itself.

Waterfront Toronto's staged approach to development corresponds with Sidewalk's iterative model of city-building. By designating Quayside as Phase 1 of the next wave of Eastern Waterfront redevelopment, Waterfront Toronto has set the stage for Quayside to become an initial testbed and a dynamic site for experimentation.

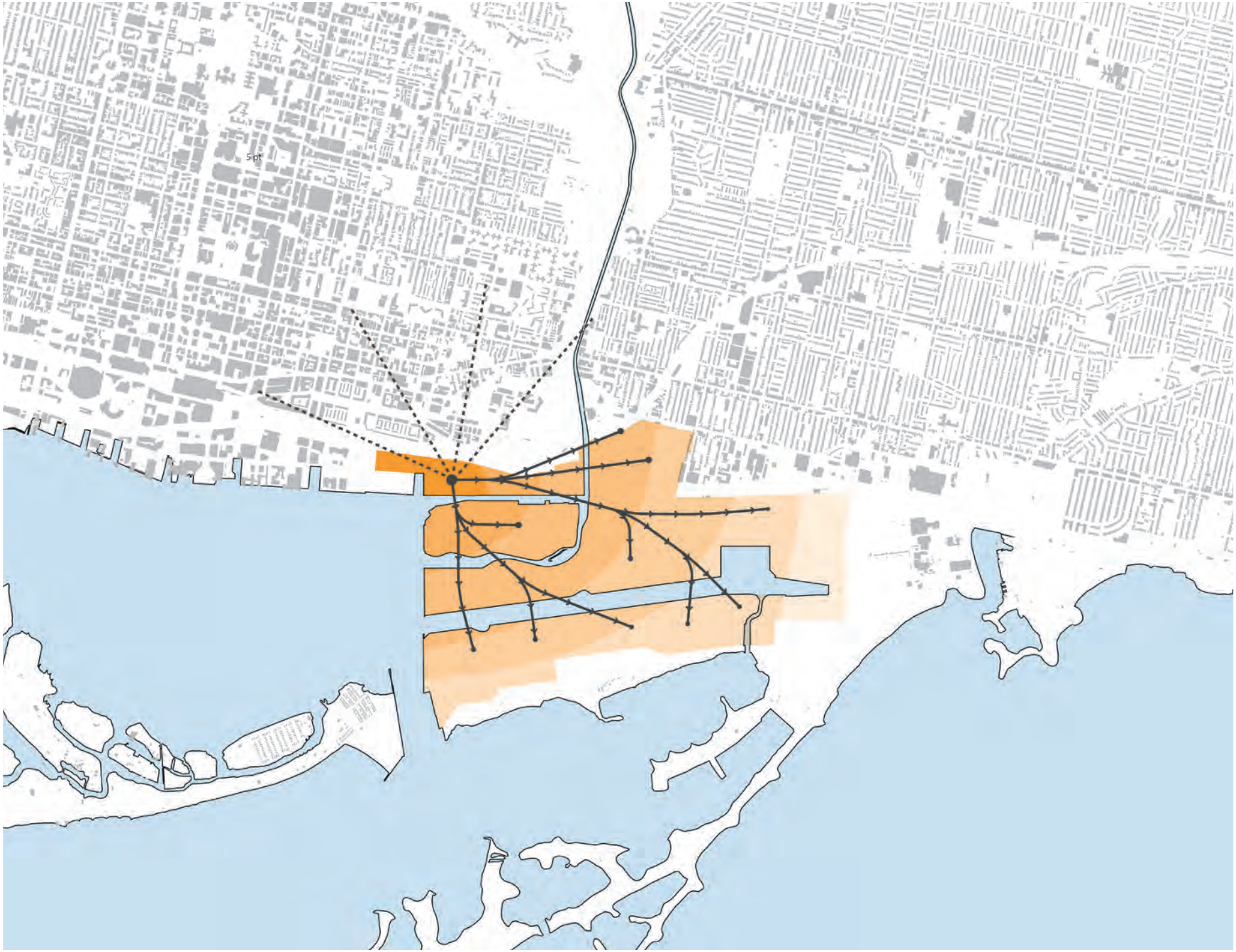
Quayside will be the launchpad for innovations at increasing scale across the Eastern Waterfront. As waterfront development expands across Keating Channel to the south and east, each successive stage will adapt and expand upon the initial concepts and ideas prototyped in Quayside.

But each new phase of the project will do more than simply scale what came before. That is just the beginning. When combined and deployed across the Eastern Waterfront, the capabilities developed in Quayside will have an impact on urban life that cannot be achieved by individual pilots operating at the neighbourhood level alone.

Those are the knowns. But taken to its most advantaged stage, the urban innovation platform established in Quayside and the Eastern Waterfront will enable new approaches to city challenges that cannot yet be imagined. Just as no one could have known the internet would one day uproot printed media, or that streetcars and automobiles would transform Toronto's original town grid, great platforms build the unknown possibilities of the future into their very foundation.

The power of innovations that emerge on the Eastern Waterfront will transfer to cities around the world—including Toronto itself. The ideas conceived in Quayside and advanced in later phases on the Eastern Waterfront will inspire changes to the rest of the city as neighbouring communities learn from each other. In time, the waterfront will draw new people and energy in, improving the quality of ideas that make it back out—a positive feedback loop for the economic and social development of the greater Toronto region.

The innovations that will establish Toronto as a world leading centre of urban innovation will start in Quayside and scale across the Eastern Waterfront.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Imagining Quayside: A Hinge Point

QUAYSIDE IS A QUIET CORNER on the border of Downtown and the Eastern Waterfront, the last waterfront development parcel on mainland Toronto before the Port Lands protrude into Lake Ontario. Yet it occupies a strategic location when evaluated in context. Quayside is, in numerous ways, a hinge, connecting important places and concepts so that the sum is greater than the parts.

It is a geographical hinge, connecting Toronto with the new neighbourhoods yet to emerge across the Eastern Waterfront. It is a physical hinge, bridging the divide between land and water. It is a digital hinge—a testbed for urban innovations that can ultimately scale across the Eastern Waterfront. And a cultural hinge, celebrating the waterfront's industrial heritage in look and feel.

Of course, even as it functions as this critical nexus, Quayside must still be a vibrant, inclusive, mixed-use complete community in its own right.

Sidewalk's approach to making Quayside the first neighbourhood from the internet up centres around five planning goals:

- Quayside must differentiate itself as a radical departure from existing developments in Toronto and around the world.
- Quayside must integrate itself as the newest addition into Toronto's existing and diverse quilt of urban neighbourhoods.
- Quayside must offer affordability to a diverse set of Torontonians.
- Quayside must start the transition to a public realm planned around the pedestrian and not the automobile.
- Quayside must demonstrate the potential implications of the convergence of physical conditions, digital capabilities, and open standards on urban innovation—catalyzing a new urban innovation cluster.

Quayside has the potential to be a true gateway between the urban fabric of Toronto's existing downtown core and the new neighbourhoods that will define its future Eastern Waterfront.

Credit: Stink Studios


ALLIED
BRICK

Between Land and Water: Living on the Lake

MARINE BUILDING TECHNOLOGIES CAN ENABLE YEAR ROUND, flexible uses on the water, opening up new opportunities for the integration of the water into daily life. As the Quayside neighbourhood wraps around its 1,680 meters of coastline along Parliament Slip and Keating Channel, public spaces, civic facilities, housing, or other uses can flexibly weave together the water and the neighbourhood.

Lightweight, movable, floating bridges can create multiple points of connectivity—between Quayside, Bayside, and Villiers Island—for pedestrians, cyclists, even self-driving vehicles. Arranged in direct response to demand or simply to provide new routes for transit access, floating bridges can easily coexist with ferries and other active maritime uses.

Floating parks can expand the public realm and soften the hard edge between land and water. Built on easily movable tiles or other structures, parks can be designed to provide near total flexibility in physical configuration and location, providing a dynamic experience and responding to weather and water conditions. Adding trees and vegetation on the water can also provide natural weather mitigation, particularly for wind conditions.

Waterborne civic uses, such as floating performance venues, can animate Quayside's public realm and create citywide cultural destinations that can be moved to other lakefront locations as desired. The inherent flexibility enabled by the water can create opportunities for adaptable, floating communities to be added to the waterfront housing supply.

Quayside may even provide opportunity for near-term testing with self-driving boat technology, which over time may become an efficient tool for the movement of goods throughout the Eastern Waterfront. As a testbed, Quayside can establish approaches for building at the intersection of land and water that can scale across the Eastern Waterfront, which will amount to 11,940 meters of coastline after the Don River naturalization.

Once Waterfront Toronto's plan to naturalize the mouth of the Don River is complete, the Eastern Waterfront will have almost 12,000 meters of coastline. Inspired by this gesture to the site's natural ecology, Sidewalk believes the addition of a slender channel east of the Portlands Energy Centre will enable water-based travel throughout the entire Eastern Waterfront.

A park in Parliament Slip constructed on floating tiles can be curated into different configurations. The park would serve different uses in both summer (top) and winter (bottom).

In subsequent phases of development, the Ship Channel could host a range of uses, from portable, floating bridges that can be installed, removed, and moved over a period of days (top), to floating communities that bring adaptable building typologies to the water (bottom).

Between City and Waterfront: Extending Queens Quay

THE REDEVELOPED QUEENS QUAY IS AN EXCELLENT EXAMPLE of a street redesigned for multi-modal transportation. Protected bike lanes and pedestrian paths encourage active uses, and the streetcar provides convenient public transit.

There is already broad consensus to extend Queens Quay East through Quayside to Cherry Street, though the design has not been finalized. Quayside is a perfect opportunity to continue Queens Quay as an active and vibrant spine that anchors a new community, designed specifically for the possibilities unlocked by new technology: programmable and flexible public space that is accessible to all, weather mitigation that enables people to enjoy the outdoors for more days each year, self-driving mobility that takes private cars off the street, and coordinated management of a rich modal mix.

The development approach in Quayside must activate the extension of Queens Quay without sacrificing its efficiency as a mobility artery. Sidewalk envisions a Queens Quay that feels much like the waterfront version of Queen Street or King Street, a grand boulevard connecting the Eastern Waterfront to Downtown, and a destination in and of itself.

Revitalized Queens Quay, facing East.

Credit: Brian Medina

Existing Queens Quay, facing West.

Credit: Mark Wickens

Reimagining how Queens Quay might look as Quayside explores alternative mobility strategies.

Between City and Waterfront: Stitching the City

PHYSICALLY AND PSYCHOLOGICALLY, the Gardiner Expressway separates Downtown Toronto from the Eastern Waterfront.

It is a relic of an earlier time, when the waterfront was synonymous with industrial expanse and good urban design meant planning for cars. Today, the eight-lane elevated roadway and adjacent rail lines divide Quayside from the core of the city.

Vehicle underpasses exist on Parliament and Cherry streets, but the distance—a span of over 110 meters via the Parliament Street passage—is uninviting for pedestrians and cyclists. The Distillery District, on the north side of the rail berm, should feel more connected with the water; after all, its majestic brick buildings were originally right at the water's edge.

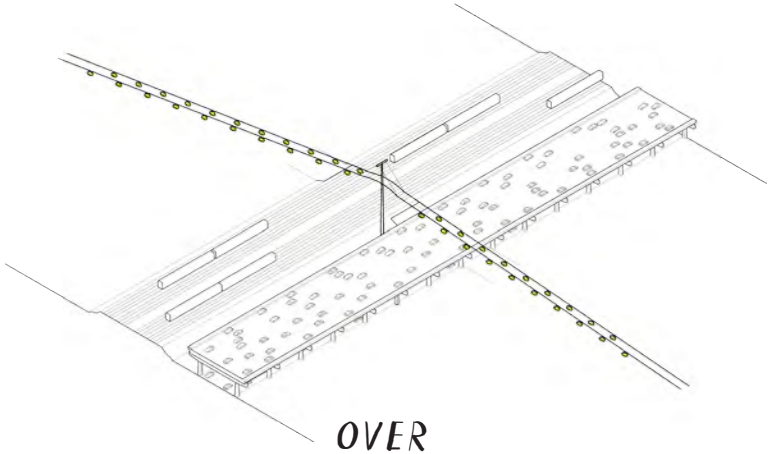
More broadly, while Toronto's subway and extensive streetcar network anchor a strong public transportation system, as the City's TOCore strategy notes, pedestrian and public transit access between downtown and the waterfront is challenging. This issue will only compound as development moves further into the Eastern Waterfront and further away from existing transit lines.

New mobility arteries that sprout from Quayside must not only be about connecting back to the already-developed waterfront to the west.

Instead, these connections should include paths north to King and Queen Streets, east to Leslieville, and south to the Port Lands. Transit infrastructure in Quayside should work in concert with the proposed East Harbour transit hub to stitch Eastern Toronto and the Waterfront into the city's infrastructure, and relieve some of the pressure on existing subway lines.

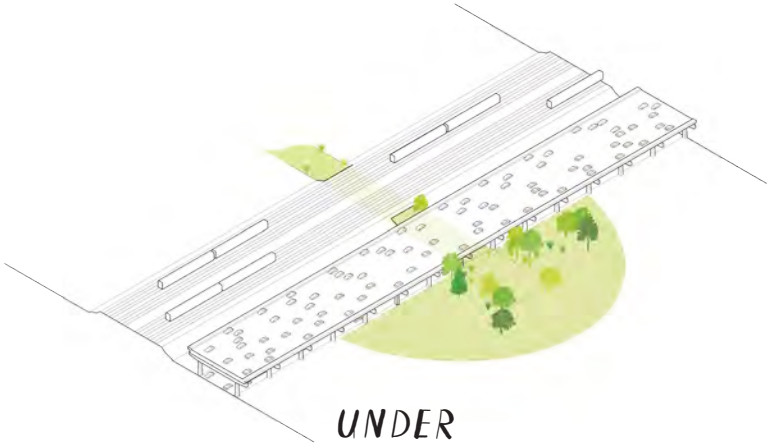
This challenge is one Waterfront Toronto knows well, and for which the city is already implementing creative solutions. Soon the Bentway will snake beneath the Gardiner on the Western Waterfront, creating new gathering place for residents and visitors. The development approach in Quayside must bring equally creative solutions to "The Stitch" in the Eastern Waterfront. There are many potential approaches, for example, to make crossing the Gardiner an experience that celebrates the character of this massive piece of infrastructure, while bringing Quayside and its so-close-yet-so-far neighbors together.

Sidewalk wholeheartedly agrees with Waterfront Toronto's vision to create Gardiner crossings that stitch the city together.

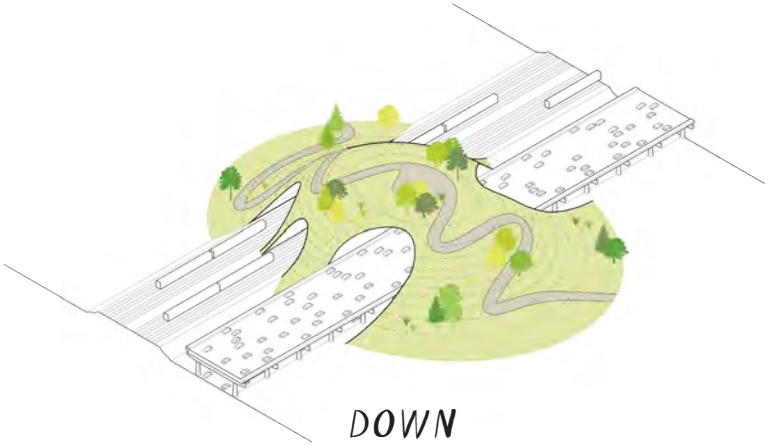


OVER

SIDEWAYS



UNDER



DOWN

Between Old and New: Embracing Heritage

NEW DEVELOPMENT OFTEN BENEFITS FROM EMBRACING HISTORY. Sprinkled throughout the Eastern Waterfront are the grain silos and smokestacks that testify to the waterfront's industrial legacy, with the Victory Soya Mills Silo in the middle of the Quayside neighbourhood a prime example. The treatment of this authentic piece of Quayside's history should be highlighted, not hidden, and its towering structure should be celebrated.

Concrete silo structures have vexed cities and developers all around the world, but new design capabilities are increasingly enabling cost effective reinventions. In Cape Town, South Africa, construction of a contemporary art museum within the V&A Grain Silo is underway.

The silo can be an organizing component of the public realm within Quayside, and its location establishes it as a powerful visual gateway as visitors travel east on Queens Quay. Its central location within Quayside may also position it to play a pivotal role as a node in a mobility network connecting the Eastern Waterfront and the city.

The silo structure could ultimately become the symbol that instantly comes to mind when people think of Toronto's urban innovation district in the Eastern Waterfront—a counterintuitive coda for a structure that was built 60 years before the iPhone was invented.

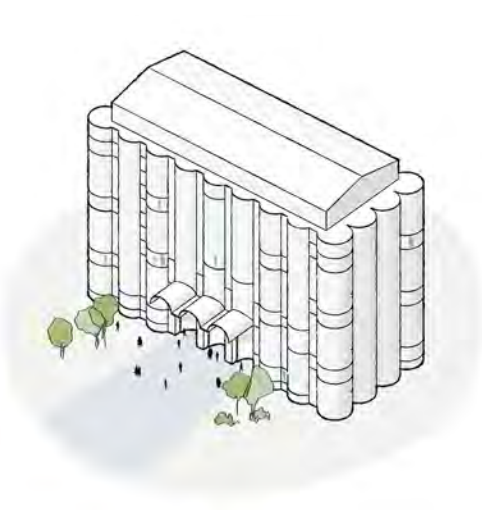
As development scales across the Eastern Waterfront, the Hearn, Cherry Street Bridge, and the Fire Hall on Commissioner Street present similar distinctive opportunities to be repurposed.

The historic grain silo at the V&A Waterfront in Cape Town, South Africa is being converted into the new home of the Zeitz MOCAA permanent contemporary art collection.

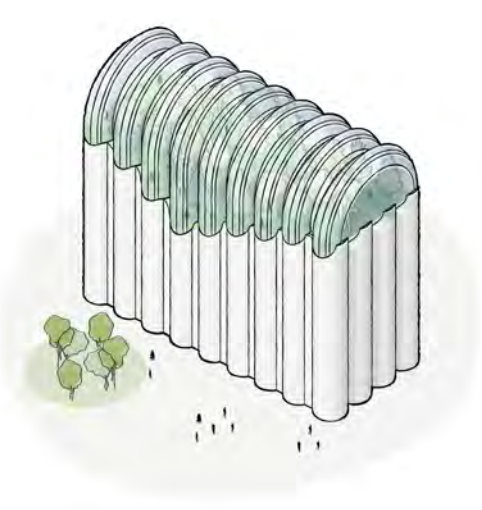
Credit: Navigator

Victory Soya Mills Silo at Quayside

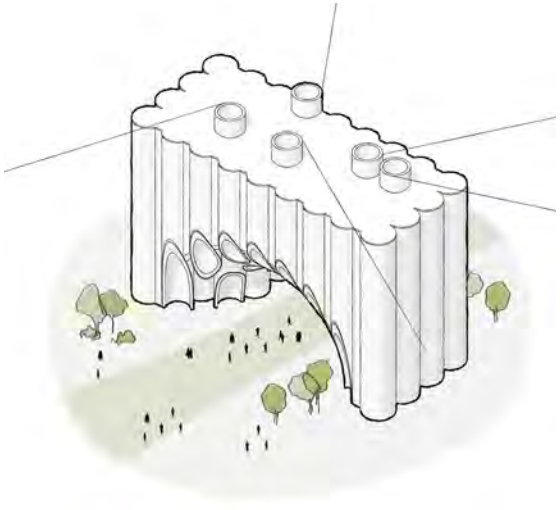
Credit: Mark Wickens



MUSEUM

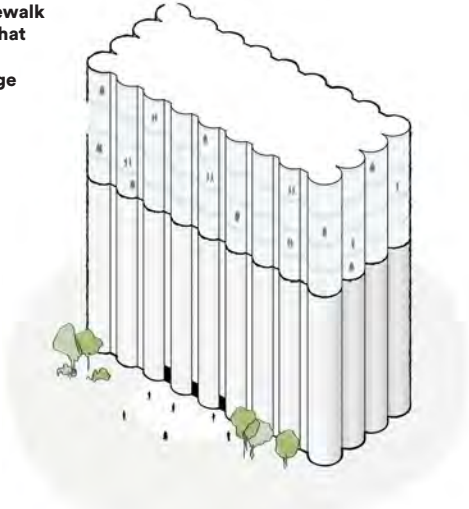


URBAN FARM



TRANSIT HUB

Victory Soya Mills Silo, an icon of Quayside's industrial past, may well become a symbol of its future. The team at Sidewalk explored a series of ideas that would simultaneously pay homage to the site's heritage while creating a beacon for its innovative future.



HOTEL

TECH INCUBATOR

GARDEN

Scaling the Network: The Greater Eastern Waterfront

QUAYSIDE WILL BE JUST THE FIRST NODE in a network of interconnected neighbourhoods. Over time, a network of neighbourhoods will extend out across the Eastern Waterfront, forming a set of diverse communities united by a larger system of communication and interaction.

The true potential of the platform is achieved when multiple neighbourhoods are interconnected. Whereas a neighbourhood of a few thousand people will catalyze an initial market opportunity to attract third parties to the platform, a series of networked neighbourhoods will be powerful enough to draw companies and entrepreneurs from all over to take part in Toronto's new ecosystem. As the network grows, it will begin to realize the possibilities of urban innovation at the scale of an entire district.

A Loft pilot at Quayside can create radical mixed-use along neighbourhood blocks for hundreds of people; this same concept, applied across the Eastern Waterfront, means transforming the way tens of thousands of Torontonians interact with the built environment and accelerating the speed at which streets evolve. A cluster of Passive House buildings at Quayside will scale to a new global standard for building energy efficiency that replaces LEED and supports a climate-positive district.

It is not just about scale. There is additional combinatorial impact that occurs when boundless innovation comes together in cross-cutting ways.

When Sidewalk's mobility solutions in Quayside lead to an Eastern Waterfront free of privately-owned cars, it does not just save families money on car-ownership and make travel more convenient. It combines with a Ground-Traffic Control System to turn every corner into a transit stop, eliminating the fixed nodes that drive up cost of living in dense areas. It combines with Loft structures and programmable space to repurpose parking for whatever the community needs most: from new housing to a ribbon of park. It combines with the advanced microgrid to power all vehicles with renewable energy, keeping the skies cleaner and hydro cheaper.

As the development on the Eastern Waterfront grows, each new neighbourhood adds a node to the network, increasing the value of the network overall.

A Network of Neighbourhoods

NEW NEIGHBOURHOODS WILL UNFURL A VIBRANT, DIVERSE QUILT across the waterfront, a natural extension of the "City of Neighbourhoods" that forms Toronto's unique character.

Eventually, the Eastern Waterfront will be composed of an entire network of neighbourhoods, with a wide variety of designs and forms possible within the basic structure of a district. The waterfront must express and extend the natural, organic diversity of Toronto itself. The most exciting thing Toronto can do is to build more of what makes so many of its neighbourhoods beloved, and to give a modern, ambitious, and generous form to the elements that make the city a success.

The site is large enough to support a dozen or more neighbourhoods of distinct personality—freed from the confines of traditional development. The street hierarchies will restrict conventional vehicles, with bike highways and autonomous ferries feeding an internal mobility network primarily serving pedestrians, cyclists, and autonomous transit. A free-flowing public realm will emphasize accessible streetscapes, short blocks, and flexible pavilions of radical mixed-use, eliminating the divide between home, work, and play. The power of nature and water will be ever-present: a green ribbon will surround the whole district, and a series of blue "water rooms"—from floating theatres to homes—will create new life on the lake.

This multi-directional dynamic will also connect residents of the new district with communities throughout the Toronto metropolitan region, forming an economic and knowledge ecosystem, and advancing Toronto's global role as a magnet for urban innovation. While Quayside and the Eastern Waterfront will be a showcase for urban design and community innovation, they must at the same time become fully embedded into the fabric of Toronto's existing neighbourhoods—a celebration of diversity within a larger sense of community for all Torontonians.

Toronto's Neighbourhoods

New neighbourhoods on the Eastern Waterfront will be a natural extension of Toronto's existing neighbourhood network. Credit: Mark Wickens

The Waterfront of the Future

EXTENDING DOWNTOWN'S ENERGY, and building off the ideas initially prototyped in Quayside, the greater Eastern Waterfront will be both a great place to live and work and a magnetic destination.

In time, the Eastern Waterfront will be Toronto's newest district, and home to tens of thousands of Torontonians. Only rarely has the city been able to build downtown communities from whole-cloth. Fifty years ago, the development of the Esplanade demonstrated Toronto's skill at creating dense, vibrant and mixed communities. More recently, the redevelopment of Regent's Park has reaffirmed the city's knack for incorporating inventive public amenities.

But the Eastern Waterfront is of an altogether different scale, and is already coming to life.

In the Eastern Waterfront, the ideas imagined and tested at Quayside can achieve the scale necessary to redefine urban life, positioning Toronto and Canada as a world leader in urban innovation, and delivering step-change improvements in quality of life to residents and communities.

The Waterfront of the Future is a series of communities at the nexus of the lake and the city.

Explanatory Note: A Holistic Approach to Planning

THE ROLE OF QUAYSIDE AS A TESTBED for innovation will be further enhanced if the Waterfront Toronto-controlled parcels are planned in concert with the adjacent sites owned by the Great Gulf Corporation and the 3C development consortium. Given the benefits that could result from the larger scale and a coordinated approach, Sidewalk's evaluation of the Quayside opportunity has included consideration of the broader Quayside neighbourhood.

Preliminary contact with both parties has been encouraging, and Sidewalk hopes that an initial priority will be to formally engage both in a collaborative planning process. Sidewalk's assessment of the Quayside neighbourhood has been based on an understanding that any ideas for the broader area will require the participation and approval from other parties.

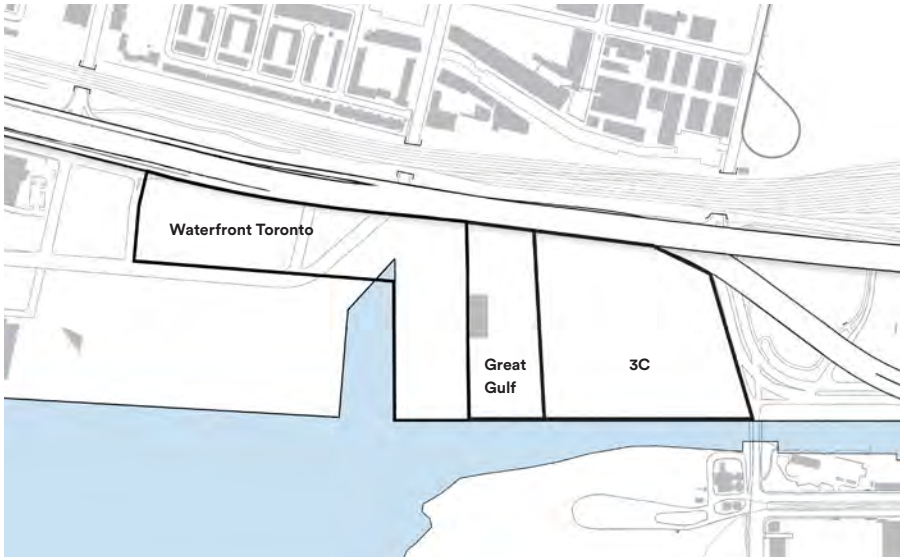
Expanding the project area from Waterfront Toronto's 12 acres (assumed to include the two small private parcels adjacent to Parliament Slip that Waterfront Toronto has indicated will be included within its Quayside development plans) to the full 33 acres enables innovation within Quayside to expand from the building level to system and neighbourhood scale.

Experimentation with the impact of autonomous mobility on the design of streets, for example, can be undertaken with the distance and density afforded by the larger neighbourhood scale. Sustainability solutions—such as a microgrid that balances power usage, or a thermal grid that utilizes waste heat and cool—not feasible on smaller developments can become achievable, too.

Quayside can contribute even more as the launchpad toward a holistic vision for the Eastern Waterfront if its public realm, mixed-use development program, and urban design are considered in a coordinated manner, beyond just a shared waterfront esplanade and the extension of Queens Quay.

As part of initial visioning and analysis, Sidewalk evaluated objectives considering both Waterfront Toronto's Quayside sites, and the full Quayside neighbourhood in the development of preliminary concepts.

Population growth projections for Toronto show increasing concentrations in the downtown core and the Eastern Waterfront, with 10,000 new residents moving to the Downtown each year, doubling its population by 2041. As this trend continues, growth will increasingly push outward to the southeast, directly towards Quayside and the greater Eastern Waterfront.



The broader Quayside neighbourhood, including privately owned parcels, should be considered holistically.

Without a deliberate development approach, Quayside could succumb to the market pressure for upper-market residential that has recently driven downtown and waterfront development, and preclude the longer-term benefits of establishing a truly mixed-use program and more complete community.

With these factors in mind, Sidewalk considered a variety of programs that range between 5.5 and 6.5 million square feet.

In all cases, the total amount and distribution of square footage among different uses was considered in light of market conditions. The goal was to maximize the amount of density on the site without sacrificing the principles on which Quayside should be built: a generous public realm, a true mix of uses, strong commercial activity, and inclusivity and affordability for a broad range of Torontonians.

Sidewalk believes that its development approach will house more than 5,500 jobs within the Quayside neighbourhood, across a range of sectors. The combination of Google's presence and urban innovation institute pulling together academia and industry will give rise to an active innovation cluster in Quayside.

The demand in the downtown Toronto market is already absorbing residential product at an aggressive pace. Given the strength of this demand, the controls on density within Quayside are most likely to stem from the balance of urban design decisions, an emphasis on planning around the public realm, and policy priorities that may value experimentation over short-term revenue.

Broadly, Sidewalk's preliminary estimates indicate that Quayside is likely to be approximately 65 percent residential, with the balance including commercial, retail, hospitality, cultural, academic, and community uses spread across a range of adaptable building typologies. Sidewalk's belief in mixed-use development also informs its approach to affordable housing, which in all scenarios has been distributed throughout the site's residential program, as opposed to being isolated in individual buildings.

Quayside's development program will ultimately be the result of an iterative, consultative process jointly undertaken by Sidewalk and Waterfront Toronto, in which innovation, community priorities, policy objectives, placemaking, phasing, infrastructure, economics, market, site planning, and technical issues will be thoughtfully merged.

Sidewalk's approach to understanding the planning potential of the Eastern Waterfront included the First Gulf Corporation's East Harbour project, as it is a critical component for the growth and development of the entire Eastern Waterfront.

Sidewalk would like to acknowledge the contributions of Beyer Blinder and Belle Architects & Planners (BBB), Brookfield Financial Real Estate Group, BuroHappold, Deloitte, Heatherwick Studio, Partnership for Architecture and Urbanism (PAU), Waterstudio, Jason Polan and Mark Wickens.

4.
Purposeful Solutions

Sidewalk's purposeful solutions together form its urban innovation platform for Quayside: both the platform's digital layer and component parts of its physical layer.

Sidewalk's team has also begun to consider how these ideas will scale on the Eastern Waterfront, and what more will be possible there.

The ideas presented here are only a starting point.

A collaboration between Sidewalk and Waterfront Toronto will build on this pathbreaking vision—and make it a reality.

Digital Layer

The digital layer allows efficient operation of the neighbourhood by providing a single unified source of information about what is going on. It also supports innovation by providing a set of well-documented and supported APIs for third parties to build on. Furthermore, by pushing as much as possible of the neighbourhood infrastructure into software rather than hardware, it increases flexibility and reduces lock-in to outmoded technologies.

The Digital Layer

JUST AS COMPUTER AND SMARTPHONE OPERATING SYSTEMS keep the device running smoothly but also allow innovators to create new apps, the digital layer is designed to keep the city running smoothly but also encourage residents, staff, startups, and larger companies to bring their most creative ideas to bear on improving life in the city.

Sidewalk's digital layer will follow the following four principles:

① Enable more value creation than you capture. Good platforms focus on enabling others to extend the platform in ways that cannot be predicted ahead of time. Platforms should function as meritocracies that provide priority, resources, and acclaim to the most talented, engaged, and valuable participants. For example, the Toronto PATH system for pedestrians provides a platform that stores, building owners, and the city have collaborated to build, and which has resulted in outsize benefits to residents, visitors, the business community, and the city.

② Provide a stable and intuitive but always improving interface. Platforms must change as users' needs evolve over time and technological capabilities expand. But each platform update imposes costs on developers. The pain of platform improvement can be managed through agile development, incremental testing and implementation, elegant functionality, and intuitive and well-documented interfaces. But platform providers need to be humble and understand the need to "earn" the right to upgrade by providing exceptional value and close support.

③ Prioritize modularity and interoperability. Successful platforms allow developers and users to engage selectively. Modular design allows developers to build up platform functionality from basic components. This reduces application development time by standardizing functionality, reducing waste, improving reusability of designs, increasing openness, enabling greater resilience, and allowing platforms to serve multiple segments simultaneously rather than optimizing for a single type of user.

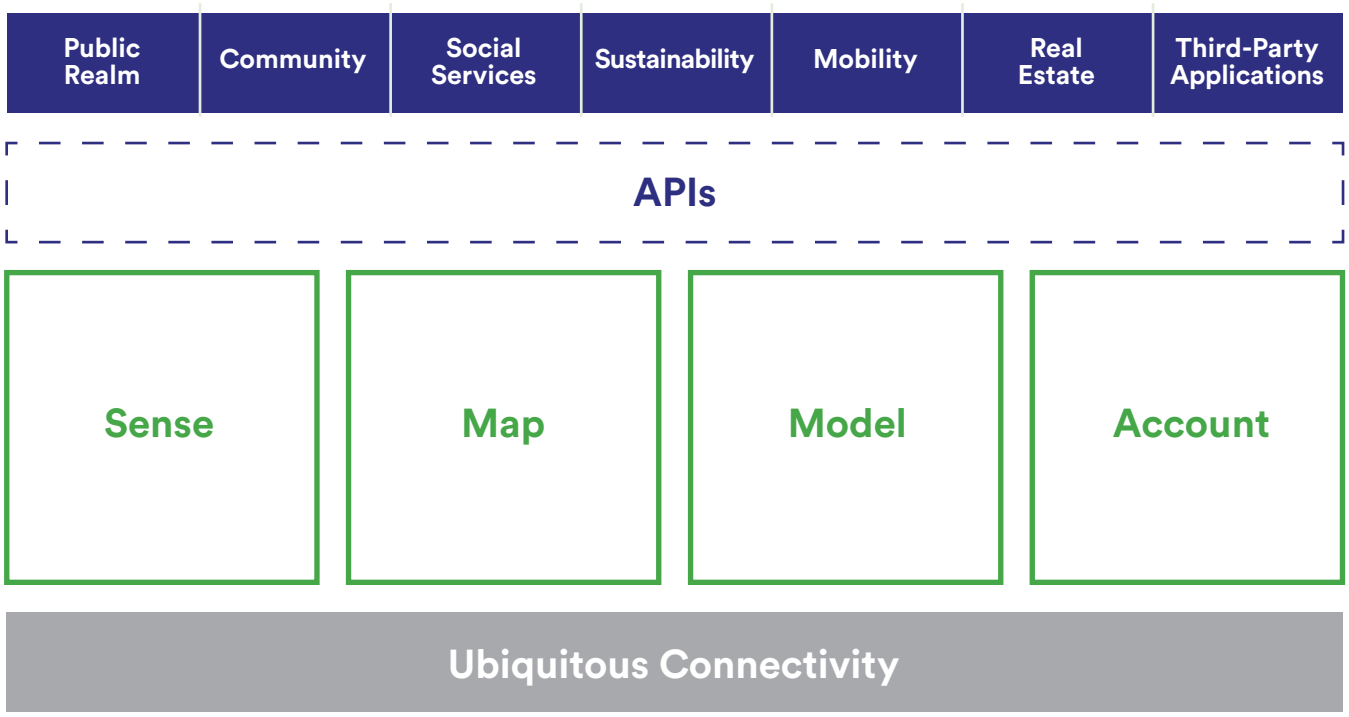
④ Never compromise user privacy. In addition to the flexibility, personalization, and efficiency that platforms provide, it is important that they maintain high standards for privacy and security. Furthermore, it is not sufficient to provide technical protections—the platform must also allow people to see and understand how their data are used, and be able to control those uses. Platforms can only flourish if their users trust and value them—and that trust comes from clear, consistent, and well-enforced policies for handling of personal information.

Sidewalk is actively developing the digital layer for its platform, which contains four essential components. A Sense feature knits together a distributed network of sensors to collect real-time data about the surrounding environment, enabling people to measure, understand, and improve it. A Model component—in development by Sidewalk's Model Lab—can simulate "what if" scenarios for city operations and inform long-term planning decisions. A Map component collects location-based information about the infrastructure, buildings, and shared resources in the public realm. An Account component provides a highly secure, personalized portal through which each resident accesses public services and the public sector. The platform mediates the interface with the physical environment

(ubiquitous connectivity) and makes all of the services available to application developers through an API layer (APIs).

And to inspire an uncompromising level of trust in the platform's data privacy and security, Sidewalk will engage with independent privacy experts and community stakeholders to advise on protections, transparency, and controls. (Ann Cavoukian, former Ontario Information and Privacy Commissioner and currently the Executive Director of the Privacy and Big Data Institute at Ryerson University has already agreed to serve on the project's advisory board if Sidewalk is selected by Waterfront Toronto.)

The Digital Layer for Urban Innovation



Applications, including those from third parties, can be built on top of the digital platform layer's APIs.

Ubiquitous Connectivity

None of the software and hardware components of the digital layer can operate effectively without a substrate of network connectivity, power, and ways of deploying hardware at low cost in the urban environment.

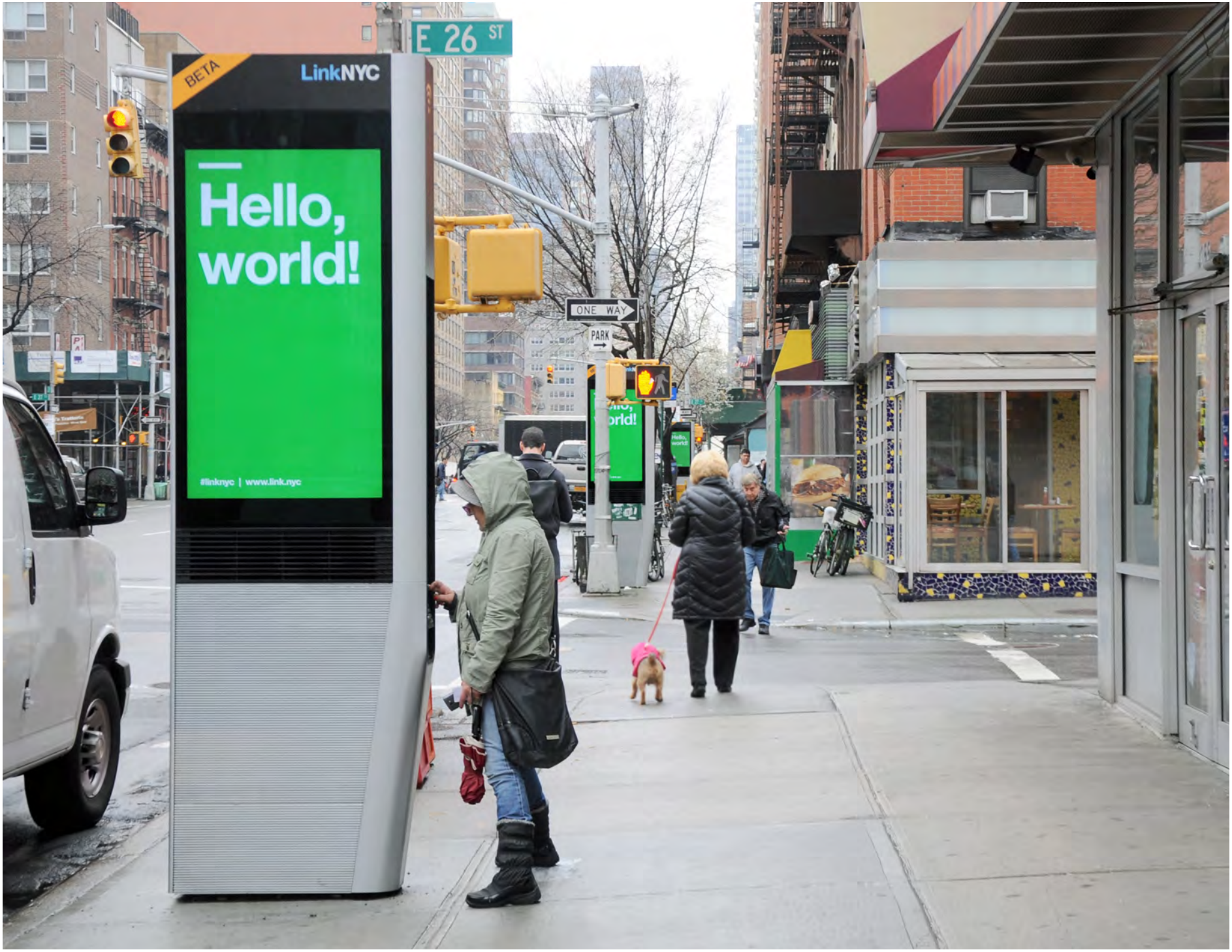
To maximize future flexibility and reduce the hassle and worry of last-mile connectivity for end users, Sidewalk will deploy a shared wired and wireless backbone that creates seamless coverage and service competition. Each access point will offer wireless connectivity via current and emerging standards, including (1) Wi-Fi (2) LTE and (3) LoRa (long-range, low-power radio), leveraging software-defined radios to optimize coverage and throughput. A significant benefit of bringing all radios in the neighbourhood under a single management structure is that it minimizes interference and allows for the greatest possible coordination, synchronization, and adaptability, resulting in the best internet experience for all consumers.

An enormous benefit of building a neighbourhood from the internet up is that needed sensing technology can be built in from the start. Rather than requiring expensive and time consuming building and street furniture retrofits to incorporate sensors, new construction will include quick-connect mounts that provide a stable platform, electrical power, and network connectivity.

Driving down the cost of sensor installation and upgrades allows, in turn, for deployment of lower-cost sensors. In much the same way that Google drove down the cost of its servers while maintaining reliability by making it quick and easy to repair or replace failing components, Sidewalk will be able to use commercial, off-the-shelf components that are significantly less expensive than components designed to survive for decades in environments where replacement is expensive and difficult. This will also have the effect of keeping the fleet of sensors up-to-date, as technology improves.

Planning for ubiquitous connectivity does not require waiting for a new build. The LinkNYC and LinkUK projects Sidewalk is undertaking with Intersection, its portfolio company, provide unprecedented free, high-speed wireless internet access in urban environments. From that starting point, Sidewalk and Intersection are experimenting with software-defined radios to future-proof built infrastructure, and with low-power, long-range networks to support low-bandwidth sensors like those focused on air quality.

LinkNYC provides free gigabit Wi-Fi access throughout all five New York City boroughs.
Credit: Intersection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BETA
LinkNYC
Hello,
world!
#linknyc | www.link.nyc
ONE WAY
PARK

Neighbourhood APIs

The digital layer will include a set of APIs, creating a stable and well-designed canvas on which developers can build applications to reimagine and reinvent how the city works.

In much the same way that software platforms like Apple's App Store, the Google Play Store, and Amazon Web Services have stimulated creativity on the web and in personal devices, the digital layer provides a set of APIs, with documentation and developer support that will inspire the same creativity in the city.

APIs include regulated access to city data and the ability to interact with the city infrastructure in ways that are safe and consistent with other uses.

Providing a programmable interface to the city will unlock possibilities for application designers—many of which cannot be anticipated. The platform will be a magnet for civic-minded software developers and technologists, and Sidewalk will provide a co-working space for students, entrepreneurs, and academics who want to advance the state of the art in urban technology.

Sidewalk expects that many residents, in general, will be attracted by the idea of living in a place that will continuously improve.

Standardized data formats and well-defined interfaces will enable the digital layer to adapt as technology changes over time. Cities benefit from the ability to choose from the widest variety of vendors and service providers, so it is important not to lock into a particular hardware or software solution.

For example, defining standard ways to provide information about places and things in the city makes it possible both to change the underlying database technology and to choose different providers and consumers of the directory information over time. Likewise, as computer vision algorithms and sensor resolution improves, it will be possible to swap in new algorithms and sensors to improve accuracy and frequency of measurement of the public realm.

Bootstrapping in Quayside

A production version of the entire digital layer needs to be complete to open Quayside.

This will enable experimentation with a broad range of sensors, initially over-provisioned, to enable parallel experimentation with multiple technology approaches. The size of Quayside makes it feasible to deploy cameras with different capabilities covering the same spaces. This will help Sidewalk evaluate trade-offs in technology and cost with apples-to-apples detection tasks on the same region. Likewise, Quayside will have multiple overlapping communications networks—an opportunity to evaluate relative value.

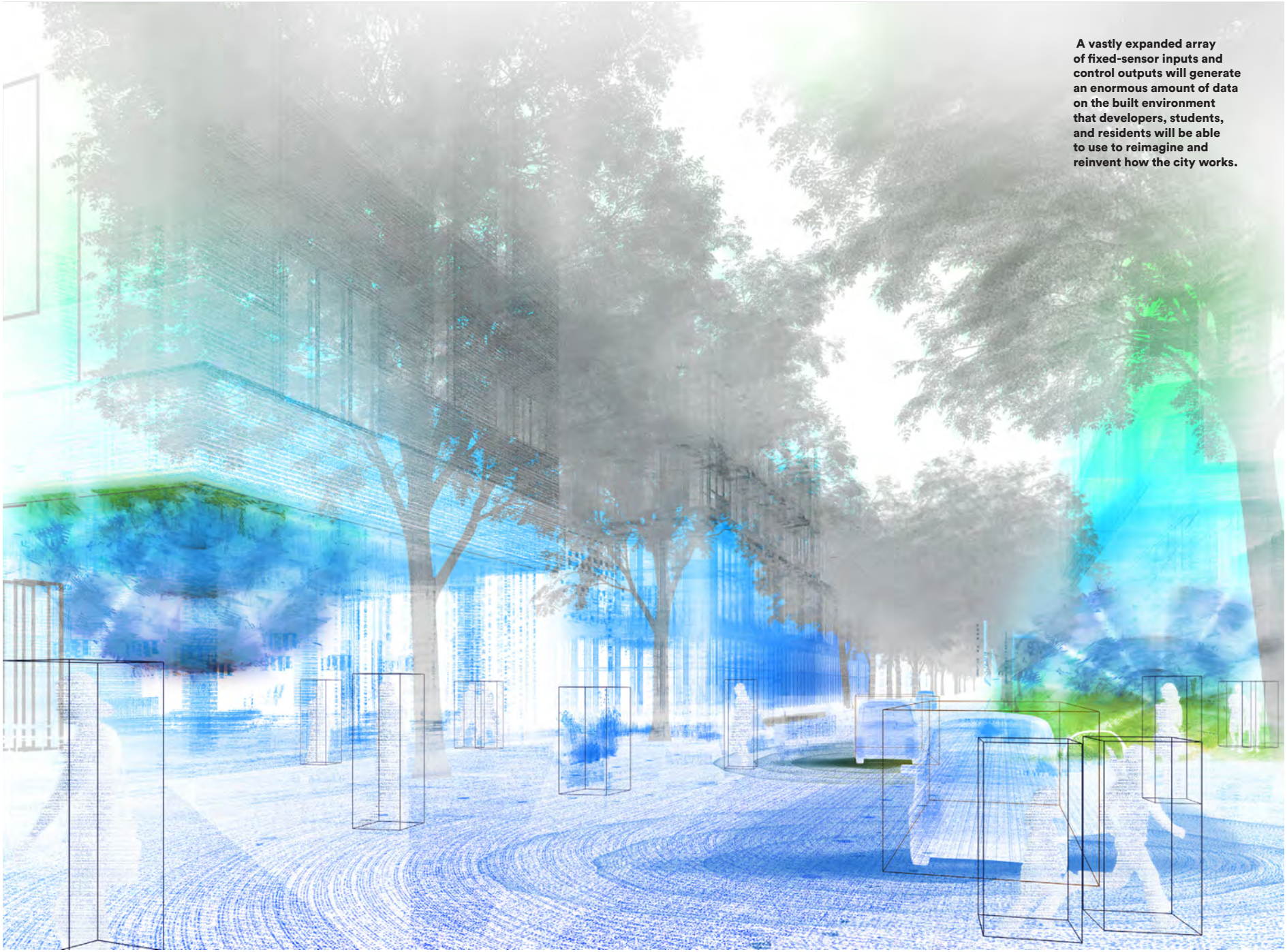
Some operational processes can be managed manually at the Quayside scale, such as monitoring elements of the public domain in need of maintenance. This presents an opportunity: these manual processes can be used to train machine learning models.

For example, for systems to be able to detect when a trash bin needs to be emptied, the system needs multiple examples of empty bins and overflowing bins. This "training data" can be used to create a computer vision model that will be able to make predictions on its own later. Capturing the regularities in patterns of full/empty cycles, and the environmental features that are likely to give rise to a full bin (e.g., a public concert in a plaza), will enable the system to anticipate a full bin.

This learning phase is human-intensive, but will swiftly result in generalizable models that will make Quayside more efficient and will themselves be ready on day one for wider implementation in the Eastern Waterfront.

The urban innovation institute Sidewalk envisions for Quayside will be an asset in the development of the digital layer. The institute will be a place for collaboration and discussion, and an unprecedented opportunity for faculty and students to test their ideas in a real urban environment. The institute will support cross-discipline, graduate-level degree programs, a broad range of faculty research with areas of deep specialty, such as application of artificial intelligence, and research and curriculum with potential reach into policy, governance, finance, and other relevant disciplines.

The institute will also be an informal location for people to collaborate. A dedicated staff will nurture the developer community and make connections between groups. A dedicated technical staff deeply versed in the details of the digital layer will be able to advise on its use, help new developers get up to speed, debug issues, and take lessons from this process back to the platform development team to effect improvements to the platform and APIs themselves.



A vastly expanded array of fixed-sensor inputs and control outputs will generate an enormous amount of data on the built environment that developers, students, and residents will be able to use to reimagine and reinvent how the city works.

Sense

THE FIRST STEP IN IMPROVING QUALITY OF LIFE AND EFFICIENCY IN A CITY is understanding it. As the cost of sensors falls and Internet of Things technology develops, ubiquitous sensing becomes feasible, and enables a deeper understanding of the urban environment.

Measurement and Sensors

It all begins with collecting useful data about the physical environment in a way that is deeply respectful of individual privacy. Over time, sensors have become less expensive, smaller, and more power-efficient. Simultaneously, the artificial intelligence techniques required to make sense of their output have improved significantly—in part due to advances in artificial neural networks led by Geoffrey Hinton from the University of Toronto (and Google).

Sensors range from low-bandwidth thermometers, which transmit a single, slow-changing number, to high-resolution cameras that capture millions of pixels dozens of times per second. Cameras deserve special attention because they raise issues of privacy. Rather than transmitting and saving full-bandwidth video, as much as possible Sidewalk will interpret the video on the same device as the camera and transmit only metrics like vehicle and pedestrian flows or the status of street infrastructure.

Quayside, in particular, presents an opportunity to instrument an area quickly with a range of production and experimental sensors, and to learn by quick iteration. The lessons from this rapid experimentation can be applied on a scaled-up basis in the greater Eastern Waterfront. For example, Quayside, will shed light on the tradeoff between camera resolution, deployment density, cost, and direct value to neighbourhood administrators and residents.

Sensors that Sidewalk expects to deploy include (1) air quality sensors (carbon monoxide, particulate matter, sulfur dioxide); (2) noise level sensors (noise generated by vehicles, construction, human activity); (3) radar, laser rangefinding, and computer vision (flow of vehicles, cyclists, pedestrians, state of the urban environment); and (4) hyperlocal weather (temperature, wind speed, humidity)

Analytics

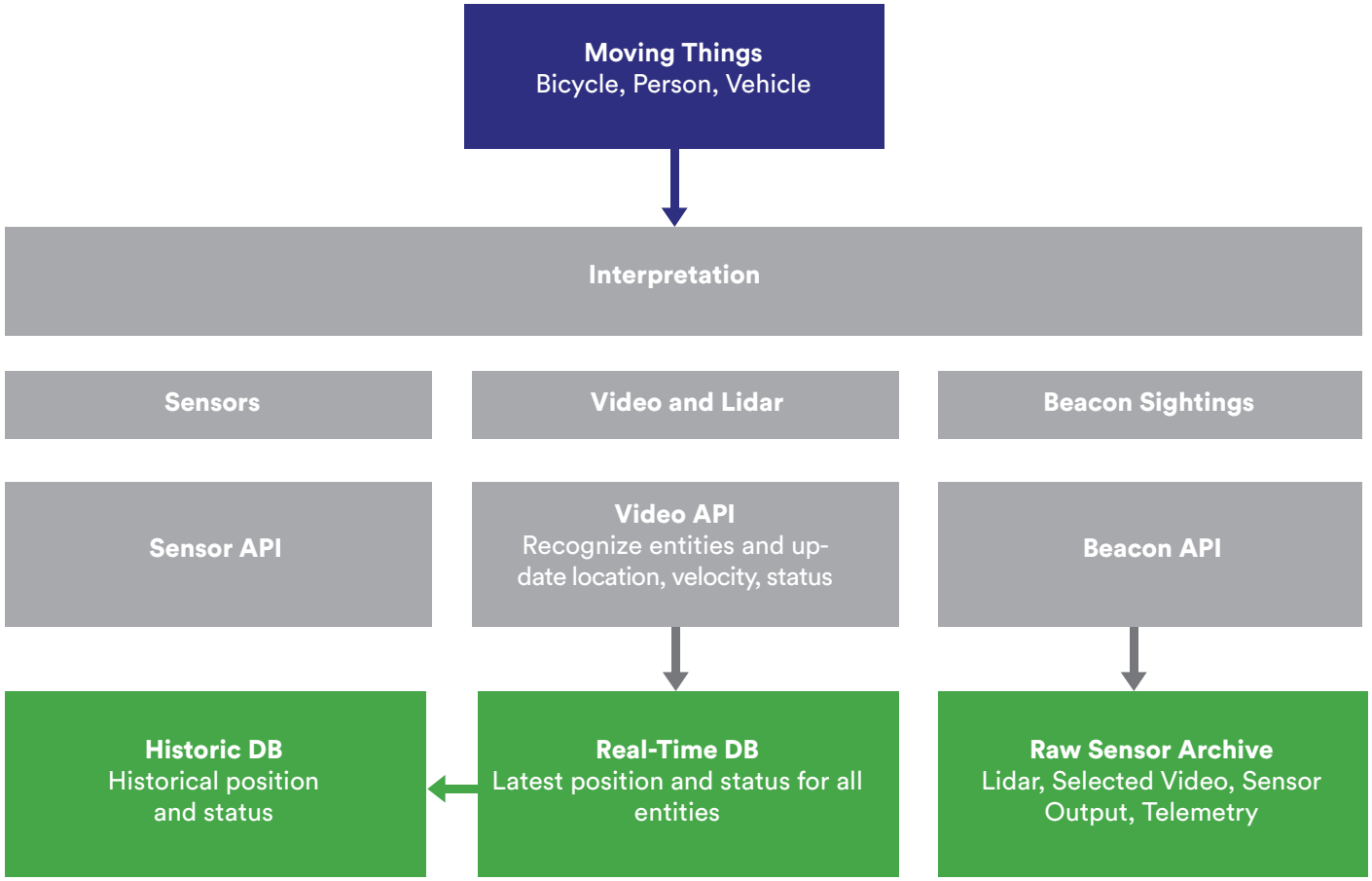
Collecting data is not valuable in and of itself. To understand what makes the urban environment work well, and detect when it is underperforming, it is necessary to perform longitudinal analysis, and be able to distinguish normal states from anomalous ones. Analytics based on measurements over time will allow users to understand variation in urban conditions, and why that variation arises—both by improving human intuition, but also by building predictive models.

Modelling

Once fine-grained data are available, it will be increasingly possible to develop a digital model of the performance of the neighbourhood, and use that model to evaluate the effect of various decisions. The ability to predict the consequences of possible interventions, and to refine the model based on measurement of actual outcomes, is an accelerant to improving the livability of the neighbourhood.

To take an earlier example: as Sidewalk experiments with various weather mitigation strategies, it will get real-time feedback on temperature and wind speed from a high-density mesh of sensors. That will enable the real-time evaluation of different interventions. Likewise, when the platform detects pedestrian congestion—for example, during entertainment events—the neighbourhood will have detailed data about where the bottlenecks are occurring and what is causing them. By making use of dynamic signage, flexible street furniture, and guidance from smartphone apps, the platform can experiment with ways to create better pedestrian flow. Even making information available about crowding in real time to residents and visitors will enable them to make informed decisions about when and where to visit locations within the neighbourhood.

Sense Interpretation Stack



Sensor and camera output is interpreted by computer vision and normalization. The resulting data are streamed to a low-latency geospatial database for real-time interventions. It is also recorded to a historical database for later analysis and planning.

Model

MANY URBAN INTERVENTIONS ARE DIFFICULT TO TEST in real-world conditions due to cost and customer inconvenience. Model provides a virtual laboratory to experiment with changes in infrastructure, policy, and the built environment. At Model's core is a metro area-scale simulation representing the movement of each person. From these patterns, Sidewalk is able to construct an activity-based model system that can inform and explore a wide range of policy options including in the areas of roadway pricing, ride sharing, zoning and land use, and incentives to conserve water and energy.

Modelling how people make choices about where to live, where to shop, whether to own a car, or how to travel from place to place are key concerns for urban planners. Current demographic, land use, and travel forecasting tools rely on statistical inferences based on sparse and sporadic data. These methods are sufficient if the travel choices are conventional and the travel networks are relatively stable (e.g., a conventional bus route). For Quayside and the Eastern Waterfront, Sidewalk's goal is to dramatically reduce the need for car ownership by offering residents new mobility options, such as shared self-driving vehicles. Since these new options have no operating history, Model will deploy more fundamental and sophisticated inferences to predict demand using machine learning techniques.

Model can be used in both operational and planning contexts. Combined with data from Sense, Model can provide a robust decision support system by simulating the next 5, 15, or 30 minutes of neighbourhood activity to anticipate problems and suggest remedial measure before they amplify. At weekly and monthly time scales, facility managers can simulate changes to infrastructure and policy to improve operational efficiency. Operational planning blends into medium- and long-range planning, which can be used to design the growth of the neighbourhood and achieve strategic objectives.

In current practice, medium- and long-range planning schemes are considered separately from near-term operational schemes. This creates an unfortunate "open loop" where each schemes fails to benefit from the other. In Quayside, and eventually the Eastern Waterfront, Sidewalk has the ability to align these efforts in order to create a unified framework to serve a wide range of applications. As Model gets exercised daily, its fidelity and accuracy will improve. These improvements will provide long-range planners with more accurate representations of people and behaviour.

Innovators can test concepts in Model's simulation environment to understand their direct and indirect impacts and solicit feedback from the community. Sidewalk believes that this level of transparency and accessibility will enable the neighbourhood to find creative, inclusive solutions faster.

Model is able to estimate the number of inbound and outbound trips to and from each site. For each trip, it can compute the distance traveled by travel mode.


Trip Generation
Total Travel Distance
km/person/year
Office
Residential
Selection
5780 -4.5%
3320 -8.0%
Study Area
6050
3608
Trips by Travel Mode
Office (in)
Residential (out)
Auto
132
20
Distance
km
<5
>30
<5
>30
Transit
447
92
Bike/Walk
21
18
Grange Park
Queen's Park
Royal Ontario Museum
Ritz-Carlton Toronto
Roundhouse Park
Rogers Centre
CITYPLACE
Spadina Ave
Bayside Toronto
GO Transit - Don Yard
BMW Toronto
Gardiner Expy

DIGITAL LAYER

Map

KNOWING WHERE THINGS ARE IN THE PUBLIC REALM allows a neighbourhood to be safe, efficient, and responsive.

For example, efficient mobility relies on knowing where self-driving vehicles are, and safety can be increased by letting cyclists know when there is a danger of collision. Keeping track of public events, and helping people find out what is going on at a glance, will improve people's experience of the neighbourhood. Understanding the patterns of use of parks, roads, and other resources permits better planning.

Map records the location of all parts of the public realm in real time, from the largest buildings to the smallest environmental sensors. This includes the fixed objects—buildings, roads, park benches—and those that move—autonomous vehicles, delivery robots, drones. Map enables people and things to move around the neighbourhood with maximum safety, confidence, and efficiency.

In Quayside, real time information on the environment will flow through Map, producing real-time snapshots of the neighbourhood. This information will directly benefit residents and visitors through its use in applications like Flow, Sidewalk's mobility subsidiary.

Account

NEIGHBOURHOOD RESIDENTS AND MUNICIPAL STAFF will each have accounts that permit them to interact with the city environment and services. Visitors can also opt to have an account to help them experience the neighbourhood. The account will provide access to places and resources they want to take advantage of. It will also enable them to connect neighbors with each other and with and municipal employees.

While fine-grained information about the public realm and the objects in it enables greater efficiency and quality of life, it also necessitates a careful approach to authentication and permissions to ensure privacy is maintained and control is appropriately circumscribed. Authentication of people as well as automated processes ensures that the platform can identify those who request access to data or control over physical objects. A universal permissions system can then enforce which information and entities a particular individual has the rights to access or modify.

Use Cases: Ordinary Use and Emergency Situations

Examples of Map and Account in action:

- A resident uses his or her account to temporarily grant a maintenance worker access to their front door. The door lock uses Policy and Permissions APIs to retrieve the required confidence threshold to grant entry.
- A car is allowed to use a street segment for a period of time.
- A building superintendent is granted rights to access apartments to conduct repairs.
- The fire department is given access, on emergency basis, to any apartment where a fire alarm is triggered.

The image at left shows the data that a combination of Sense, Map, and Account could make available to firefighters during a crisis. Emergency-only permissions could grant firefighters unrestricted access to data at a crisis location, assessing the environment and expediting the process of finding people in a harmful situation, while still preventing personally identifiable information from being easily obtained.

DIGITAL LAYER

Roadmap

Product Development Strategy:

Sense

Development of Sense is under way through experimentation with existing sensors, cameras, lidar, radar, and accompanying computer vision and machine learning techniques. Sidewalk plans to deploy these in existing cities—including Toronto, if possible—to establish the right technical approaches, reduce risk, and to start to value engineer the technologies that appear to be promising.

Model

Sidewalk is investing in the data science research needed to bootstrap a region-wide activity-based model that uses mobile location data. Leveraging the kinds of aggregated, anonymized data that Google has made available through the Better Cities program, Sidewalk's initial model calibration will focus on multimodal transportation, which includes private cars, public transit, private transit, ride-sharing services, bicycle, and walking. Similarly, using census and other open data, Sidewalk is building synthetic populations to support high-fidelity models that enable a significant leap in accuracy and consistency in the state of the art of urban simulation.

Map

Sidewalk is developing the first version of Map to support the output of Sense experimentation, including analyzing the paths and flow rates of vehicles through intersections and measuring air quality in existing cities. Through Sidewalk's subsidiary Flow, which focuses on mobility, Sidewalk is surveying existing cities—particularly curb space—at high resolution. Likewise, Flow is collaborating with Google to contribute real-time urban information to users via Google Maps.

Account

Sidewalk is actively investigating existing technologies that support identity and authentication—from commonly used identity systems such as Google and Facebook to sophisticated cryptographic proofs of identity and authorizations. Sidewalk believes, for example, that it will be possible to prove the right to access a particular resource without revealing identity, which reduces the attack surface for the system. We are drawing on Google's significant experience and product thinking in this area to ensure that the permissions system is both easy to use and secure.

Quayside Pilot:	Eastern Waterfront Manifestation:
Sidewalk will likely deploy a larger range of technologies than strictly necessary in Quayside in order to learn what works best and which applications are most important. The opportunity to integrate these technologies into the urban infrastructure at high density over a significant area will provide opportunities for learning available nowhere else in the world. The sensor network will be responsible for helping to run the neighbourhood from day to day, but will probably involve a higher level of manual configuration and monitoring than if at a larger scale.	Extending this approach to the Eastern Waterfront will create economies of scale in the manufacture, installation, and operation of Sense technologies. The sensors and supporting power and communications networks will have been value-engineered, and the platform supporting the sensors will be tested and ready for scaling. The larger scale will represent real “big data”—where machine learning techniques that work best with massive quantities of measurements will be applicable. These datasets will transform our understanding of urban environments, and will allow us to automatically configure, monitor, and optimize the neighbourhood.
Sidewalk will apply the modelling framework to the Toronto region and calibrate it against Toronto’s regional travel demand model. Such a regional model, running on Google’s Cloud Computing platform, will allow Sidewalk to model the interactions between the neighbourhood and its environs—evaluating many what-if scenarios in parallel. Specifically, Sidewalk can forecast how many neighbourhood-external trips will be generated by “attractors” in the neighbourhood. The same model can be used during the design process to study neighbourhood-internal travel patterns and the relative attractiveness of novel travel modes. As the development team sets the desired population and land-use patterns, the model will update the demand conditions for mobility, services, and infrastructure.	Learning from the Quayside site, Sidewalk can scale its models to work on the larger site using the same tools and methods. At this scale, neighbourhood-internal transportation modelling becomes much more interesting—especially since this is likely to be the first large autonomous vehicle-only district in the world.
Quayside will produce orders of magnitude more data about district layout and operation than is available in existing cities. As the master plan and the plans for individual buildings are produced, they will be stored in Map—even before construction. Sidewalk will also add the results of surveys conducted with technology based on Google’s Tango platform, which uses stereoscopic and inertial techniques to capture the as-built environment efficiently. During the operation of the Quayside neighbourhood, real-time state information on the environment will flow through Map producing a real-time snapshot and recording historical information for retrospective analytics.	At the Eastern Waterfront scale, Map will be fully realized—the schema will have been expanded to cover the diversity of building types, public spaces, vehicle types, and activities. The size of the neighbourhood will make Map indispensable for navigation and awareness—whereas people will be able to grasp the whole layout of Quayside from macro to micro, Map will be necessary to finding one’s way around and discovering what is going on at the other end of the neighbourhood. Similarly, Map’s support for the operation of the neighbourhood will require new summary analyses and intelligent alerts to permit efficiencies of scale.
Quayside will introduce the concept of a single-login portal to residents, administrators, and visitors. There will be cases where the portal will be critical to providing services in a secure, efficient way. But there will be new uses created by the developers working as part of the urban innovation institute that can’t be anticipated. This is where the power of a consistent identity system will begin to emerge—as developers start to take advantage of a preexisting identity and permissions framework that allows them to access resources and perform tasks on behalf of users, innovation will accelerate.	The Eastern Waterfront will be able to take advantage of novel uses developed in Quayside from day one. Developers will have the opportunity to build in many of the experiences and abilities enabled by the Account systems as Sidewalk and its partners design infrastructure and processes in the broader Eastern Waterfront.

Sustainability

Toronto is a global leader in urban sustainability, and its revitalized waterfront must reflect and advance its environmental ambitions. Sidewalk Labs envisions Quayside as the testing ground for breakthroughs in a broad set of sustainability-related innovations, including energy efficient buildings, electricity management, district heating and cooling, solid waste, and water.

Taken together, these will make Quayside the most greenhouse gas–efficient neighbourhood in North America. And they will set the stage for the Eastern Waterfront to become the first truly climate positive community on Earth.

Realizing the Vision for Climate Positive

An Ambitious but Achievable Approach

Waterfront Toronto's commitment to making the Eastern Waterfront climate positive establishes a high bar. While sustainability targets are easy to set, realizing ambitious goals requires careful planning, diligent execution, and above all a commitment to achieving and reporting progress.

Sidewalk has developed strategies to make Quayside itself nearly climate positive. We believe this is achievable through a set of enhancements to current technology: Passive House buildings with advanced building controls; a flexible thermal grid that draws on multiple sources of green thermal energy; an advanced microgrid both to generate onsite power and to manage power drawn from the grid; and an innovative approach to handling solid waste. In Quayside, many of these solutions will be at their early stages, making the neighbourhood a testing ground for urban innovation.

These innovations will bear fruit when applied at the scale of the Eastern Waterfront. Most importantly, the Eastern Waterfront's scale will allow us to tap three major sources of available thermal energy: the Portlands Energy Centre, the Ashbridges Wastewater Treatment Plant, and Lake Ontario itself. Any one of these would make the Eastern Waterfront Climate Positive; all three will make it a major supplier of clean thermal energy to the rest of downtown Toronto.

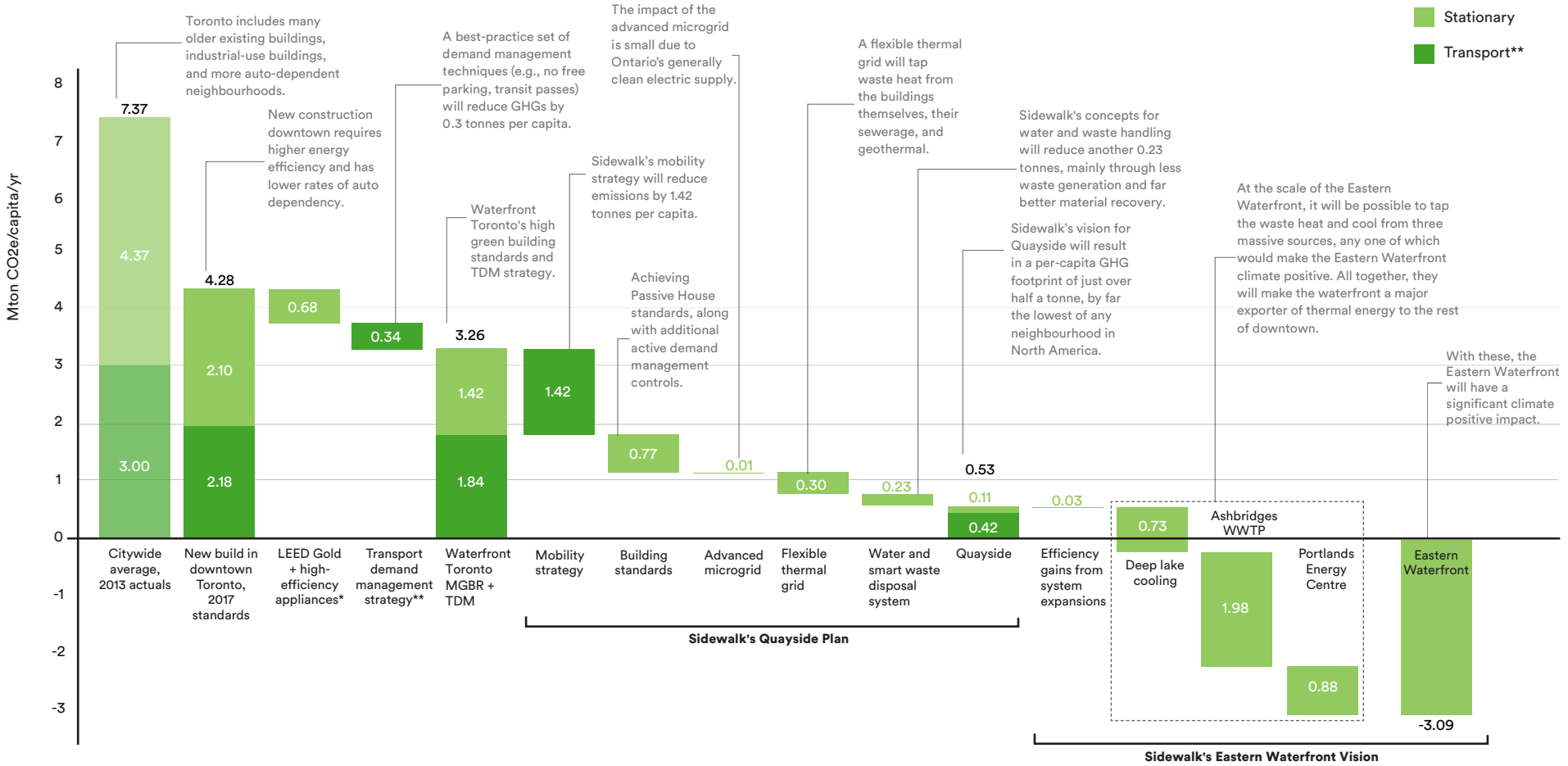
C40 CITIES

The sustainable design of the Lower Don Lands park reflects the commitment of Waterfront Toronto to realize its Climate Positive ambitions.

Credit: C40

A Roadmap to a Climate Positive Eastern Waterfront

Per capita annual GHG emissions, CO2e metric tons



* Mandated WT LEED Points. Renewable energy production, 5%, 2 points. Optimize energy performance, 50% cost savings relate to MNECB 1997. Peak heat 65% less, peak cool 30% less, relative to MNECB 1997.

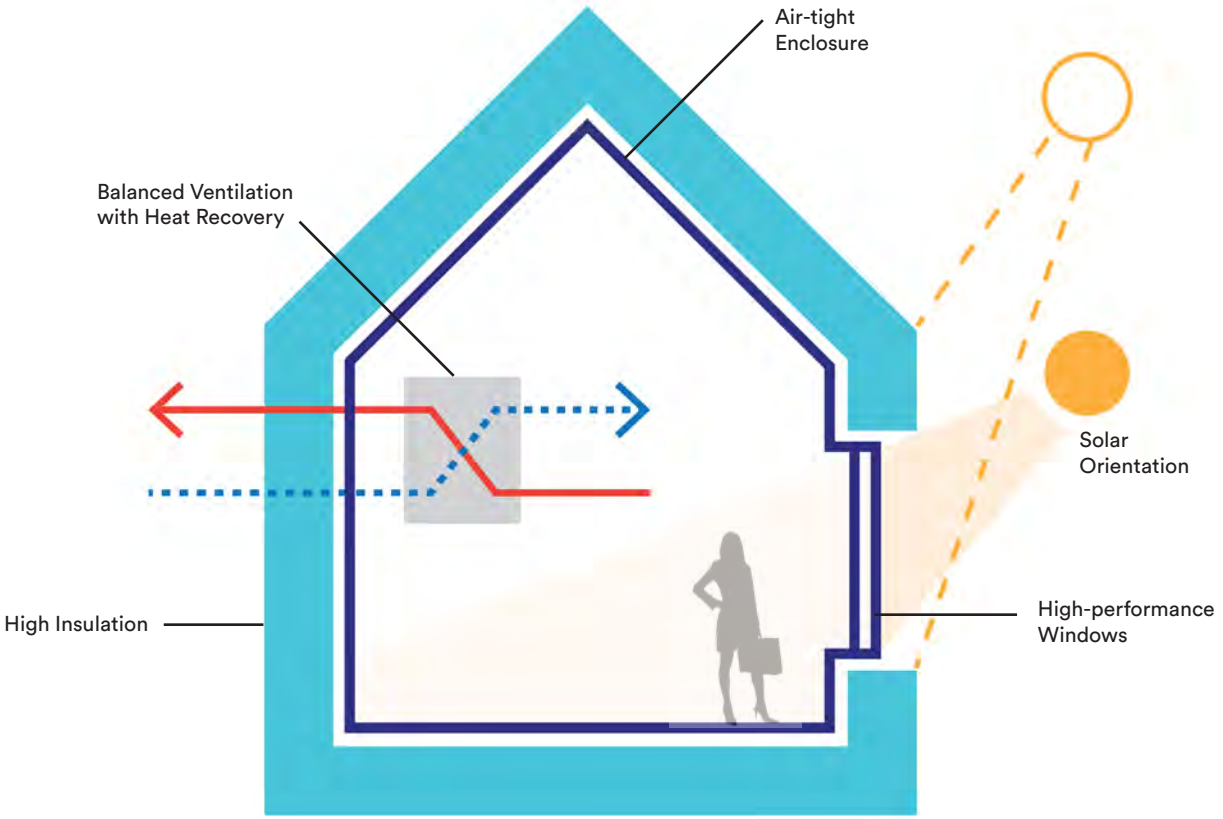
** Using residential allocation methods.

Reducing Energy Demand: Building Standards

CORE TO ANY URBAN sustainability strategy is having buildings that are highly efficient. Waterfront Toronto has set a high bar with its Minimum Green Building Requirements, but Sidewalk Labs believes that Quayside can be the largest cluster of large-scale Passive House buildings yet constructed in North America. Combined with advanced demand management, we believe we can reduce building-related energy consumption by 25 percent over the Waterfront Toronto MGBR at a reasonable cost.

Passive House

The Passive House standard has been much more common in Europe than in North America, although it has recently been applied to a limited number of large-scale buildings here. An older standard than LEED, Passive House is based on a design philosophy rather than a points system. The lessons of one such building, on Cornell University's new Roosevelt Island campus in New York City, inform Sidewalk's thinking here, both in terms of areas that will require innovation and in Sidewalk's confidence that the incremental cost of Passive House will decline significantly if it is deployed in several buildings at once.



A schematic showing key design features of the Passive House. Core to Passive House is the idea that design should take into account the natural flows of thermal energy, including managing direct solar energy as the seasons change, guiding warmer and cooler air to flow where it is needed rather than simply being vented, and using heat pumps rather than combustion.

LEED vs. Passive House

A key difference between the Passive House and LEED standards is that LEED uses a point system with some mandatory achievements, while Passive House has a limited set of specific energy performance targets and a design philosophy. Passive House energy targets are set based on climate zone; the figures shown here are appropriate for Toronto.

LEED Gold v4

- Points-based system
- Energy points are awarded from 1 to 10 points for energy cost savings of 10.5% to 42%
- Points for some design choices but all are optional
- Controllability of systems, lighting = 1 point
- Site development, protect or restore habitat = 1 point

Passive House

- Absolute energy targets, based on climate zone
- Heating load ≤ 10 W/m2, annual heating demand ≤ 15 kWh/m2, annual primary energy demand ≤ 120 kWh/m2, thermal bridging Psi ≤ 0.0, airtightness ≤ 0.60 ACH@50Pa
- Design philosophy to manage heat/cool/light passively
- Maximize solar gains for winter, minimize solar gains for summer
- Keep window sizes smaller to prevent leakage

At 26 stories, Cornell Tech's residential tower is the tallest Passive House building ever built. It is projected to achieve a 73% reduction in overall energy consumption compared to the median of comparable New York City buildings. Although Passive House added 5-10% to the cost of this building, key cost drivers were identified as sources of future innovation and savings, such as developing new techniques for testing how well the building is sealed. Credit: Cornell Tech

Active Demand Management

Active Demand Management

Active demand management systems use data to minimize demand. Data, especially predictive information, about the drivers of demand, enable significant tailoring of consumption; this includes pre-warming a building when a day is expected to be cold, or reducing air conditioning on a summer afternoon when calendars indicate that many employees are planning to leave early. Even more significant are smaller-scale interventions, such as room-specific thermostats that drive variable-speed fans to balance temperatures across rooms.

Alphabet's Nest thermostat represents an example of applying computer learning principles to the control of heating and cooling in single-family homes. In a multi-family or office setting, good controls will be applied to HVAC, lighting, computers, and other major sources. While the Passive House standard emphasizes the passive management of thermal energy, a Passive House building's insulation also makes it an excellent candidate for active energy management.

In some cases, active demand management goes well beyond the basic types of occupancy sensors and other systems that many LEED buildings have; it is possible, for example, to have conference room screens "sleep" when a central calendar does not show a meeting scheduled. In other cases, the thermal inertia that is designed into a Passive House building makes it an excellent candidate for highly intelligent building management, such as pre-heating and pre-cooling during off-peak hours based on temperature predictions for the subsequent day.

Overall, the potential for active energy savings in a Passive House structure actually exceed the savings over Waterfront Toronto's MGBR, and many of these active savings opportunities would not be available without the Passive House design.

Electricity Consumption of a Mid-sized Passive House Office Building and Impact of Active Controls

Electrical Load	% of Total	Impact	Control
HVAC	25%	High	Occupancy sensors, compensation with outdoors
Lighting (Overhead)	16%	High	Occupancy sensors plus natural lighting
Lighting (Task)	3%	Medium	Occupancy sensors
Kitchen Appliances	7.5%	High	Power up/down based on occupancy
Desktop Computers and Monitors	9.5%	High	Predict powering up/down based on occupancy patterns
Laptops	6.5%	Low	Designed for minimum drain
Printers/Copiers + Conference room screens	19%	High	Predict powering up/down based on occupancy patterns
Other	14.5%	n/a	Other features designed for minimum drain

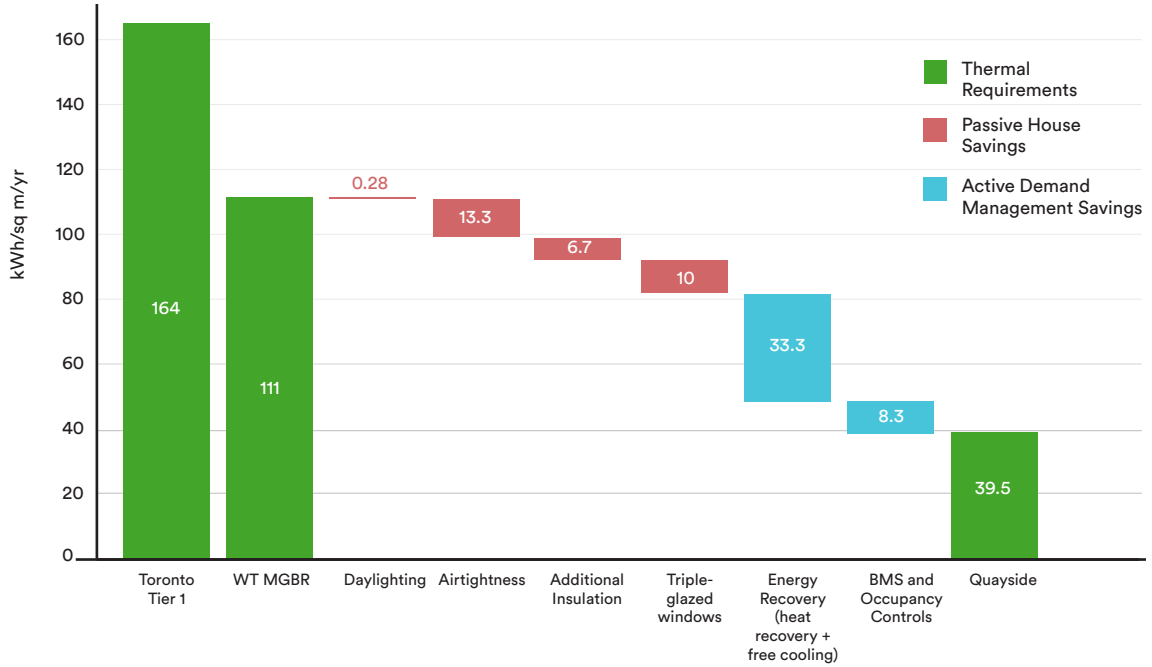
Thermal Savings

Given the variability of the climate, thermal energy is the largest aspect of energy demand for buildings in Toronto, and the focus of Passive House design thinking. Between Passive House design and active demand management, Sidewalk Labs expects to reduce thermal energy demand by more than 64 percent of the Waterfront Toronto MGBR. The largest single area of potential is in actively managing the thermal energy that Passive House design keeps within the building, an exciting potential synergy between these two approaches.

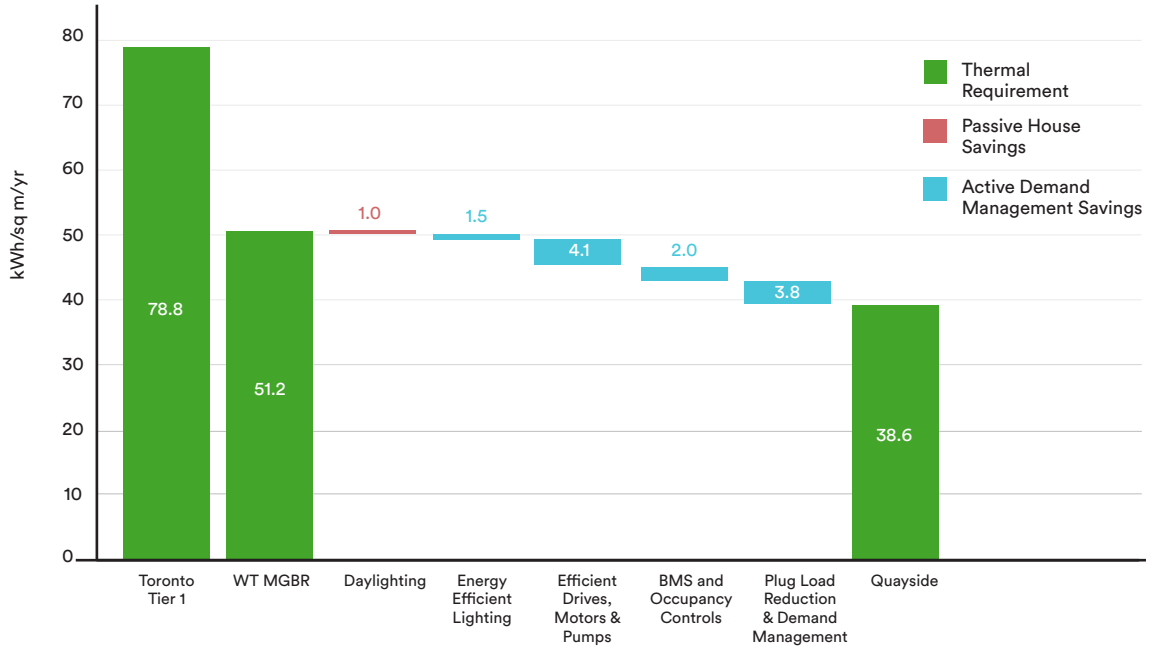
Electric Savings

Electric demand is only one-third of the overall demand of either a Tier 1 or an MGBR building. Although we expect another 25 percent reduction based mainly on active demand management, much of the remainder is the plug load, which is difficult to reduce further, as it comprises the computers, appliances, and other systems that serve the users of the buildings.

Passive House and Active Demand Management Thermal Savings (per sq m)



Passive House and Active Demand Management Electricity Savings (per sq m)

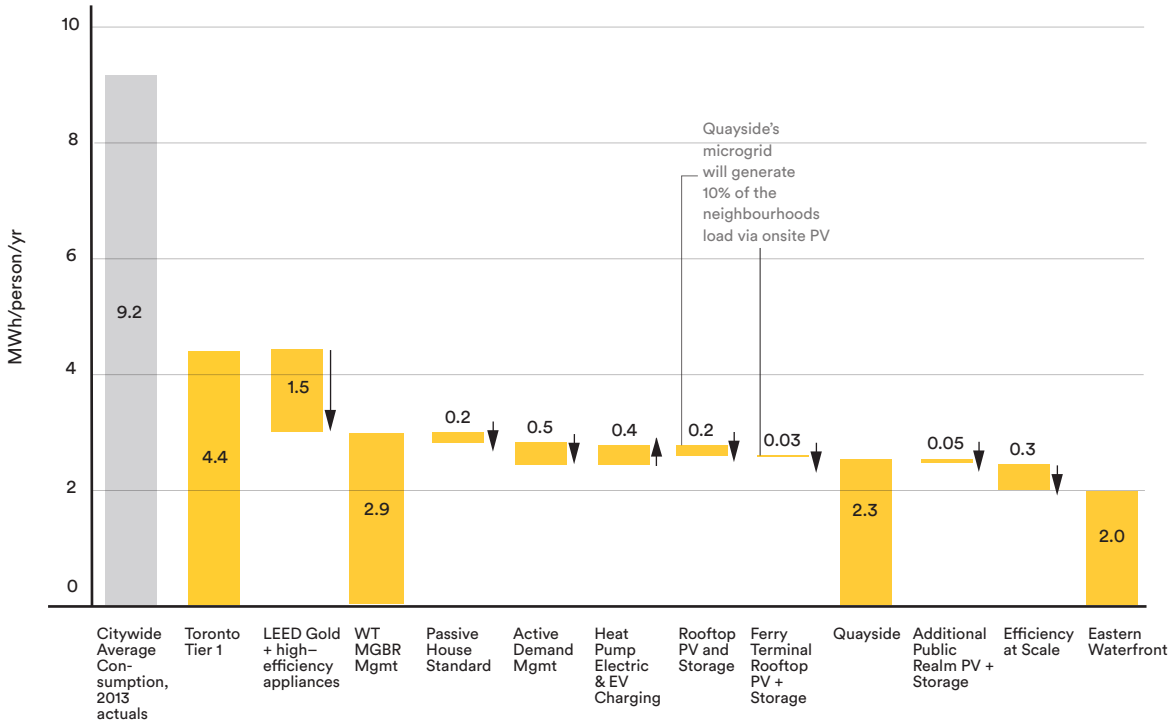


Providing Clean Energy: Advanced Microgrid

AS THE PRICE OF photovoltaics continues to decline, the key constraint on increasing onsite renewable generation in urban environments is less about cost and more about grid interactions. This is because it is still impossible to power multi-storey buildings entirely from onsite power generation, and that problem is not expected to be solved in the foreseeable future. To innovate around this challenge, Sidewalk envisions Quayside as a place where a combination of onsite generation, onsite storage, and inter-building trading creates a microgrid that maximizes onsite generation, minimizes the greenhouse gas footprint of imported electricity, and reduces the stress that large amounts of solar power may put on the surrounding electric grid.

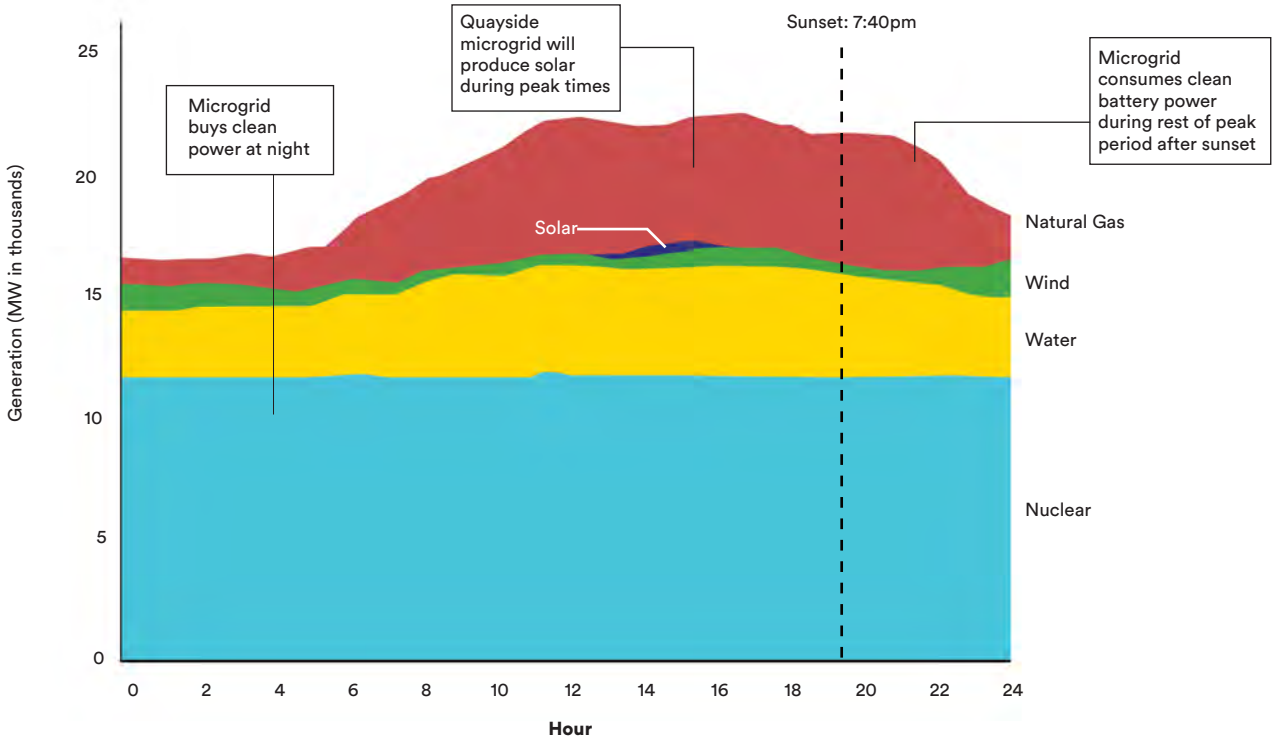
Waterfront Toronto has set an ambitious goal that onsite renewable power generation meet at least 10 percent of annual electricity demand. We believe this will be achievable with 50 percent of the roof space, so that the remainder can be used for green roofs. Depending on the site plan, and the evolution of technology, façade-integrated PV may also be feasible. However, given how clean Ontario's grid is during off-peak hours, adding battery storage and managing the system to optimize when it draws electricity from the grid is likely to be the most environmental and economic approach to providing clean electricity supply for Quayside and the Eastern Waterfront.

Per Capita Electricity Consumption from the Grid



Managing a Microgrid to Lower Emissions and Costs

The microgrid uses solar and battery storage to store, generate, and consume power when it is cheapest and cleanest.



This graph shows Ontario's electricity demand curve on September 7, 2016 using data sourced from the Ontario Ministry of Energy.

To manage the microgrid efficiently, a local independent system operator (ISO) will use cutting-edge software and smart metering technology installed throughout Quayside to balance electricity supply and demand seamlessly between buildings and manage trading with the wholesale market. The local ISO will maximize Quayside's economic and carbon efficiency, as well as ensure that its onsite generation does not cause any disruption to Toronto Hydro's grid stability.

The ISO will dispatch clean power stored in the microgrid's batteries to avoid peak costs and lower Quayside's emissions factor. In the summer, the ISO will buy power at night from the grid when it is relatively cheap and clean, and store it in batteries to be consumed during the hours of peak demand when electricity from the grid is dirtiest and most expensive. When the sun begins to set and demand from the grid steeply increases, referred to as the "duck curve," the ISO will smooth out the curve by gradually dispatching excess stored solar energy as the sun goes down. Finally, when the power goes out, the ISO will disengage from the grid and distribute Quayside's onsite generation where it is needed most.

Flexible Thermal Grid

AS HOME TO ENWAVE'S DEEP LAKE COOLING system, Toronto is already a user of one of the most innovative district energy systems in North America, and both the city and Waterfront Toronto have strongly endorsed expanding district heating and cooling as a sustainable approach to providing the thermal energy that Toronto's climate demands. Most district energy systems focus on capturing thermal energy from one reliable source of heat or cool; to the extent that source is variable, they usually rely on mechanical chillers or boilers to compensate for the times when it is unavailable. This makes all district energy systems somewhat reliant on fossil fuels, and also prevents such systems from tapping large but highly variable sources of energy.

As Waterfront Toronto's innovation partner, Sidewalk will organize the development of a truly flexible "thermal grid." The thermal grid will capture heat and cool from multiple sources, balance it in a thermal energy centre, and distribute it to buildings via hot and cold water pipes, just as the energy grid taps multiple sources of electricity generation and manages the electric grid to match demand. But since its main components are a hot-water tank and a cold-water tank, a thermal energy centre will not be a dangerous or noxious land use, making it far easier to site than most electrical facilities.

In Quayside, the system will draw on ground-source heat and cold pumps, sewage generated by the neighbourhood itself, and the anaerobic digester envisioned as part of the neighbourhood's waste system. The system will also include a return loop, which will effectively capture waste heat and cool from the participating buildings themselves.

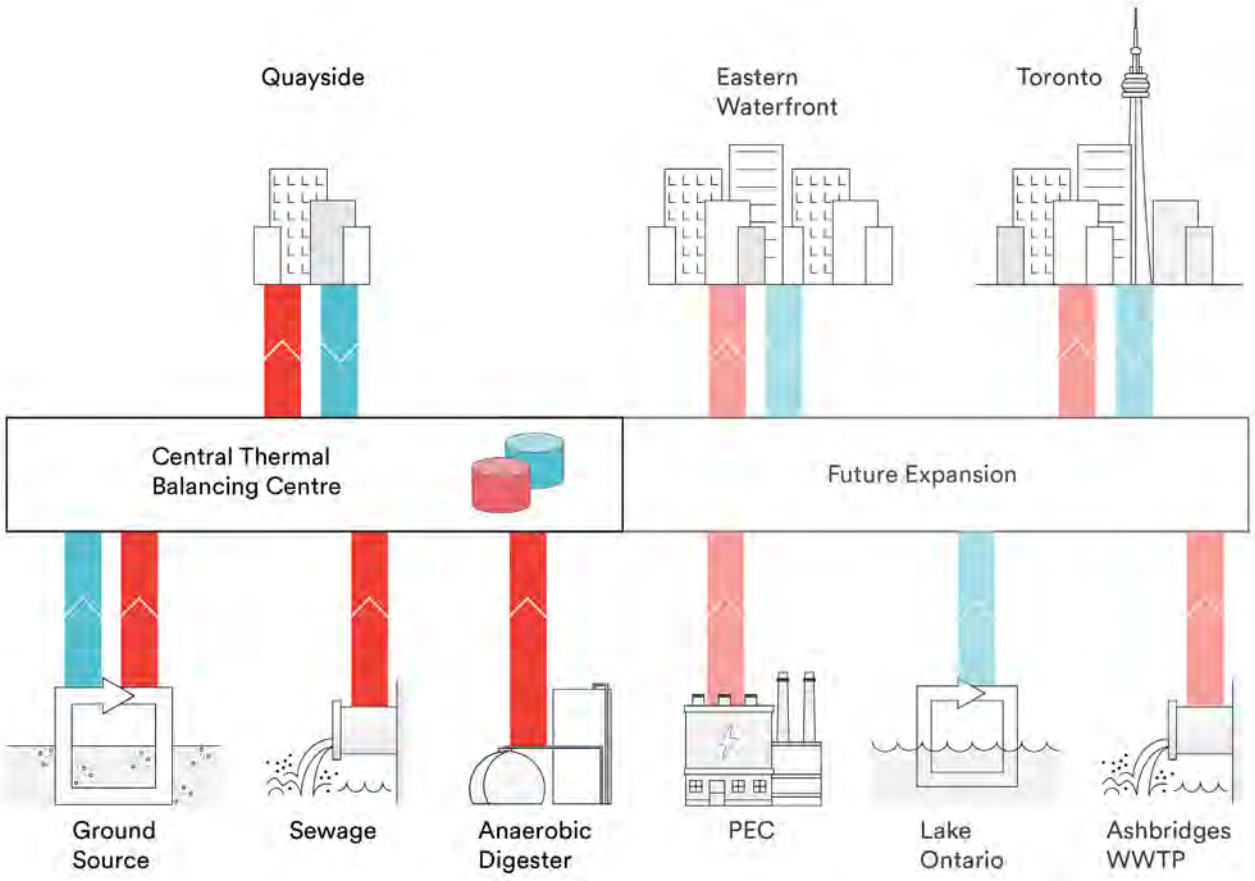
The tremendous advantage of a flexible thermal grid will be realized most fully at the Eastern Waterfront scale. Two massive sources of waste heat exist in and near the waterfront: the Portlands Energy Centre power plant (PEC) and the Ashbridges Wastewater Treatment Plant (WWTP). Traditional district energy systems would have difficulty using these sources, because their output is highly variable. As a peaker plant, the PEC only operates about a quarter of the time; the sewage flowing into the Ashbridges treatment plant is generally warm but its temperature varies during rainfall and snowmelt due to Toronto's combined sewer system. Thanks to the grid-management impact of the proposed central thermal-balancing centres, and the reliable heat thrown off by the neighbourhood's own sewage and ground-source heat pumps, the heat from these two facilities can be captured, saving tremendous amounts of fossil fuel consumption.

The Eastern Waterfront also provides the scale necessary to finance the construction of a new Deep Lake Cooling system. Although such a system does not require a flexible thermal grid, thanks to the lake's layer of reliably cold water, the capital investment necessary will require a committed user base much larger than Quayside.

Any one of these three sources would generate far more thermal energy than the Eastern Waterfront actually needs, and thus could be exported to the rest of Toronto. If all three sources were tapped as part of the Eastern Waterfront, it would have the potential to cover a large portion of downtown Toronto's thermal energy needs.

Multiple Sources of Reusable Thermal Energy

Several sources of thermal energy are available at both Quayside and Eastern Waterfront. However, the scale of the Eastern Waterfront allows us to tap the tremendous potential of three sources: the PEC, Lake Ontario, and Ashbridges Wastewater Treatment Plant.



	Ground Source	Sewage	Anaerobic Digester	PEC	Lake Ontario	Ashbridges WWTP
Quayside Technical Potential (MWh)	10,792	1,854	1,784	n/a	n/a	n/a
Eastern Waterfront Technical Potential (MWh)	119,814	56,203	20,745	400,000	1,250,790*	900,000

*Assumes a new facility sized similarly to the current Enwave Deep Lake system.

Managing Solid Waste Wisely: Smart Disposal Chain

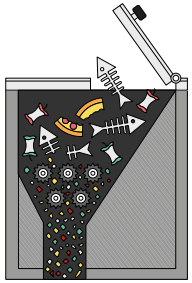
Waste Strategy

Toronto's 2016 solid waste management plan set a citywide waste reduction target of 70 percent diversion of recyclables and organics by 2026, and Waterfront Toronto is set to meet that goal in future developments. Sidewalk proposes managing waste to meet the target with four main strategies that will exceed Waterfront Toronto's standards. First, organic waste macerators will be incorporated into every kitchen, creating a direct and easy way to separate out organics; this will feed into the waste system rather than the sewer system (which is prohibited in Toronto). Second, pay-as-you-throw (PAYT) incentive structures will be implemented in multi-family residences, incentivizing lower waste-generation rates and enabling three-bin separation where traditionally diversion rates have been low. Third, trash will be transported below ground in dedicated utility channels, reducing the traffic impact of collection and lowering associated emissions. Lastly, local recovery and processing of organic waste will be provided, enabling the collection of the methane from the digestion process to generate heat for the thermal grid. Overall, Sidewalk expects a reduction of landfill waste of more than 90 percent, with much of that coming from waste reduction and anaerobic digestion, two of the most environmentally beneficial approaches to waste reduction.

	Current Toronto Diversion Rate	Sidewalk Projected Diversion Rate
Single Family	66%	n/a
Multi-Family	26%	90% at minimum
Industrial, Commercial, Institutional	13-18%	90% at minimum

Solid Waste System

The solid waste system Sidewalk imagines has four components: (1) organics disposal units, conveniently located in every kitchen and office; (2) chutes for inorganics that scan and charge for what is disposed; (3) a waste haulage system that relies on autonomous vehicle technology; and (4) recovery centres to aggregate and process waste.

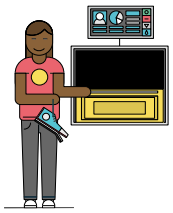


① **Organic-waste macerator**

Every commercial and residential kitchen will have macerators that grind, dilute, and pipe organic waste to a waste container in the basement utility channels.

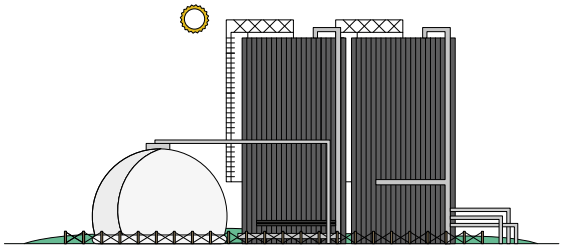
② **Smart chute**

The smart chute uses digital technology to implement PAYT in multifamily buildings, leveraging research that shows that accountability and payments drive down waste generation and increases recycling. A next-gen version will verify and sort disposals by recycling category.



③ **Autonomous waste transport**

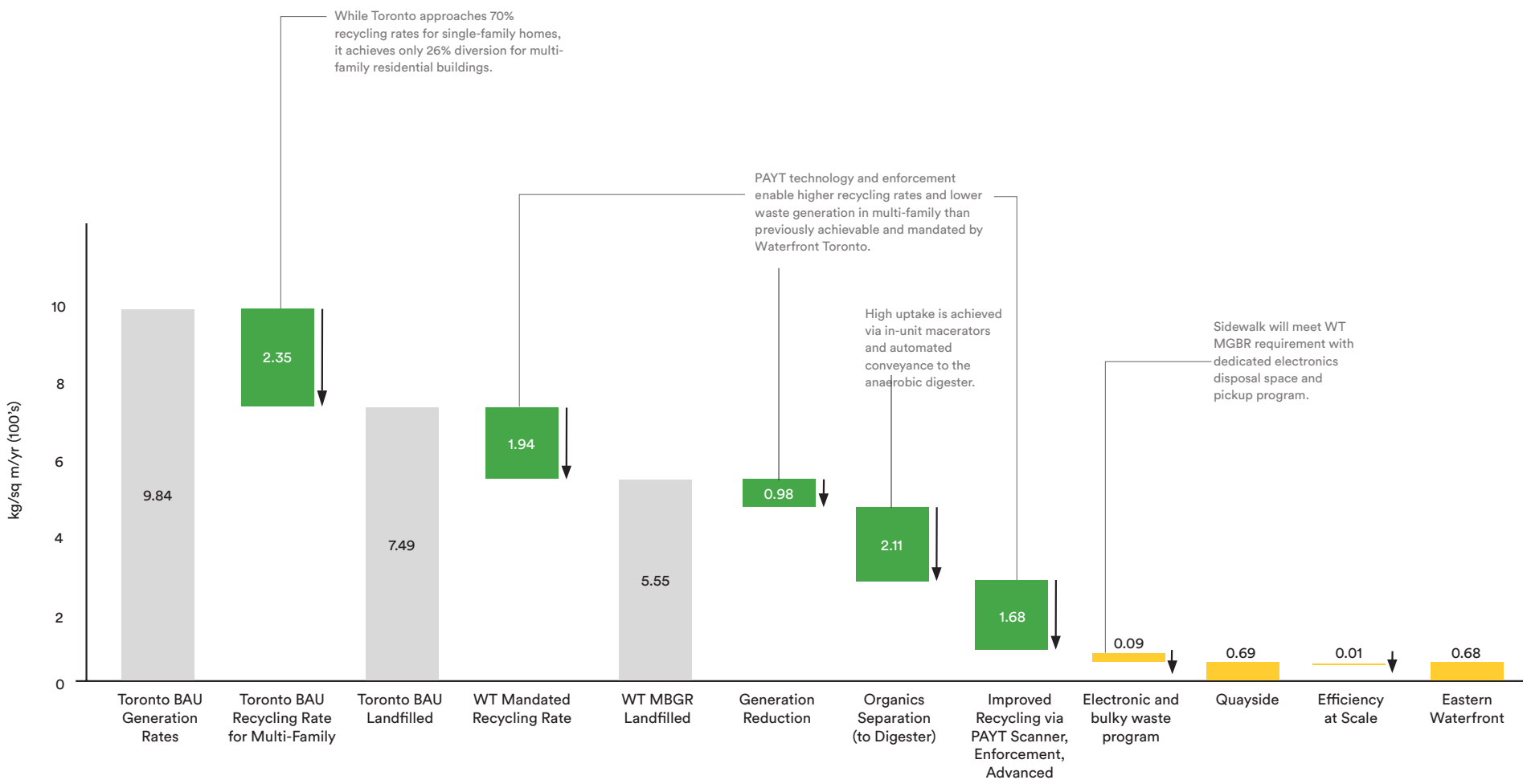
Industrial autonomous pallets will facilitate solid waste removal within utility channels that connect every basement to central facilities.



④ **Recovery Centres**

In Quayside, an anaerobic digester will accept containerized organic waste and process it onsite. At the scale of the waterfront, an onsite materials recovery facility is feasible.

Annual Waste Diversion to Landfill



Roadmap

Product Development Strategy:

Building Standards	Sidewalk will leverage expertise in developing large-scale North American Passive House projects to pilot an innovation agenda for buildings likely to include new approaches to testing seals and managing thermal exchanges between rooms and across multiple floors. Sidewalk will also work with Passive House Canada to explore standards appropriate to the innovative building designs that Sidewalk envisions (e.g., modular construction).
Active Demand Management	Sidewalk will initiate the development of building control products for the multi-family market, including exploring potential partnerships with Nest and similar companies.
Advanced Microgrid	Sidewalk will identify a proposed microgrid project, likely in Ontario or New York State, to use as a test bed for software developed to optimize the internal trading of electricity across the grid and utilization of onsite storage to optimize power drawn from the grid.
Thermal Grid	Sidewalk will partner with an established district energy firm to co-develop a flexible thermal grid. This will likely involve developing or optimizing existing software to accommodate the smooth integration of multiple intermittent thermal loads as well as reimagining the design of the thermal energy centre.

Quayside Pilot:	Eastern Waterfront Manifestation:
Sidewalk will seek to use Passive House, or an equivalent standard, as its basis for buildings constructed within Quayside. In cases of non-traditional construction techniques, Sidewalk will work with Passive House Canada to develop viable alternatives if and when existing Passive House standards prove not to be viable for those types of innovative construction.	Based on the learnings from Quayside, Sidewalk will refine the building standards. The objective of Passive House on the Eastern Waterfront will be reach Passive House standards at less than a 1 percent cost premium to traditional construction.
Sidewalk will implement demand management systems and mandate standards for active demand management, which will incorporate into all buildings a data-reporting system compliant with Waterfront Toronto's requirements.	Sidewalk will refine and expand on active demand management systems developed for Quayside to improve performance and standards across buildings in the Eastern Waterfront.
Sidewalk will implement an advanced microgrid within Quayside, including the requisite software to manage the exchange and storage of electricity on the microgrid and optimize the electricity purchased from the main power grid.	The Eastern Waterfront will include a large microgrid using technology evolved from the Quayside microgrid. Quayside will be integrated into this new, larger microgrid.
Sidewalk will implement a flexible thermal grid, including at least one neighbourhood-scale thermal energy centre. The system will draw from local sewers, ground-source heat pumps, an onsite anaerobic digester, and waste heat/cool flows from the buildings themselves.	Sidewalk and its thermal energy partners will construct a new deep lake cooling centre and will undertake a project to capture waste heat from the Portland Energy Centre and the Ashbridges treatment plant. Critical to the financial success of these ventures will be the extension and integration of the thermal grid into adjacent parts of Toronto so that excess thermal energy can be economically delivered beyond the Eastern Waterfront.

Roadmap

Product Development Strategy:

Smart Disposal Chain	Sidewalk will implement the smart disposal system in Quayside, including macerators in kitchens, smart chutes with PAYT capability for inorganic waste, a robot-powered waste movement system, and an onsite anaerobic digester at either the neighbourhood or the building scale.
Utility Channels	Sidewalk will develop the ideal design for the utility channels, including pathways for robot delivery and waste haulage.

Quayside Pilot:

Sidewalk will develop phase one of the "smart chute" as an internal product development effort. It will partner with existing industrial robotics firms to assess the requirements for a waste transport system, and will likely develop the standard container appropriate to building-generated waste (both organic and solid) internally. It will develop a partnership with a proven neighbourhood-scale anaerobic digester producer.

Sidewalk will implement utility channels throughout Quayside. Channel design will be tested across a variety of criteria to further optimize the design and concept.

Eastern Waterfront Manifestation:

Sidewalk will expand the smart disposal system across the Eastern Waterfront. Smart chutes will identify types of waste and sort recyclables at the point-of-throw. Due to the scale of the Eastern Waterfront, an advanced materials recovery facility will operate on the Eastern Waterfront, separating waste and shipping separated reusable materials to users.

Utility channels based on the Quayside design and updated to include learnings from Quayside will be deployed across the Eastern Waterfront.

Assumptions and Figures Used to Estimate GHG Emissions

Overall Assumptions:

Energy, water, and waste values are calculated by multiplying an assumed building gross floor area for each land-use type by the generation value (e.g., Energy Use Intensity, Waste Generation Intensity) for that land use. Carbon emissions are calculated based on the total energy (electricity and thermal), water, and waste consumption, multiplied by the respective carbon coefficient. Data based on a conjectural full-build Quayside population of 7,482.

Category	Sources and Assumptions	Values
Citywide Average		
Buildings (and Waste) GHGs	Toronto's 2013 Greenhouse Gas Inventory	GHGs: 12,205,605 mtons Population: 8,383,396
Transport GHGs	Toronto's 2013 Greenhouse Gas Inventory	GHGs: 8,383,396 mtons Population: 8,383,396
New Build in Downtown Toronto		
Buildings Area	Sidewalk's Program (sample)	Quayside: Total: 468,637 sq m (76% residential, 18% commercial/office, and 6% retail)
Building Energy Use	The EUIs for Toronto Green Standard Tier 1 (2015)—a 15% improvement over 2012 Ontario Building Code	Residential: electric (83 kWh/m2/yr), thermal (177 kWh/m2/yr) Commercial: electric (66 kWh/m2/yr), thermal (124 kWh/m2/yr) Retail: electric (36 kWh/m2/yr), thermal (115 kWh/m2/yr) Social: electric (95 kWh/m2/yr), thermal (122 kWh/m2/yr)
Water	City of Toronto Water Efficiency Plan (use and residential composition); Ontario sewer codes (use for non-residential) Non-residential composition values derived from AWWARF	Residential: 221 LPPD Commercial: 4 L/m2/day Retail: 5 L/m2/day
Water-Related Energy Use	Energy for water treatment and wastewater treatment (Water Use Model for Quantifying Environmental and Economic Sustainability Indicators. Journal of Water Resources Planning and Management)	Water: 700 kWh/ML Wastewater: 820 kWh/ML

Category	Sources and Assumptions	Values
New Build in Downtown Toronto (continued)		
Waste	City of Toronto residential generation values and diversion rates (Final Long Term Waste Management Strategy) Non-residential generation and composition derived from CalRecycle	Residential: 1.12 kg/hh/day (assumption of 71.1 sq m per hh) Residential (multi-family) diversion: 26% Commercial: 0.0267 kg/m2/day Retail: 0.026 kg/m2/day Institutionial, Commercial, Industrial diversion rate: 18%
Transport	Sidewalk's analysis for trips	13 km vehicle/trip
	Trip distance	6.5 km public transit/trip
	Mode split	Car driver (33%), Car Passenger (8%), Public Transport (34%), Active Transport (20%), Other (5%)
	Residential trips	Trips by residents: 17,771/day
	Total trips	Total trips: 45,974/day

Assumptions and Figures Used to Estimate GHG Emissions

Category	Sources and Assumptions	Values
New Build in Downtown Toronto (continued)		
Carbon Dioxide Equivalents	Emission Factor for electricity - Environment Canada. National Inventory Report: Greenhouse gas sources and sinks in Canada. Environment Canada and Natural Resources Canada. "Determination of the Impact of Waste Management Activities on Greenhouse Gas Emissions: 2005 Update Final Report, Contract No. K2216-04-0006". Waste GHG Calculator Emission Factors. October 2009 Passenger vehicle emissions (source: EPA) Transit (kWh/km for San Francisco streetcar using TTC Flexity streetcar weight difference. TTC car is ~8x heavier)	Electricity: 50.1 g/kWh Thermal (gas): 189 g/kWh Waste Landfill: paper (0.240 mton CO2eq/mtonnes waste), food (0.830 mton CO2eq/mton waste) Waste AD: food (-0.23 mton CO2eq/mtonnes waste), yard: (-0.26 mton CO2eq/mton waste) Passenger vehicle emissions: 417 g CO2e/mile, 21.6 mpg Transit: TTC Flexity streetcar 67.597 kWh/km, 50.1 gCOe2/KWh (electricity grid power), 3,386.60 g CO2e/km, capacity of streetcar 251 people
LEED Gold+High Efficiency Appliances		
Buildings Energy	Strawman assumption: 38,778 m2 of rooftop available Reductions are based on best practice based and previous WT MGBR	50% of roof cover solar photovoltaic 35% reduction from Toronto Green Standard Tier 1
Water	Strawman assumption: 38,778 m2 of rooftop available Precipitation: Canadian Climate Normals. Environment Canada (95% rooftop runoff coefficient) Reduction values were based on water fixture calculations and best practice. Rainwater harvesting values based on precipitation, roof area, and runoff coefficients.	33% reduction from low-flow fixtures and efficient appliances, 10% rainwater harvesting from the roof, and no potable water for irrigation. Precipitation: 842.3 mm/yr

Category	Sources and Assumptions	Values
LEED Gold+High Efficiency Appliances (continued)		
Waste	5% reduction due to waste generation reduction, 41% of recyclables and organics, and 50% of additional electronic and bulky waste diverted	5% reduction due to waste generation reduction, 41% of recyclables and organics and 50% of additional electronic and bulky waste diverted
Carbon Dioxide Equivalents	Emission Factor for electricity - Environment Canada. National Inventory Report: Greenhouse gas sources and sinks in Canada. Environment Canada and Natural Resources Canada. “Determination of the Impact of Waste Management Activities on Greenhouse Gas Emissions: 2005 Update Final Report, Contract No. K2216-04-0006”. Waste GHG Calculator Emission Factors. October 2009	Electricity: 50.1 g/kWh Thermal (gas): 189 g/kWh Waste Landfill: paper (0.240 mton CO2eq/mton waste), food (0.830 mton CO2eq/mton waste) Waste AD: food (-0.23 mton CO2eq/mton waste), yard (-0.26 mton CO2eq/mton waste)
Transport Demand Management (TDM) Strategy - Transit Passes, Car Share, Bike Share, Limited Bike/Pedestrian Improvements		
Transport	Sidewalk's analysis Mode split	TDM Car Driver (28%), Car Passenger (6%), Public Transport (33%), Active Transport (29%), Other (4%)
	Residential trips	Residential trips: 17,771 per day
	Total trips	Total trips: 44,932

Assumptions and Figures Used to Estimate GHG Emissions

Category	Sources and Assumptions	Values
Sidewalk's Mobility Strategy: Transit Extensions, Shared Ride And Mobility-As-A-Service, Parking Management, Pedestrian Links Across The Gardiner Expressway, Assumes 60% Of Auto Trips Are Car-Share Evs, Remainder Consistent With 20% Car Ownership		
Transport	Sidewalk's analysis Change in mode split	Mobility Car Driver (17%), Car Passenger (5%), Public Transport (34%), Active Transport (31%), Other (13%)
	Change in total trips	Trips: 44,932
	Transition of all residential trips to electric vehicles (no additional carbon hit)	Residential trips: 2,636
Sidewalk's Building Standards		
Building Energy Use	Passive House standards were assumed for all buildings. A parametric analysis process was built to calculate heating and cooling energy demand in Quayside. The modelling allows the potential for energy sharing to be evaluated over the course of a typical year. In this setup, a proportion of heating demand will be met using heat recovery chillers and a proportion of the cooling demand could be met using free cooling at a given point in time. Conditioning demand was modelled based upon zonal gains simulated using IES energy modelling software. An Excel model was built to calculate the variation in heating and cooling demand. The use of a parametric Excel-based approach builds upon the reliable energy calculations performed in IES. The model assumed Model National Energy Code of Canada for Buildings (MNECB) +25% as the baseline. Best–practice assumptions were assumed for plug loads and lighting reductions.	**Electric:** daylighting (2% reduction from Waterfront Toronto MGBR), energy efficient lighting (3% reduction from WT MGBR), variable–frequency drives and efficient motors/pumps (8% reduction from WT MGBR), BMS and occupancy controls (4% reduction from WT MGBR), plug load reduction and demand management (8% reduction from WT MGBR) **Thermal:** daylighting (0.25% reduction from WT MGBR), airtightness (12% reduction from WT MGBR), additional insulation (6% reduction from WT MGBR), triple-glazed windows (9% reduction from WT MGBR), energy recovery (30% reduction from WT MGBR), BMS and occupancy controls (7.5% reduction from WT MGBR)

Category	Sources and Assumptions	Values
Sidewalk's Advanced Microgrid		
Electric Energy	PV array: Assumes 17% efficient panel	19,389 m2 of roof area (50% roof area) and an assumed 1,550 sq ft ferry–terminal canopy (or canopy on waterfront facility in the public realm) area available at 180 kWh/m2 of roof area
Sidewalk's Flexible Thermal Grid		
Thermal Energy	Sewage Heat: (from various sources including SHARC, ThermWin, TubeWin, Rabtherm, PKS-Thermpipe, etc. manufacturer data) Geothermal: Engineering assumptions BH (field tests required to verify) Radiant Snowmelt System: Engineering assumptions BuroHappold Anaerobic Digester: Engineering assumptions BuroHappold	Sewage Heat (from SHARC manufacturer data): small system (0.96 kW(heat)/gpm at 220 gpm with COP of 5) Geothermal: energy pile systems (20W/ft at 100 ft per borehole, COP of 4, boreholes in Quayside (924) Radiant Snowmelt System: (0.51 BTU/lb @1°F (to 32°F), 144 BTU/lb @1oF (after 32°F), 0.625 lb/inch of snow)
	Electricity of heat pumps and pumps subtracted as penalty (different heat pump COPs used)	Anaerobic Digester: 100 m3 of biogas generated per tonne of food waste

Assumptions and Figures Used to Estimate GHG Emissions

Category	Sources and Assumptions	Values
Sidewalk's Water and Smart Waste Disposal System		
Water	Strawman assumption: 38,778 m2 of rooftop available, 18,725 m2 of hardscape Precipitation: Canadian Climate Normals. Environment Canada (95% rooftop runoff coefficient) Reduction values were based on water fixture calculations and best practice. Rainwater harvesting values based on precipitation, roof area and runoff coefficients. Blackwater recycling (Eastern Waterfront) based on wastewater generated and potentially available after treatment at Ashbridges (additional non-potable water is available from city sources)	40% reduction from low–flow fixtures and efficient appliances 100% leak reduction 95% rainwater harvesting for reuse and no potable water for irrigation 100% blackwater recycling in Eastern Waterfront
Waste	Generation reduction based on best–practice waste programs and source reduction programs Organic waste removed from waste stream via macerator Recyclables removed from the waste stream via separation due to PAYT (real-time charge and enforcement maximizes separation of recyclables for Quayside; future optical scanner ensure a minimum 90% separation) Electronic, hazardous, and bulky waste room in buildings to remove these from the waste stream	15% reduction due to waste generation reduction 92% of recyclables and organics diverted 90% of additional electronic and bulky waste diverted

Category	Sources and Assumptions	Values
Efficiency gains from scale		
Buildings Area	Based on the assumed diversity of mix of Eastern Waterfront compared to Quayside (i.e., increased mix of uses)	Total (Eastern Waterfront): 7,803,933 sqm (46% residential, 25% commercial/office, 13% retail, and 15% social/institutional)
Deep Lake Cooling		
Thermal Energy	Lake Source Cooling: Enwave data (assumptions based on total tons of refrigeration per gpm potable)	Lake Source Cooling: 1.98 kW(cool)/gpm at 72,000 gpm (assumes 40,600 tons refrigeration)
Ashbridges WWTP		
Thermal Energy	Sewage Heat: from various sources including SHARC, ThermWin, TubeWin, Rabtherm, PKS-Thermpipe, etc. manufacturer data and daily treatment as Asbridges WWTP	Sewage Heat 1.93 kW(heat)/gpm (Ashbridges assumed 50% of the year in use due to combined sewer), 106,804 gpm of wastewater, COP of 5
Portlands Energy Centre		
Thermal Energy	Portlands Energy Centre: Information about size of system from Environment Assessment and annual reports	Portlands Energy Centre: Assumes 200MW of heat available (max) for 25% to 35% of the year

Buildings and Affordability

Sidewalk's vision of a complete community starts with a place that reflects and amplifies the social, cultural, and economic diversity of the Greater Toronto Area. It means a place that is inclusive, one that builds on Toronto's greatest strength—its diversity—and welcomes all comers to contribute to the fabric of urban life. It means a place that is flexible, one in which buildings and spaces can change to address the evolving needs of the populations they serve. It means a place that is accessible in every dimension: welcoming, pedestrian-friendly, participatory, and adaptable.

Most importantly, it means a place that is affordable.

Building Complete Communities

THE UNPRECEDENTED PRICING PRESSURE in the Toronto housing market has been well-documented. Unmet housing demand has generated rapid increases in rents and sale prices, persistently low vacancy rates, and severe limitations on homeownership and access to quality housing. The average home price in the GTA has climbed by roughly 33 percent over the past 12 months and now exceeds 900,000 CAD, while median family income has only shown annual growth of 3 percent in recent years. The numbers from the rental market tell a similar story, with condo-rentals climbing 12 percent over the course of 2016 and vacancy rates less than half of both New York City and Montreal.

If Toronto is to remain a city that is affordable for the diverse population from which it draws its strength, it needs a multipronged approach to a historically complex and notoriously difficult problem: the built environment is traditionally created in a moment in time and governed by static code. Developers fail to leverage the construction efficiencies provided by mass production. Zoning separates homes from offices and retail outlets when most people need all three on a given day. And master-planned communities often fall short of aspirations—locked into fixed typologies and conceived to address needs that are already out-of-date by the time construction is complete. This rigid system creates underutilized space, suppresses supply, and ultimately creates pricing pressures that undermine affordability.

Sidewalk's vision for a complete community will address how buildings are constructed, how they are governed by code and zoning, and how they adapt to the differing and ever-evolving needs of end users, touching both the supply and demand sides of the housing equation. Sidewalk's vision will allow buildings to be constructed more easily and less expensively—creating more efficient layouts that require less space per person and more adaptable spaces that better serve the demands of a changing population. In this way, the physical environment of Quayside and the Eastern Waterfront will be embedded with the same design principles as the digital environment: flexible and highly responsive to end-user needs.

Given the diversity of housing needs in the GTA, Sidewalk will also prioritize optionality in housing typologies, accommodating a wide variety of personal preferences and budgets. As Sidewalk iterates on this strategy in Quayside and throughout the Eastern Waterfront, it will strive not only to meet the demands of residents today, but to better position the city to meet the evolving demands of its residents in the future. Sidewalk's vision aims not only to reach the affordability goals laid forth in the city's Housing Opportunities Toronto Action Plan, but to exceed them.

In close collaboration with Waterfront Toronto, all three levels of government, and the community at large, Sidewalk will deploy new occupancy models, new modes of home ownership, and new innovative financing structures to transform the ways in which communities are organized and funded, and the ways they evolve. By anticipating and addressing the needs of its residents, new neighbourhoods on the waterfront will keep affordability at the forefront, improve the urban experience, and provide a scalable blueprint for delivering dynamic, socio-economically diverse, multigenerational communities across Canada and abroad.

Allocating 20 to 30 percent of housing units as affordable will be just one component of this holistic strategy. As the first place Sidewalk will prototype solutions across the five concepts discussed in this chapter, Quayside will be the testbed for an entirely new urban experience on the Eastern Waterfront.

Downtown's high-rise condominiums embody Toronto's rapid growth and demand for a new housing supply.

Credit: Mark Wickens

Construction Methodologies

SIDEWALK THINKS HOUSES can and should be built like cars are built, through a vertically integrated process spanning the full product lifecycle from design to delivery. While this concept is not new, existing efforts have been unable to fully reap its benefits. A lack of vertical integration has limited manufacturing standardization and efficiencies. In many cases, buildings are designed before the decision is made to "go modular," leaving modular factories looking more like indoor construction sites than advanced manufacturing lines. Similarly, a lack of focus on upfront design considerations that would allow multiple aesthetic and functional configurations of a single chassis has led to the negative associations many consumers have with modular and low-quality, monotonous housing.

In Quayside, Sidewalk will employ new construction methodologies that have the potential to significantly decrease construction costs and lessen the design constraints of modular housing. This would create increased access to affordable housing by dramatically reducing the cost of adding supply. To achieve this vision, Sidewalk proposes a multifaceted approach using prefabrication and new material innovations—in particular, tall timber construction—to create solutions that will be replicated, improved upon, and brought to scale on the Eastern Waterfront.

Modular Construction

Sidewalk will not be the first company to deliver modular construction, but its holistic, integrated approach to prefabrication will help it achieve the combination of cost savings and product improvements at scale that have so far eluded previous modular developers. Sidewalk's vision includes more than just volumetric construction modules—the six-sided boxes completed primarily off-site, shipped to a site, and installed by crane. Instead, Sidewalk will incorporate both linear (one-dimensional components) and planar (two-dimensional, panelized components, used as part of a standard construction approach, such as SIPS, CLT panels or curtain walls) systems in addition to volumetric systems. This comprehensive approach will enable the creation of an entire parts library with standardized connections and interoperability that will supply every major assembly in a variety of building typologies.

By combining this versatile product library with advanced manufacturing techniques, such as repeatable assemblies, robotic construction, on- and off-site automation, and 3D printing, Sidewalk will be able to achieve new production efficiencies in design, labor, and material use.

The integration of these systems will change the way structures are designed and built. Designing appealing spaces for residents and tenants will no longer require the expensive customization that defines stick-built construction. Mass production will facilitate scale efficiencies in layouts and design that will enable residents to live more comfortably in less space.

Together these innovations will capture an enormous opportunity to drive down the cost and time required for new construction at scale. In fact, Sidewalk estimates that modular systems can cut the assembly time in home production to one-third of conventional construction, saving both time and money. In addition to reducing the initial capital costs of construction, operating and renovating expenses will be reduced, as prefabricated units are interchangeable, standardized product components that can be easily replaced or recycled.

In advance of construction in Quayside, Sidewalk envisions embedding an innovation team from its Build Lab with one or more leading modular construction firms to design and test components and processes.

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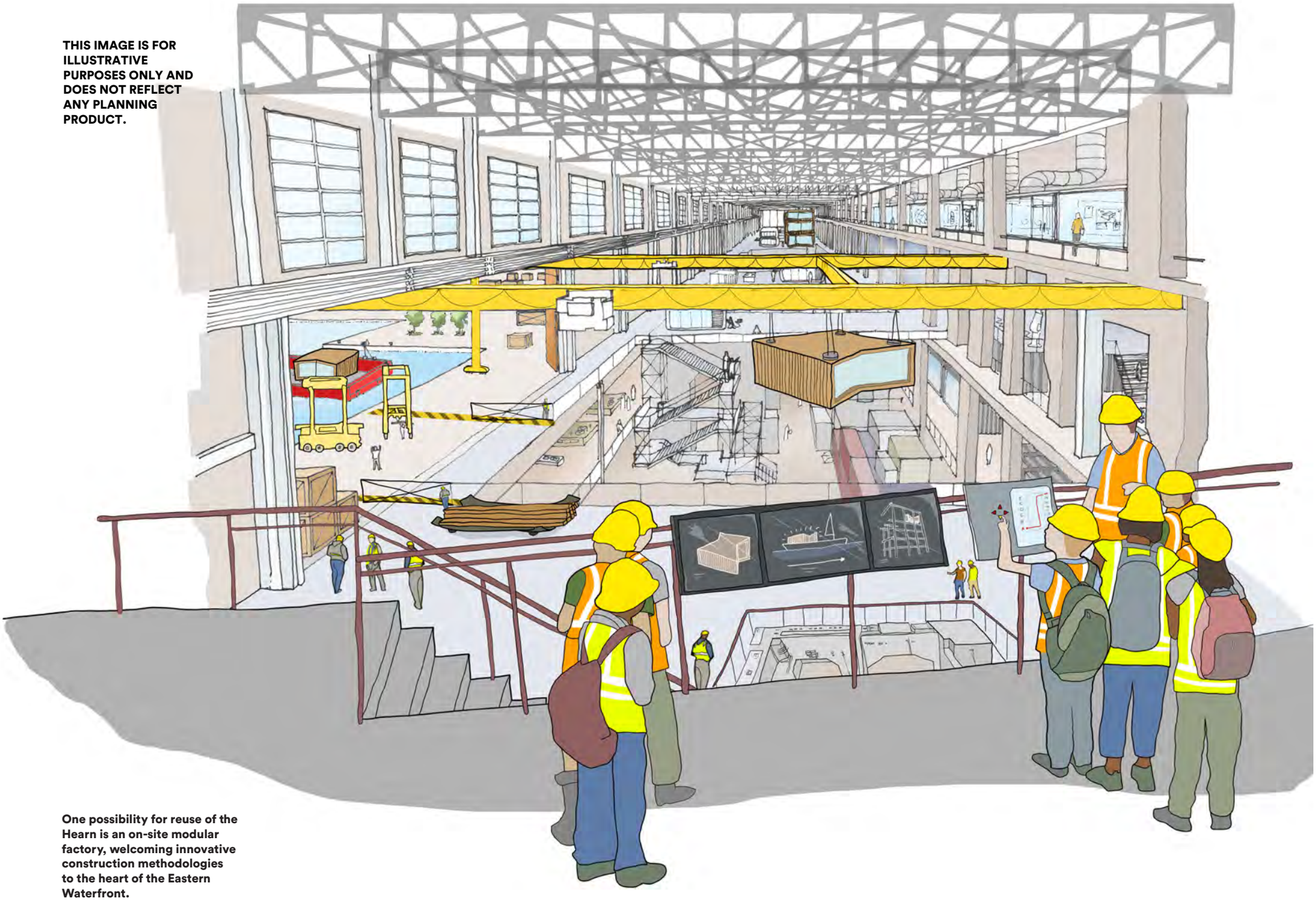


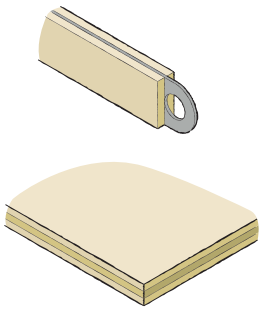
One possibility for reuse of the Hearn is an on-site modular factory, welcoming innovative construction methodologies to the heart of the Eastern Waterfront.

Material Innovation

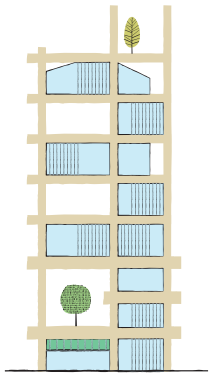
Another critical component of new construction methodologies is material innovation. Sidewalk is focusing its initial efforts on materials that are more sustainable without sacrificing affordability or design flexibility. As such, it will source ecologically benign construction materials that embody less energy and reduce waste sent to landfills.

At the forefront of Sidewalk's materials strategy is "tall timber," the construction of mid- or high-rise buildings with wood. New wood technologies offer advantages in terms of cost savings, speed of construction, and environmental impact compared to traditional steel and concrete. Timber can be locally sourced, further stimulating the Canadian economy and minimizing transportation costs. Wood construction is also faster, especially when leveraging prefabricated sub-assemblies. In fact, the use of lighter lumber segments can reduce installation and foundation work costs by up to 20 percent, while maintaining structural strength, flexibility, performance, and safety standards. Finally, tall timber performs better than traditional materials in terms of both embodied energy and resulting air and water pollution, while achieving a 90 percent reduction in carbon footprint (from steel's 1.82 kgCO2/kg to the 0.18 kgCO2/kg of dry wood). [Sources: Forest Foundation, Canadian Raw Materials Database]

Additionally, Sidewalk is exploring potential materials innovations in Structural Insulated Panels (SIPs), a standard construction material. Sidewalk's prototype aims to reduce embodied energy, waste, off-gassing, and toxicity by working primarily with two new materials: mycelium for structural strength, and Shikkui plaster for surfacing. Mycelium is a strong fungus that can be grown in confined spaces, using agricultural waste as feedstock. Shikkui plaster is a Japanese lime plaster made of slaked lime (a food additive) with additives including seaweed extracts, soybean oil, natural plant fibres, and other natural aggregates. Each natural component adds performance characteristics, such as stability, workability, water-repellency, and anti-cracking properties. These two materials represent opportunities to improve building performance, lower costs, and improve sustainability.



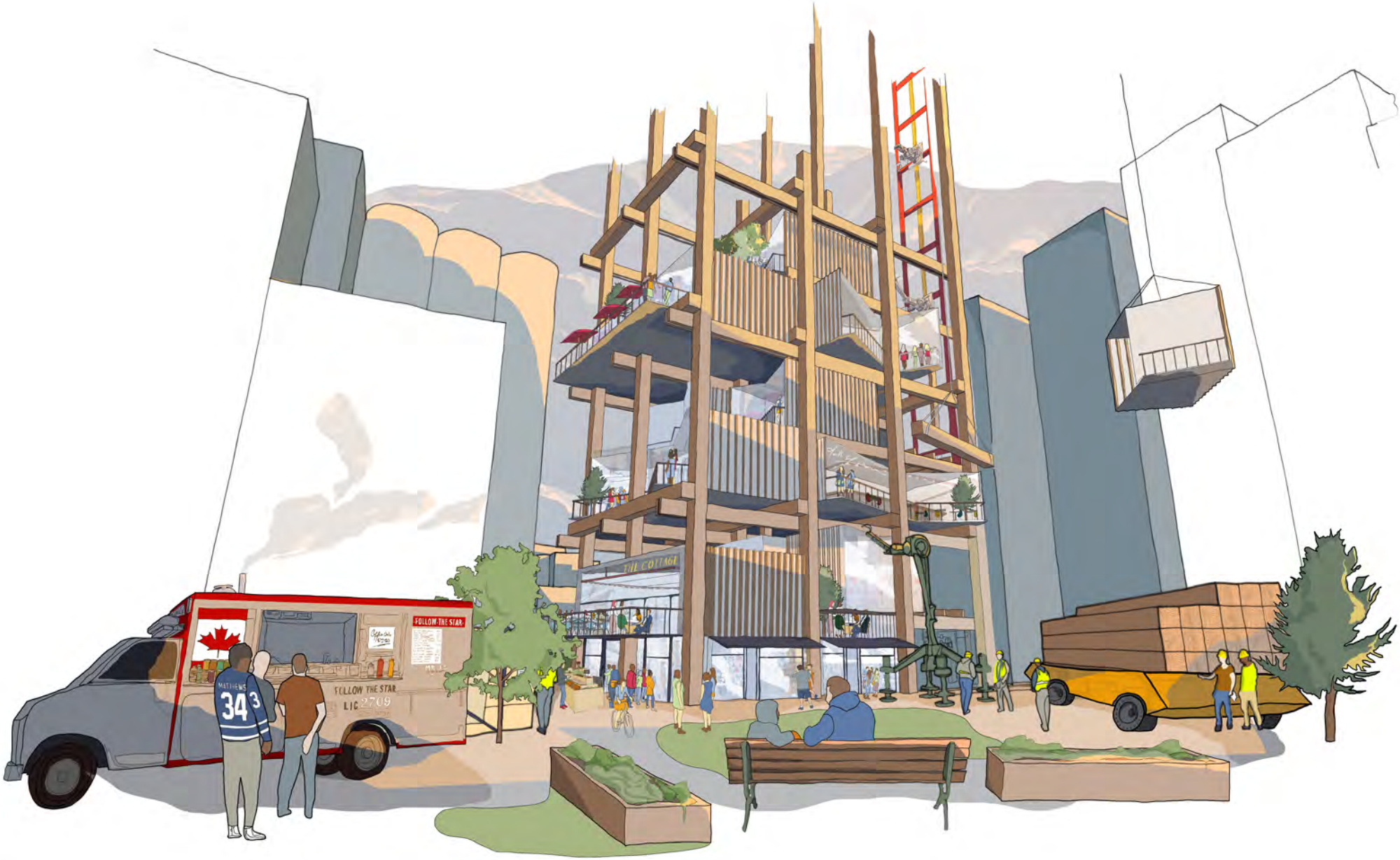
Hybrid building systems and composite panels can be timber-based.



Timber construction is possible at all scales and at pioneering height.

Sidewalk believes that these combined innovations in pre-fabrication and materials should have an impact that cascades beyond construction savings. Radically standardized materials and units will lessen the burden of building code approvals. Expedited and more predictable construction timelines will lower contingency costs and shorten the payback period, increasing the availability of financing. And better overall project economics will open up new land for affordable residential construction.

Opposite: Mid- or-high rise buildings will substitute traditional steel or concrete materials with lighter, more eco-friendly tall timber.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Building Typologies

CITIES, THEIR ECONOMIES, AND THEIR DEMOGRAPHICS change over time, often in unpredictable ways. Building usages should change with them. The cast-iron buildings that line the streets of New York's SoHo today, for example, were once manufacturing sites housing massive machinery. Despite New York's decline as an industrial hub, these buildings have maintained their relevance—re-inventing themselves as light manufacturing spaces, small offices, live-work studios, and apartments. This multiuse life cycle is made possible by the buildings' strong skeletal structure—their "good bones"—allowing them to accommodate and anticipate changing use over time.

Quayside will be no different. Whereas today buildings tend to be designed for single use, Quayside structures will be designed upfront to accommodate a radical mix of uses and anticipate changing preferences. Optimized for optionality, spaces will be equipped with the core infrastructure to adapt to the evolving demands of Torontonians. A parking structure built for conventional vehicles today will be able to adapt over time to become a marketplace, makerspace, creative office, or residential lofts, as conventional cars become less prevalent and self-driving cars more popular.

The overarching goal is to allow neighbourhoods along the water to evolve to match changing user needs—a model that can wholly redefine urban experiences by maintaining dynamic neighbourhoods.

Loft

Buildings today are usually designed for a singular purpose. However changing user needs and shifting economic conditions often demand change. This exposes a problematic mismatch: buildings are designed to last far longer than their users' needs remain constant.

While modular construction is one means of injecting flexibility into urban areas, a second strategy is to design buildings with an adaptable shell and versatile core structure that can be more easily flexed for different uses. This idea is the basis for Sidewalk's Loft concept.

Loft improves upon traditional loft buildings by planning explicitly for ongoing and frequent interior changes around a strong skeletal structure. Its structure will remain flexible over the course of its lifecycle, accommodating a radical mix of uses (such as residential, retail, making, office, hospitality, and parking) that can respond quickly to market demand.

While the Loft concept is primarily geared toward renovations and retrofits to accommodate shifting user needs on a months- or years-long time frame, Sidewalk believes a retail-oriented variation of this notion could allow spaces to change almost daily. Sidewalk calls this derivative Next-Gen Bazaar. By outfitting space typically reserved for temporary retail uses—like farmers markets and shopping stalls—with the more sustainable core infrastructure developed for Loft, the waterfront can create greater diversity in the types of pop-up establishments that will appear for a limited time in different neighbourhoods. This will better serve the varied needs of new start-ups, makers, satellite restaurateurs, and more traditional businesses looking for temporary meeting or public engagement space. More specifically, it would allow them to experiment with new offerings and product lines without the overhang of a massive capital expense, creating a much more dynamic retail environment.

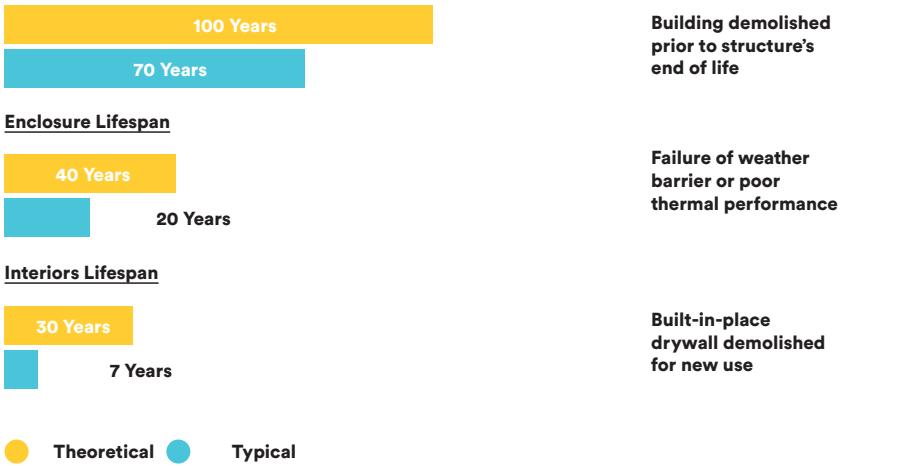
Sidewalk will prototype both the core Loft and Next-Gen Bazaar concepts in Quayside. The Loft pilot will likely contain parking space that could easily transition to other uses once shared mobility reduces private car use and parking needs. The Next-Gen Bazaar pilot will blend public and private space to allow retailers and new businesses to set up shop in Toronto's newest neighbourhood without upfront capital risk.

Typical Buildings

Built only for one use

Today, all building systems have functional lifespans far beyond their desired lifespans, resulting in waste and inflexibility.

As illustrated below, building components made available by current construction methods are used for only a fraction of their potential material lifespan.

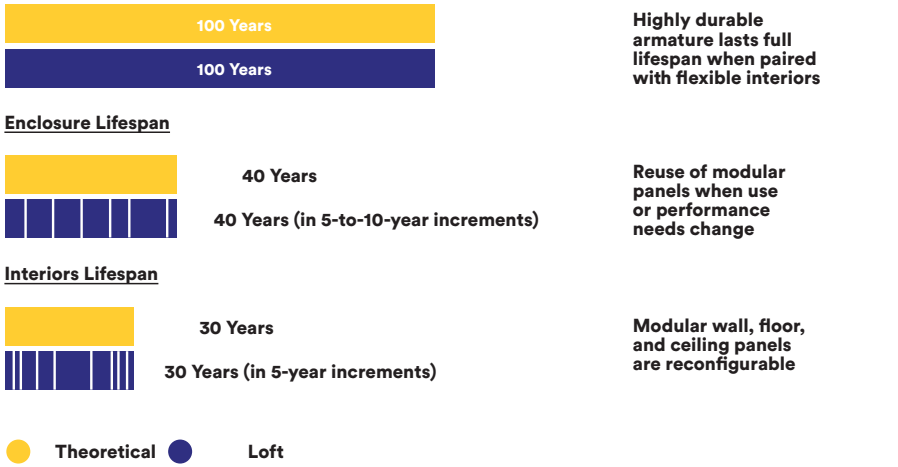


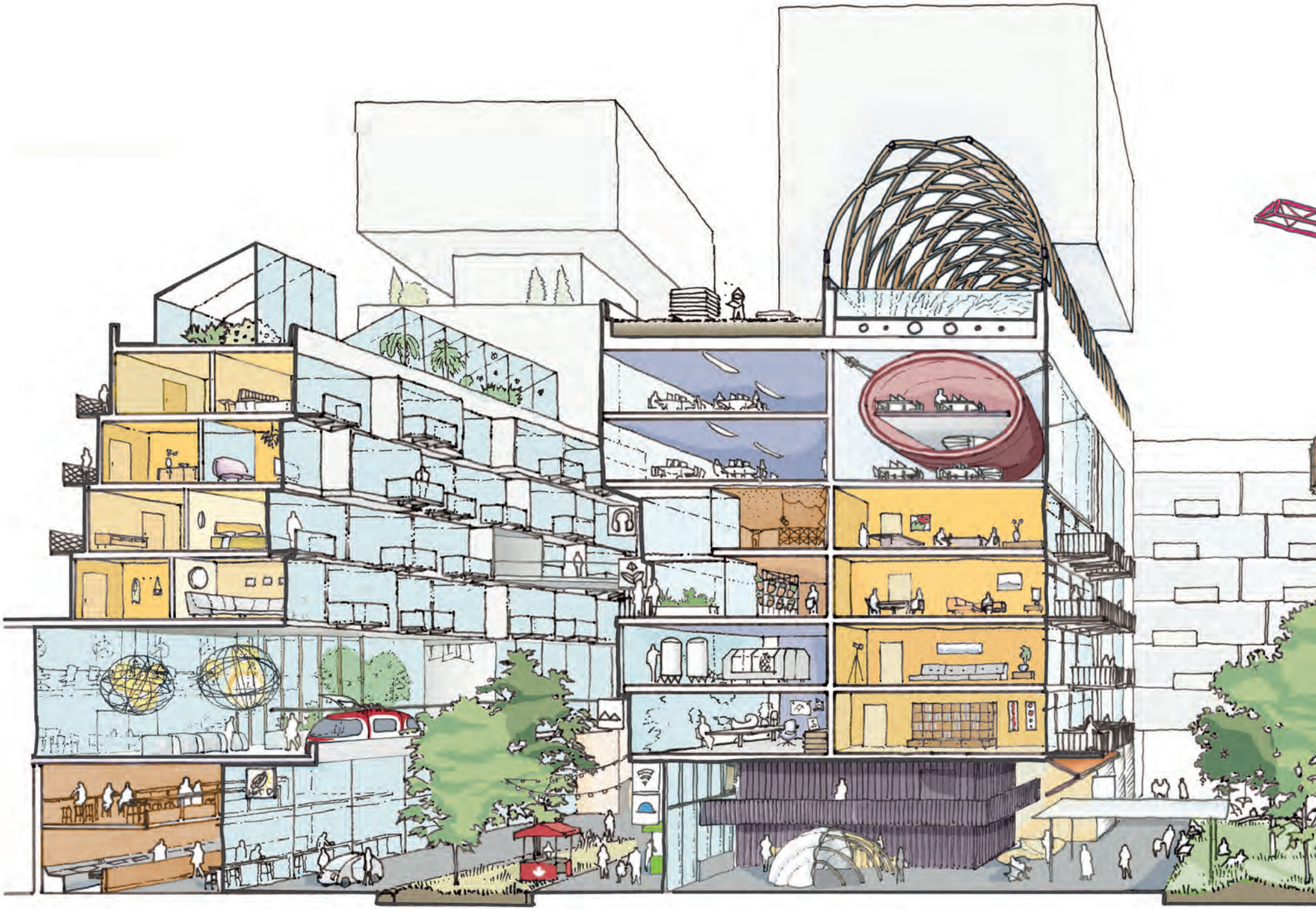
Loft

Built for the ages

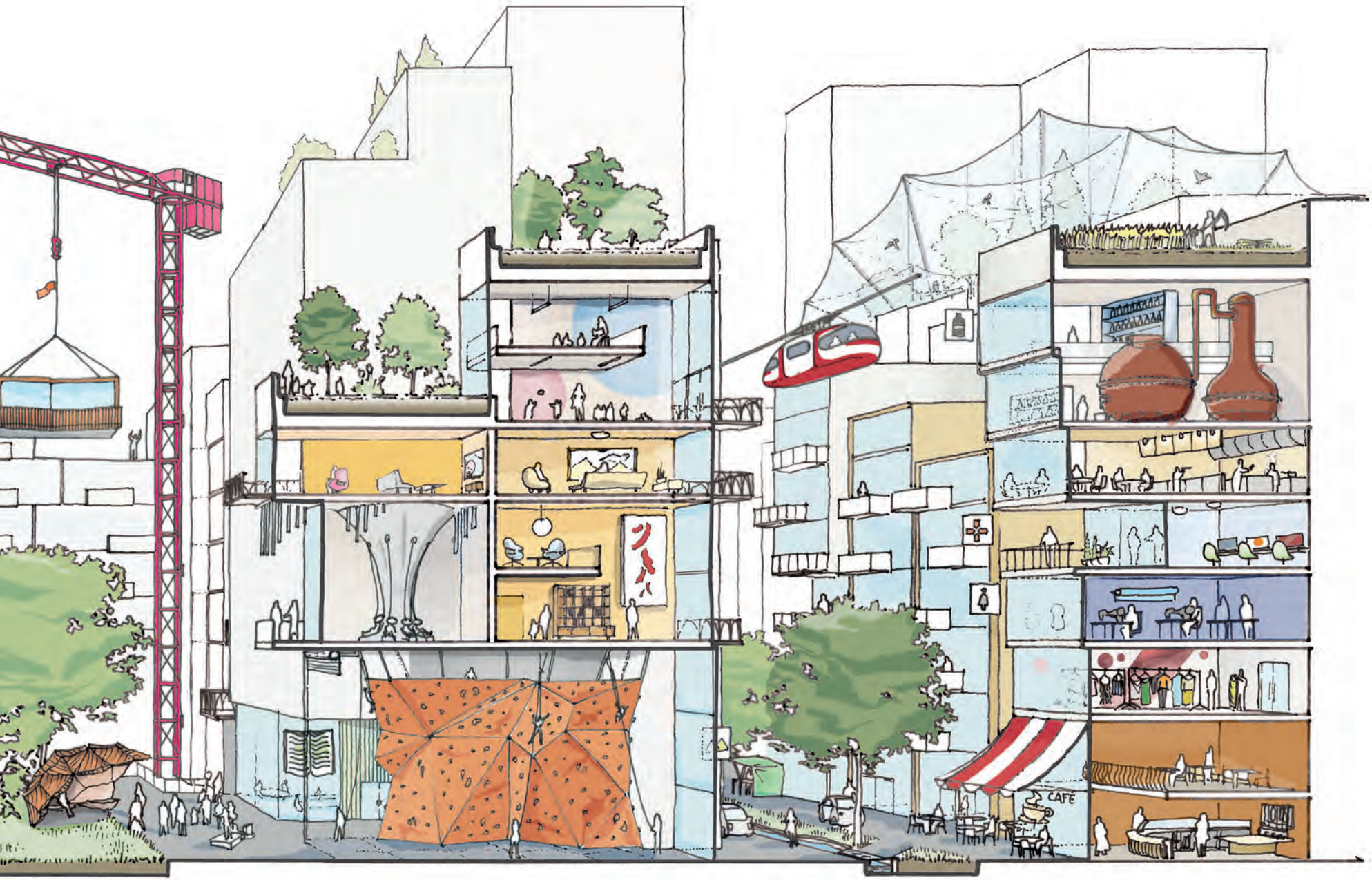
Loft addresses this mismatch in use and lifespan by focusing on a robust building exterior, taking advantage of the extremely long lifespan of major building components.

Then, by making the interiors highly flexible with standardized dimensions and interconnections, Loft facilitates easy and ongoing adjustment so that even an old building will meet its users' needs perfectly and with minimal waste.





Adaptable buildings, such as reconfigurable Loft spaces, enable completely radical mixed-use environments.



Loft (continued)

Technical Foundations

Flexibility Founded on Standards

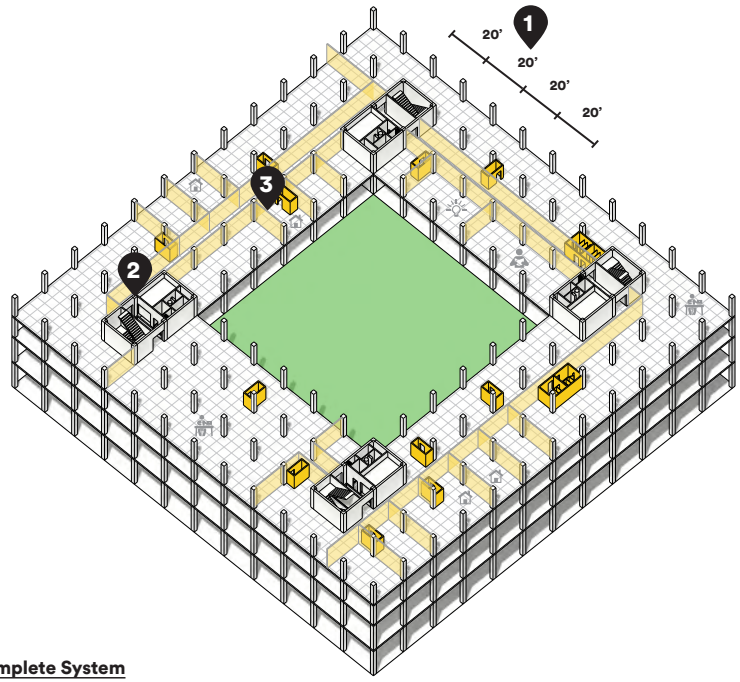
Loft buildings will be designed around standard units of five feet. For example, support beams, elevator shafts, and other fixed components will be placed only at multiples of five-foot intervals. This enables a wide variety of room sizes using the same parts—from a 5'-by-5' closet to a 10'-by-15' bedroom to a 40'-by-20' conference room. By creating standard interchangeable interfaces along with these standard dimensions, Loft will ensure that interior fittings, façades, doors, and similar building components are not only interchangeable and flexible, but also reusable.

This flexibility will allow for easy modifications to match evolving style preferences and floor-plan reconfigurations to serve changing space needs. With sufficient ease of adjustment, a company could reconfigure a space to accommodate a weeklong training seminar and then return it to offices or small conference rooms. A family might decide to subdivide a room to accommodate a visitor staying for a few months, or, they might recycle and exchange modular components when a room no longer meets their needs. Within the building, modular interior components will also facilitate easy access to utilities through standardized connections, further supporting future spatial reconfiguration and ongoing maintenance. Additionally, manufactured building components will help improve neighbourhood quality of life by using incorporated sensors to measure real-time building performance relative to applicable performance-based codes. Loft's flexible design and construction methods allow buildings to catalyze a wide range of uses, adapt to ongoing changes in land use, and meet future space demands, all while preserving the visual character of a neighbourhood.

Modular Fitting and Components

The standards built into Loft will create a competitive marketplace of interchangeable fittings. The interiors of Loft will greatly reduce the cost and waste of interior remodelling because they will be standardized and reconfigurable. With standard sizes replicated throughout similar buildings, interior components become reusable, more like quality furniture than like drywall. Having interior fittings like doors, walls, and finishes that are reusable will have a significant impact on sustainability, helping to cut down on the approximately 200,000 tonnes of construction debris added to Toronto's landfills every year by renovations alone.

This interchangeability requires a high degree of standardization, including dimensions, basic services provided in each building, and the interior components themselves. The dimensions of the buildings, from the proportions of a block to the size of modular floor panels, should accommodate disparate and changing uses. This planning will ensure reuse, interoperability, and faster construction and renovation times, effectively future-proofing the structure for a variety of uses. Modern buildings with robust interior layouts get reskinned every 25 or 30 years to improve environmental performance and maintain a contemporary look. Loft's façade components will adopt the same standardized units to enable low-cost, frequent updates to the exterior. This loose-fit design—one built for easy disassembly and reuse of parts—has ancillary benefits to the environment as well, enabling structures to be built, renovated, and demolished at a roughly 30 percent less carbon cost than traditional demolition.



A Complete System

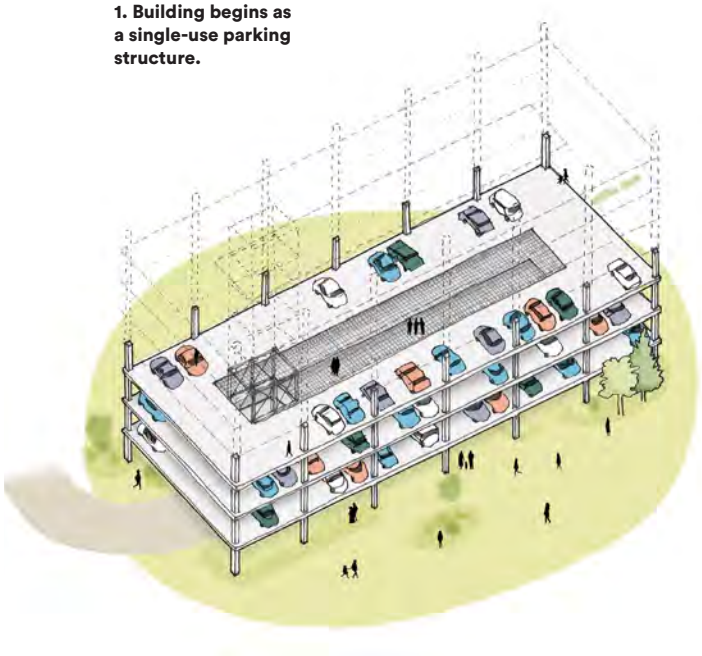
Loft will create long-lasting but highly flexible buildings that can accommodate a variety of shapes, floor plates, and styles, all of which could be built to Loft standards.

① Standard dimensions ensure that all of Loft's spaces and components are interchangeable.

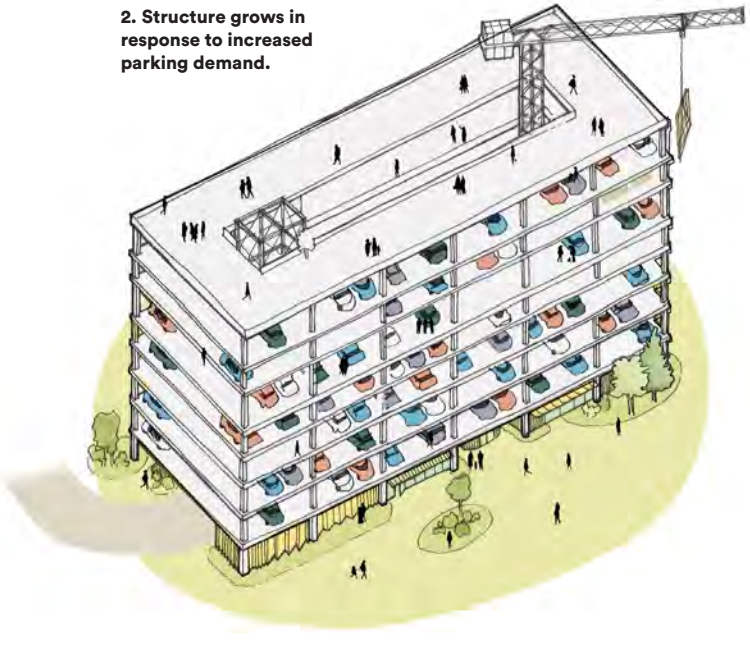
② Generous stairways, utility capacity, and building services will support a wide variety of uses.

③ Modular interior fittings and façade modules ensure buildings are rapidly reconfigurable, and that components can be reused.

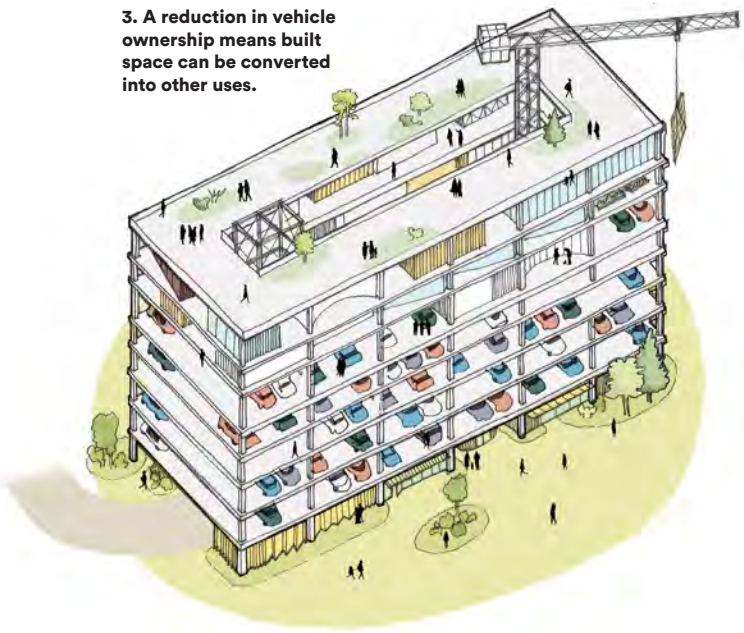
1. Building begins as a single-use parking structure.



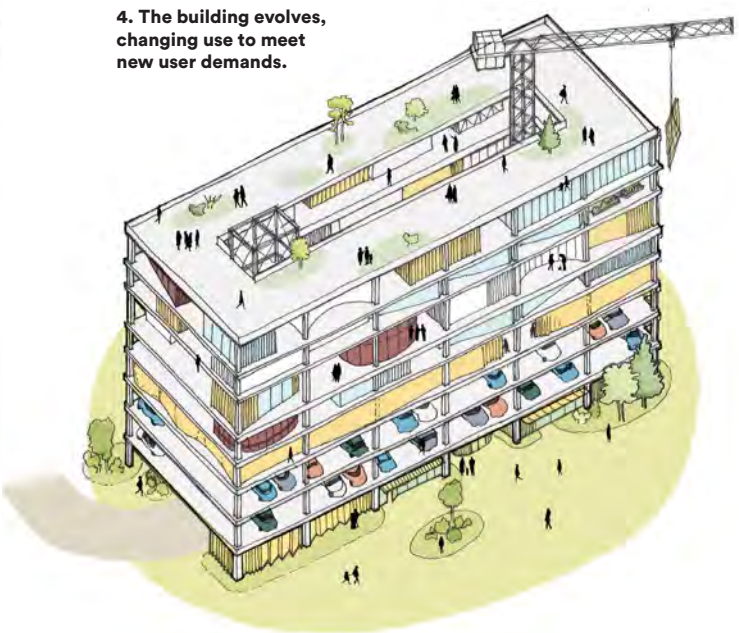
2. Structure grows in response to increased parking demand.



3. A reduction in vehicle ownership means built space can be converted into other uses.



4. The building evolves, changing use to meet new user demands.



One possible manifestation of Loft is a structure that can begin its life as a parking structure. Over time, as self-driving cars and better public transit change the demand for parking, the building can efficiently evolve for new uses.

In all, Sidewalk's flexible Loft structures will drive further affordability by better allowing the physical infrastructure to adapt cheaply and quickly to the changing needs of the neighbourhood. This can create incremental real estate value, keeping more inventory online at less cost. While designing these adaptable buildings for reuse will have higher upfront design costs, new units will be constructed at less cost and operated at significantly higher efficiency over traditional demolition models.

Outcome-Based Code

IN ORDER TO FOSTER DYNAMIC NEIGHBOURHOODS that can efficiently and safely deliver a shifting range of uses over time, a city must have an equally flexible building code that enables innovation without compromising safety.

Historically, static zoning and building ordinances are the mechanism by which cities regulate the built environment—construction, building use, neighbourhood composition, quality of life standards, building safety. These codes were the best tools cities had to segregate potentially harmful uses from residents. However, static regulations often result in low-quality, single-use neighbourhoods that reward obsolete approaches and penalize innovation.

Despite these problems, a city cannot do without building standards and zoning codes. The fundamental need to protect human health, ensure safe buildings, and manage negative externalities remains absolute.

But in today's environment—one where home and work are increasingly intermingled, and the building code definition of "manufacturing" often includes the large and growing maker economy—there is opportunity to improve upon static regulations and broad zoning codes with more precise tools and performance-based regulations.

As an alternative to traditional regulation, Sidewalk envisions a future in which cities use outcome-based code to govern the built environment. This represents a new set of simplified, highly responsive rules that focus more on monitoring outputs than broadly regulating inputs. With embedded sensing for real-time monitoring and automated regulation, this new code will reward positive behaviours and penalize negative ones, all while recognizing the value residents and visitors increasingly place on having a variety of uses within one neighbourhood.

Under such a system, rather than zoning for use types, the city could zone to protect against the negative externalities themselves usually associated with managing different uses. Instead of limiting light industrial space, the city could set maximum amounts of noise pollution and traffic; instead of limiting residential space, the city could set minimum standards for air quality, daylight access, comfort, and sustainability.

Sidewalk expects these codes to encourage more efficient and dynamic use of space, and expedite the path toward radical mixed-use neighbourhoods. By enabling greater adaptability, Outcome-Based Code incentivizes reuse rather than demolition, and leads to more sustainable and affordable ways to serve the community's needs.

This new system will reward good performance, while enabling buildings to adapt to market demand for mixed-use environments. It is Sidewalk's belief that outcome-based codes, coupled with sensor technology, can help to realize more sustainable, flexible, high-performing buildings at lower costs.

There is no doubt that adopting such a system is a long-term process in which safety and quality of life must be prioritized before rapid change. The first step in designing and evaluating this system is installing the necessary infrastructure and collecting the necessary data to accurately measure the types of impacts that are essential for protecting safety and quality of life.

Specifically, Sidewalk proposes to outfit buildings in Quayside, including Loft, with sensors to measure the data needed to explore the Outcome-Based Code system. Sidewalk plans to work with local agencies to design informative pilots that begin with comprehensive data collection within existing regulatory frameworks.

When fully implemented, Outcome-Based Code will have employed four strategies for meaningful reform:

① Simplification

Today's building codes often include different standards for dozens of different types of buildings. While highly tailored, these different standards also make it difficult for one type of building to serve multiple uses or to change over time. Sidewalk will reduce the number of defined building types, targeting 80 percent of interior uses for reclassification into a new "use-neutral" category, in turn permitting a greater number of uses. This can support implementation of adaptable Loft units, versus the more stringent, static building codes of today.

A simplified building code will reduce the number of defined building types.

Existing International Building Code Use Groups	
A-1	Theatre and Performances
A-4	Indoor Sporting Events
A-5	Stadiums
I-2	Hospital, Nursing Homes
I-3	Jails
A-2	Restaurants and Bars
A-3	Worship, Recreation, Amusement
B	Public and Private Businesses
E	Education
F-1	Moderate-Hazard Factory (Industrial)
F-2	Low-Hazard Factory (Industrial)
I-1	Supervised Residential Adult Personal Care Services
I-4	Day Care Facilities
M	Mercantile/Retail
R-1	Transient Living Spaces
R-2	Multiple Dwelling Units Buildings
R-3	Single Dwelling Units
R-4	Assisted-Living Facilities
S-1	Moderate-Hazard Storage
S-2	Low-Hazard Storage
U	Utilities (Misc. Structures)
H-1	Materials with Detonation Potential
H-2	Materials with Deflagration Potential
H-3	Materials that are Easily Combustible
H-4	Materials that are Toxic and Corrosive
H-5	Hazardous Production Materials (HPM)

Example Proposed Use Groups	
A-1	Theatre and Performances
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80% of Building Uses Will Fit Into the One New Flexible Use Category

②

Flexibility Enabled by Monitoring

Sidewalk will begin implementing this strategy in Quayside by reviewing existing building codes, identifying the performance levels that are implicit in today's design standards. Covering topics such as life safety, daylight access, air quality, comfort, sustainability, and infrastructure capacity, these targets will ensure that Quayside's buildings perform as well or better than those governed solely under existing code. Whenever possible, Sidewalk will convert these performance targets into outcome standards that will be enforced through monitoring during use, rather than pre-build restrictions. Sidewalk's fundamental belief is that Toronto can realize lower costs and higher performance through a mix of flexible building design and real-time use management.

Current vs. Proposed Conditions

Compared to a generic approach to zoning and code, Sidewalk's Outcome-Based Code emphasizes flexibility and innovation while adhering to the same standards and increasing compliance.

	Current System	Outcome-Based Code System
Use Mix	Uses separated to avoid conflicts	Conflicts managed by monitoring and guaranteed enforcement
Structural Integrity	Design review is only real point of enforcement	Ongoing structural monitoring enables new construction techniques
Daylight Access	Building shaped to avoid shadow	Creative site-specific solutions encouraged based on performance
Nuisance	Uses restricted to prevent noise/odour issues; after permitting, complaint based	"Trust but verify" approach enables creative uses but ensures that violators are immediately enforced by fine or other intervention
Energy/Water	Energy/water modelling required to test designs, but outcomes never checked	Actual performance monitored for compliance with standards, enabling lower-cost, more creative solutions

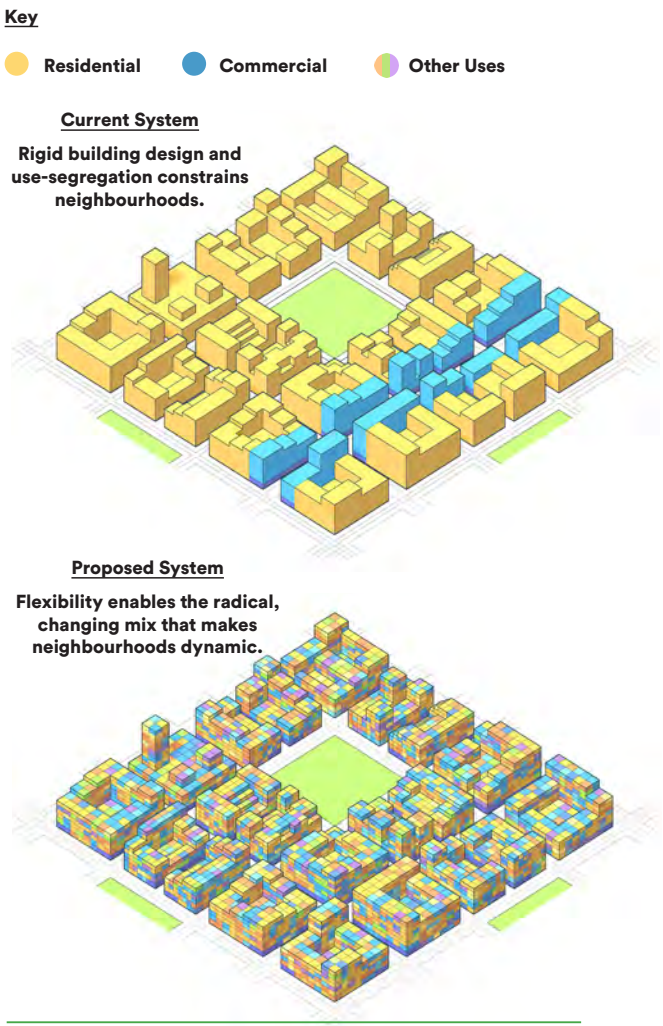
③ Interoperability

An additional component of the code will ensure that buildings have the facilities and the interoperability to create a well-functioning district. Rather than create plot-by-plot rules, the code coordinates objectives across scales: building, block, neighbourhood, and district. Most cities have some type of requirement along these lines. For example, elevators must allow firefighters to override controls. But Sidewalk's system approach will require a greater level of interoperability in terms of solid waste disposal, modular interior fittings, utility channels, and similar systems. Taken together, these requirements will mandate that buildings accommodate these district-wide functions in a standard way.

④ Automated Permitting Review

As of late 2013, some 20 percent of Toronto's building permit applications took longer to process than deadlines set out in provincial regulations. Outcome-based code will change that. Throughout the planning and design phases, Sidewalk's digital layer will provide instant feedback on whether a specific design option meets performance and safety criteria. Thus, the broad range of development possibilities will be clear to owners, architects, and end users, while limiting the hindrance of documentation or review processes.

These Strategies Enable Radical Mixed Use



Eventually, Sidewalk envisions piloting outcome-based code in parallel but subordinate to existing regulatory frameworks in Eastern Waterfront neighbourhoods. When the approach is further validated, it will become the primary system in those neighbourhoods, and then finally, expand back into existing Toronto neighbourhoods as the necessary hardware retrofitting is achieved. This entire process will be undertaken in partnership with the City of Toronto (in accordance with its Zoning bylaws and Municipal Code), the Province of Ontario (and its Ministry of Municipal Affairs and Housing), and other key governmental agencies critical to setting public standards.

Occupancy Models

OVER 40 PERCENT OF TORONTO'S HOUSEHOLDS are currently occupied by a single person. According to the Canada Mortgage and Housing Corporation, these households are projected to grow faster than any other type over the next two decades, making them Canada's largest household type by the mid-2020s. Single-person households are more likely to rent, and on average, spend more per person on housing than larger households.

Sidewalk believes there is a real opportunity to experiment with new occupancy models in Quayside. By trading gross square footage for efficiency of design and optimization of community services and amenities, Sidewalk believes that new occupancy models can offer this large and growing segment of the population a better housing product at a materially lower cost. And while the pursuit of innovative occupancy models is often weakened by the misconception that they are the exclusive province of the young, it is important to recognize the potential value these models bring to a diverse population of residents. There is little doubt that the 42 percent of the GTA's young adults aged 20 to 29 who still live in a parent's home (drastic increases from historical levels of 32 percent in 1991 and 27 percent in 1981) will benefit from an expansion of housing types; however, individuals in the 55-and-older cohort, who have a need for more community, services, and/or care than those that can be provided by a co-inhabitant alone, have much to gain as well. These models could also benefit low-income and homeless populations.

These alternative occupancy models will never fully supplant Toronto's core multifamily housing stock, but they will open up Quayside to a diversity of residents and forward-looking uses that might not otherwise be attainable. And more broadly, these models can be a powerful tool in helping the city meet its goal, as expressed in the Housing Opportunities Toronto Action Plan, of assisting nearly 260,000 households to find or keep the affordable housing options they need. Sidewalk is committed to using Quayside as a laboratory for experimenting with these models—including co-housing, micro-units, and other alternative typologies.

Co-housing

Sidewalk and Waterfront Toronto can work together to break away from traditional leasing models, instead ushering in a new standard of living based on flexibility, community, and affordability. Sidewalk's initial efforts in this process will build on current co-housing models, improving access to convenient options that offer a high level of amenities and services included in the base rental cost. Sidewalk offers the potential to create newer models for Torontonians by integrating a digital layer—one that empowers residents to organize and make their own programming decisions. Effectively, Sidewalk believes all aspects of one's housing should be easily accessible and controllable through a digital interface—the ability to select a new unit in a new location, to reserve and control shared space, to coordinate in-home care and refill prescriptions, to digitally communicate with neighbours for babysitting, or to organize Sunday-night family-style dinner.

In addition to the enhanced level of convenience and accessibility afforded to Torontonians, these co-housing models should offer improved economics. Radical sharing of durable goods, Splitting costs of building and personal services, and increasing space efficiencies (up to 70 percent, by some estimates) offer tangible monetary benefits that will be passed on to residents. [Source: Negev Co-Living Model]

Micro-units

Micro-units will also be part of the solution. Sidewalk team members were intimately involved in New York City's first pilot with affordable micro-units, an initiative that revealed tremendous interest and demand for less expensive, small (250 and 350 square feet), private living spaces. The result, Mt. Carmel Place, was the first micro-unit building constructed in New York City, delivering 55 units at a lower cost than existing studio apartments in the neighbourhood. Nearly 60,000 applications were received for the 14 units formally designated as affordable. The addition of this type of unit in a high-demand Manhattan neighbourhood provided access to the core of the city for people who would have otherwise been unable to afford to live there. With similar dynamics at play in downtown Toronto, and a virtual blank canvas with which to work on the Eastern Waterfront, the impact at scale of a micro-unit program could be transformative for the local housing market.

Possible Module Sizes and Layouts

Micro-units offer smaller, affordable alternatives to traditional apartments, while offering more privacy than shared living arrangements.

By providing a diversity of housing typologies, Sidewalk and Waterfront Toronto can significantly enhance resident's quality of life. For instance, the integration of a digital layer can bring individuals of shared interest and values together. From a building owner's perspective, more innovative occupancy models create potential for higher resident retention, incremental building value, reduced operating costs, and streamlined user-friendly property management. Most importantly, these typologies will open the door for a wider range of affordable housing options—and thus help facilitate a community that truly reflects the socio-economic, cultural, and generational diversity of the Greater Toronto Area.

Home Ownership and Innovative Financing Structures

SINCE 2010, THE CITY OF TORONTO has worked with developers (both nonprofit and private sector) to construct nearly 3,000 affordable rentals and nearly 800 affordable ownership homes, working towards its target of 10,000 affordable rental homes and 20,000 affordable ownership homes by 2020. Waterfront Toronto alone, through its ambitious development programs, has built 500 affordable housing units, with an additional 80 under construction. Despite this progress, the city is predicted to fall short of its 10-year target, given the current pace of construction.

Even if fully achieved, the 10-year goal will improve housing options for many, but will not fully address the housing crisis in Toronto, nor supply the entire estimated 88,000 households currently waitlisted for affordable units. Thus, in addition to the new occupancy models discussed above, it is imperative that Sidewalk creates an environment that incentivizes the ongoing delivery of apartments that can accommodate households of all income levels.

Sidewalk recognizes that achieving sustainable affordability in Toronto will require a deep understanding of both market drivers and potential policy interventions. Several members of the Sidewalk team played key roles in the development and implementation of New York City's New Housing Marketplace Plan. The plan was responsible for the creation and preservation of more than 165,000 affordable housing units over the past decade, and was the basis for implementing a set of tools that yielded an unprecedented volume of new affordable housing construction. These tools included low-cost financing (80/20 program), dedicated revenue streams (the NYC Housing Trust Fund), and tax abatements (421-a). New York's first exploration into inclusionary housing also occurred during this period.

Sidewalk will work with local stakeholders to develop multifamily financing and affordable home ownership solutions that are uniquely tailored to Toronto's market dynamics. These could be modelled after existing programs like those found in New York, chart a new way forward (such as a national "affordable housing bank" that will act in a similar manner to the proposed Canadian Infrastructure Bank and provide low-cost financing for projects that meet agreed-upon affordability thresholds), and/or draw on successes in other major urban centres throughout the world.

Sidewalk will also pursue models of partial ownership that have proven to be successful in Toronto and abroad. For example, Sidewalk will work in partnership with Toronto's existing nonprofit organizations that provide affordable housing options in the GTA, leveraging models where a nonprofit serves both as a residential housing developer and as an investment fund or lender to the occupant. This allows the nonprofit entity to sell units for a combination of "cash and kind," and make units available for purchase to people who would otherwise be unable to afford them. Working with Waterfront Toronto, Sidewalk is committed to giving these housing non-profits a platform in Quayside and the broader Eastern Waterfront on which to expand their work.

Sidewalk will work with Waterfront Toronto to make a diverse set of housing options available to all Torontonians.
Credit: Mark Wickens

Roadmap

	Product Development Strategy:
Construction Methodologies	Sidewalk is surveying best-in-class players for prefabrication/modular construction and innovative materials, and is in active partnership discussions with several industry leaders. Sidewalk envisions embedding an innovation team from its Build Lab with one or more leading modular construction firms to design and test components and processes. Additionally, Sidewalk will expand on its early experiments in innovative building materials (including tall timber and mycelium/Shikkui plaster SIPs) to inform new building designs.
Building Typologies	Sidewalk is currently working with BuroHappold Engineering on the technical principles underpinning the Loft concept. To catalyze the creation of an initial concept, Sidewalk and Waterfront Toronto will launch a "Loft Competition" to solicit broad input on potential designs from a range of sources.
Outcome-Based Code	Sidewalk will work with Waterfront Toronto and the relevant regulatory agencies—including the City of Toronto and the Province of Ontario's Ministry of Municipal Affairs and Housing—to identify provisions that may be appropriate for prototyping and stress-testing an outcome-based code approach. Sidewalk's dedicated Build Lab team will assess the feasibility of Outcome-Based Code that appropriately regulates the building inhabitants, and design the necessary hardware and software needed to measure standards effectively.
Occupancy Models	Sidewalk will inventory community living models currently in use in the GTA and will collaborate with Toronto residents, building an advisory council with vision-aligned residents of target segments to articulate ambitions for the space.
Financing Structures	Sidewalk will partner with Toronto's local, provincial, and federal partners to identify and refine product and policy innovations, creating a development strategy for Quayside as a living laboratory. Sidewalk will actively leverage its experience in New York City's evolving affordable housing landscape to collaborate with Waterfront Toronto and improve access to affordable housing.

Quayside Pilot:

In partnership with one or more industry players, Sidewalk will prototype both modular and tall timber construction in Quayside. Specifically, Sidewalk envisions using the same modular "base" to construct a diversity of building types on different parcels, including at least one high-rise modular structure, to demonstrate the flexibility of its modular approach. Sidewalk also plans to explore opportunities to apply other innovative materials (e.g., mycelium/ Shikkui plaster SIP) in at least one building in Quayside.

Following the Loft Competition, Sidewalk will refine the design for a pilot project (two stories or higher with a parking structure), finalize a use plan, and undertake permitting approval (applying for waivers) for Quayside planning. During the pilot, Sidewalk will assess its ability to monitor building code as well as its progress toward sustainability and affordability goals.

Sidewalk will outfit a series of Quayside buildings (across all use types) with a network of sensors to measure structural integrity and environmental quality. Sensors will likely include vibration, noise level, light level, temperature, humidity, carbon monoxide, per-circuit electricity usage, and movement via infrared or radar. These sensors will be registered with the district Map database and transmit measurements in real time. To ensure privacy, access to these measurements will be available only to authorized systems and users, and will feed into a compliance platform, tracking real-time performance in accordance with the code.

In Quayside, Sidewalk will develop test properties and will collaborate with Waterfront Toronto to attract residents of different tenures through community-based structures, emphasizing prototypes geared toward people at all stages of life. Integration of digital and physical networks will help to gather residents of common interests.

The Sidewalk team will partner with city government and community organizations to pilot financing and affordable home ownership models in Quayside, with the intention of scaling offerings across the Eastern Waterfront in future years.

Eastern Waterfront Manifestation:

At scale in the Eastern Waterfront, Sidewalk will shift a meaningful portion of construction to the techniques prototyped in Quayside. The Eastern Waterfront will feature modular multifamily housing, built (potentially at an on-site modular factory) with the aid of automation and material innovation. The increased volume of units produced for the Eastern Waterfront will achieve greater cost reductions while providing greater flexibility to the end user.

Following initial occupancy on the Quayside site, Sidewalk will closely monitor building performance to assess and improve design specifications, manufacturing, construction, and installation processes in real time. Sidewalk envisions building multiple Loft structures with different initial uses, while maintaining certain structures for continuous prototyping and experimentation, particularly on interior renovations.

Sidewalk envisions piloting outcome-based code in parallel with but subordinate to existing regulatory frameworks in Eastern Waterfront neighbourhoods, then as the primary system in those neighbourhoods, monitoring the built environment for public nuisances, ensuring that light manufacturing, commercial use, office space, and residential housing can coexist safely, and laying the groundwork for wide-scale adoption. Finally, Sidewalk envisions Outcome-Based Code expanding back into existing Toronto neighbourhoods as the necessary hardware retrofitting and regulatory approvals are achieved.

Sidewalk will develop further test properties in the Eastern Waterfront and, in conjunction with Waterfront Toronto, will continually test, learn, and adjust these models, establishing a launchpad for expansion to the broader Eastern Waterfront.

Successful pilots in Quayside will be scaled to the Eastern Waterfront where a proven track record will help secure increased financial and political support.

Mobility

Sidewalk's vision for mobility represents nothing less than a paradigm shift, relying on a full suite of tools and options for residents, workers, and visitors from across the Toronto area.

Quayside will be a place where transit enhancements, forward-thinking urban design, and technology make car-ownership rates the lowest in Toronto and walking and cycling the primary modes of transportation.

When the systems piloted in Quayside are deployed together with innovations make possible by the scale of the Eastern Waterfront, they will shape the future of urban mobility around the world.

Moving Towards a Car-Free Neighbourhood in Quayside

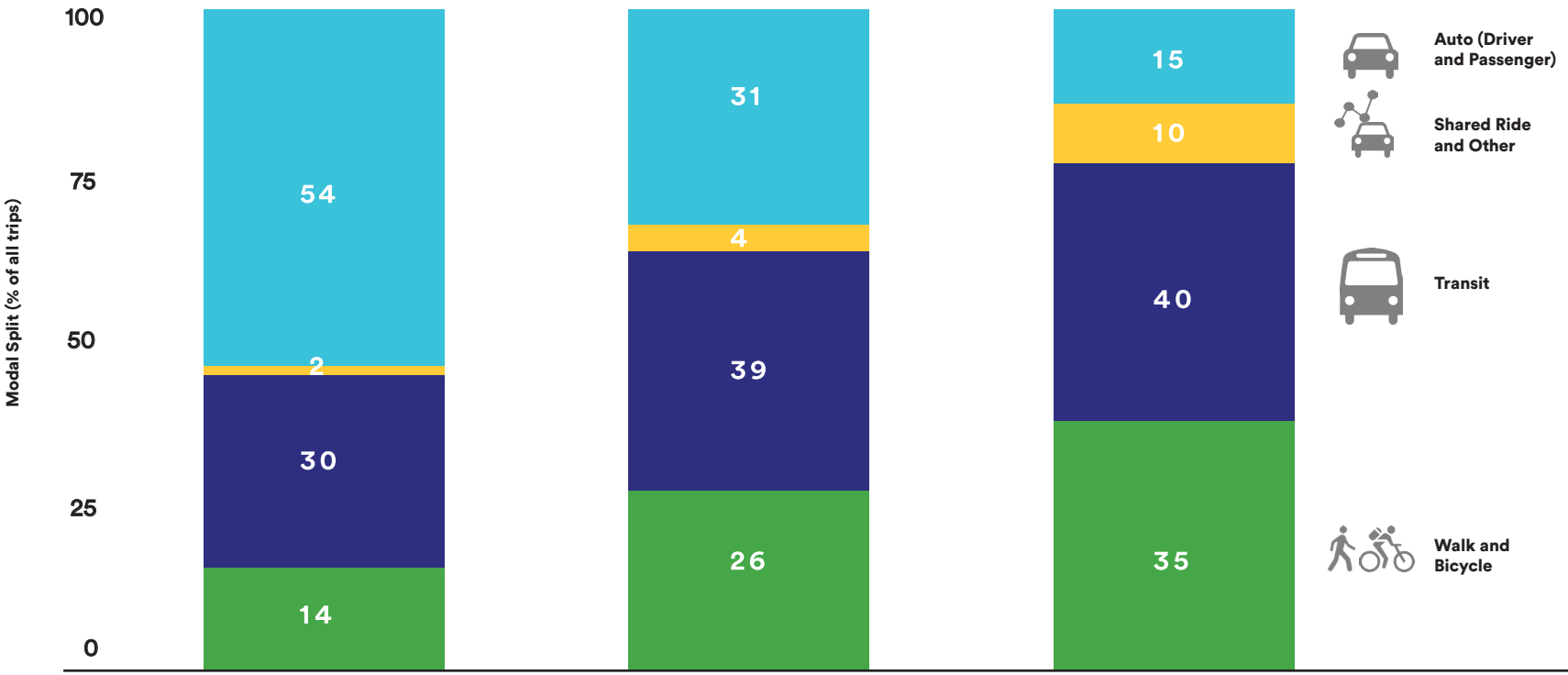
DESPITE ITS PROXIMITY TO DOWNTOWN TORONTO, Quayside risks being a car-dominated area because it sits at the junction of two major highways and is cut off from the neighbourhoods to its north. To achieve walking, cycling, and transit rates similar to other downtown neighbourhoods will require interventions to connect Quayside to the heart of the city: from streetcar extensions, to an abundance of bikeshare stations, to creative solutions that make crossing the Gardiner Expressway easy and inviting for pedestrians and cyclists.

Sidewalk's plan, however, will do all this and make the neighbourhood a case study in mobility innovation. A comprehensive strategy that includes weather mitigation, shared ride services, and limited parking to discourage private car ownership will make walking and cycling the dominant modes of transportation in Quayside. A fleet of shared, energy-efficient vehicles will mean that when residents must drive a car, they can, but without the need to own one. And when they do, they will emit no greenhouse gases. Altogether, Sidewalk's plan will virtually eliminate transportation-related greenhouse gas emissions from Quayside residents.

In addition, Quayside will be the place to pilot new technology that represents the future of urban transportation. Robot-driven urban freight, city-friendly self-driving shuttle buses, and traffic lights that can sense pedestrians are some of the systems that can make a positive difference in Quayside itself and lay the groundwork for larger-scale innovation and system enhancements that can be deployed on the Eastern Waterfront.

Although only blocks away from each other, Quayside and the Distillery District are worlds apart in terms of the modal choices their current layouts encourage. Key to making Quayside into a pedestrian, bike, and transit-oriented neighbourhood is giving it a high-quality public realm and linking it fully into the sidewalk, bike path, and transit network of downtown Toronto. Even the Distillery District's area, however, has significant auto ownership rates, suggesting even greater improvement is necessary. Credit: Mark Wickens

A Plan for Greener, Healthier Transportation Choices



Business as Usual

Although Quayside sits in Ward 28, its highway access, lack of direct streetcar service, and the barrier created by the highway/rail corridor make it possible that its future mobility patterns could reflect the more auto-dependent Ward 30 to its east. Ward 30's mode splits, shown above, would be a severe disappointment for a site with such potential.

Source: Transportation Tomorrow (2011), 24-hour mode shares for residents of Wards 30 and 28. "Shared ride" includes other modes such as school bus, taxi, and GO Transit.

Best Practice Plans

Integrating Quayside into downtown Toronto using best practices would result in a mode split more reflective of Ward 28, shown above. This would include several of Waterfront Toronto's requirements: a mixed-use environment, pedestrian and cycling amenities, and less parking, as well as current plans such as links under the Gardiner and the proposed Eastern Waterfront streetcar. By making it easier to walk, bike, or take transit to downtown, these modes would increase dramatically and displace driving. Nonetheless, parking availability in the surrounding neighbourhoods and convenient highway access could still encourage higher auto orientation than for neighbourhoods in the center of downtown Toronto.

Sidewalk Vision

Sidewalk's vision for Quayside goes further than current best practices. Mitigating weather effects will encourage even more walking and biking by doubling the amount of time that the outdoors feels comfortable; Sidewalk estimates this to switch 9 percent of trips away from driving and transit. Shared-ride services will eliminate the need for many auto trips, especially among the very short trips to drop off a passenger; this should enable a 6 percent switch to rideshare, from driving and transit. Carsharing will reduce auto ownership, providing the ability to drive when necessary, but also prompting residents to take transit when the auto is not really needed. With these innovations, Quayside could be the most auto-independent neighbourhood in Toronto.

Stitching Quayside into Downtown Toronto

AS ONE OF NORTH AMERICA'S MOST PEDESTRIAN-ORIENTED CITIES, and increasingly an attractive place for cycling, Toronto offers an excellent network of walkable streets and bike lanes. Quayside will connect to the sidewalk and cycling network of the rest of the city, across the currently formidable barrier of the Gardiner Expressway. Walking will be the dominant mode choice for all trips within the neighbourhood and into the vibrant neighbourhoods just to the north. Cycling rates will be among the highest in the city. Altogether, walking and cycling will make up 35 percent of all trips by residents.

Sidewalk's walking and cycling strategy has three components:

1. Designing for short trips

Core to achieving high levels of walkability and bikeability is the right urban form. Quayside will be planned so that all residents live within a five-minute walk from everyday needs, with parks, grocery stores, restaurants, and transit nearby.

Cycling will be easy and convenient, with an abundance of Toronto bike share stations. This density of pedestrian and bicycle amenities will lead to WalkScore and BikeScore ratings of more than 95.

2. Connecting to the rest of the city

Quayside's mobility network will create extensive connections with existing and planned cycling and pedestrian networks in Toronto. In addition, it will feature a brand new pedestrian/cycling bridge to connect with Parliament Street and hook into the potential path north of the Esplanade, and provide for much-needed north-south service.

Quayside's location creates a natural impulse to walk or cycle to adjacent areas, like the Distillery District. However, as the city's TOCore strategy notes, access between downtown and its waterfront is unappealing because of the Gardiner Expressway and the rail corridor. Incremental changes, including improved lighting, public art installations, and protected space for food trucks and other programming, will help make both the Parliament and Cherry Street underpasses more attractive, but the potential exists to create a truly iconic link to the heart of the city.

3. Making the public realm pedestrian- and bike-friendly

A core part of Sidewalk's mobility strategy is a public realm that invites and facilitates more active transportation options.

An intelligent public realm management system will identify the maintenance needs of the streets and sidewalks before pedestrians and cyclists are inconvenienced; it will also track the demand for sidewalk, bike lane, and road space and allocate lanes accordingly through pavement-embedded LEDs that can signal changing uses. Responsive traffic signals will identify pedestrians and cyclists and manage auto traffic to give them priority.

Making the links across the Gardiner and the railway attractive to pedestrians is critical to integrating Quayside into the vibrant pedestrian cultures of the Distillery District, the Esplanade, and Old Toronto. Sidewalk Labs will work with Toronto Bike Share to ensure a generous provision of bike stations.

Weather Mitigation to Further Encourage Active Mobility

TORONTO'S CLIMATE IS PART OF ITS DNA, but wind, rain, and extremes of hot and cold weather keep people indoors more often than is necessary and discourage active mobility.

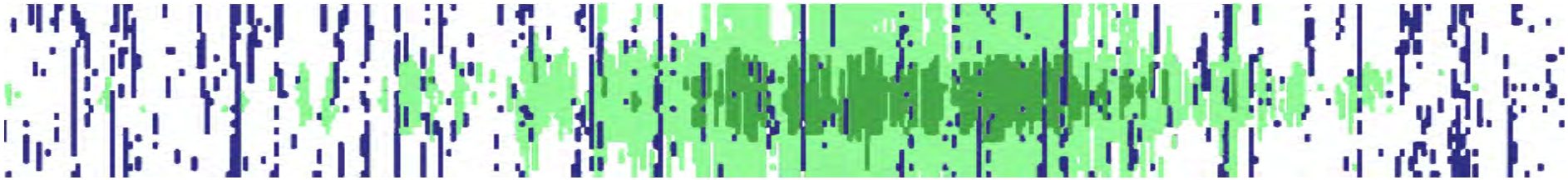
Innovative urban design, new lightweight materials, and better weather prediction capabilities make it more feasible than ever before to manage the outdoor experience without turning public spaces into indoor winter gardens. Awnings that block rain, physical structures that block wind during the winter but not during the summer, and sun shades can all add significantly to the daytime and evening hours when the experienced temperature feels comfortable to most people.

In planning Quayside, Sidewalk will incorporate a variety of weather mitigation strategies into buildings, pedestrian areas, and bike lanes. A fully implemented set of interventions could more than double the number of hours that people spend outdoors, dramatically increasing walking and cycling as a means to get around.

Weather mitigation structures will make outdoor public spaces more widely used, more of the time.

More Comfortable Hours Outdoors Per Year

Current



January — 2,364 Comfortable Hours Outdoors per Year — December

With Sidewalk's Proposed Weather Mitigations

January — 5,131 Comfortable Hours Outdoors per Year — December

Mitigating Climate: This grid shows comfortability during every hour of every day over an average year, as measured at Billy Bishop Airport. Comfort is defined using the universal thermal comfort index. In Toronto, there are on average 2,364 total comfortable hours in a year. Using analytically-determined weather mitigation interventions, including basic wind breaks and trees, Sidewalk will increase total comfortable outdoor hours to 5,131 per year.

Source: Environment Canada

Legend

- Precipitation
- Too Hot
- Comfortable
- Too Cold

Linking to Downtown: Expanding Quayside's Transit Accessibility

SIDEWALK BELIEVES THAT A FEW KEY, strategic transit investments can transform Quayside into one of the most transit-connected parts of the city. These include extensions of existing transit lines as well as the creation of new services, and will require creative partnerships with Waterfront Toronto and the Toronto Transit Commission.

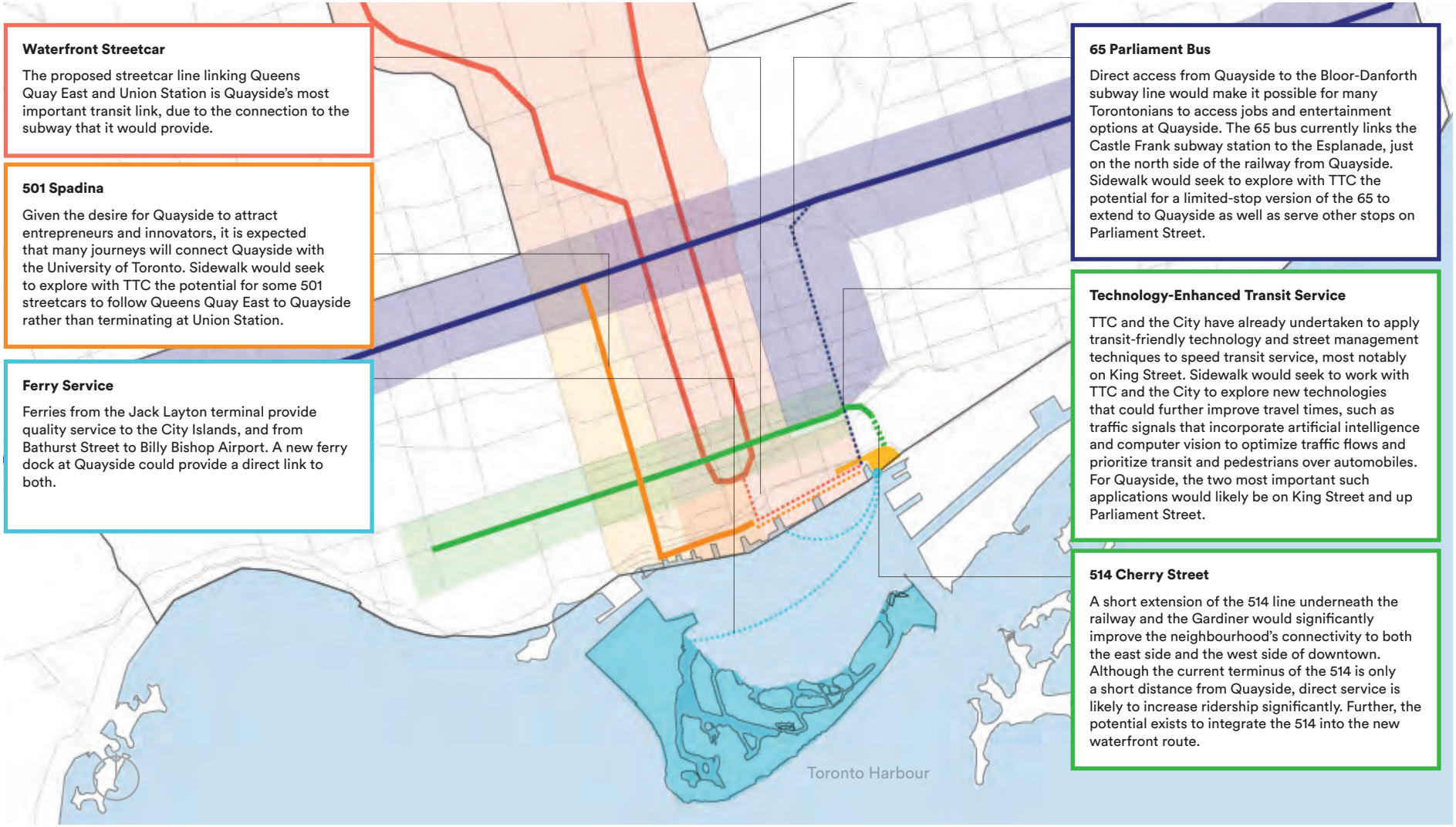
While the planned waterfront streetcar is one critical link, Sidewalk's vision includes several other incremental improvements that together will enable high-quality transit access to most downtown destinations.

This will enable most Quayside residents, and most Quayside workers, to get to their jobs by transit.

Extension of existing streetcar service is a critical part of the plan to better connect Quayside with Downtown Toronto.

Credit: Mark Wickens

Transit Enhancements



Waterfront Streetcar

The proposed streetcar line linking Queens Quay East and Union Station is Quayside's most important transit link, due to the connection to the subway that it would provide.

501 Spadina

Given the desire for Quayside to attract entrepreneurs and innovators, it is expected that many journeys will connect Quayside with the University of Toronto. Sidewalk would seek to explore with TTC the potential for some 501 streetcars to follow Queens Quay East to Quayside rather than terminating at Union Station.

Ferry Service

Ferries from the Jack Layton terminal provide quality service to the City Islands, and from Bathurst Street to Billy Bishop Airport. A new ferry dock at Quayside could provide a direct link to both.

65 Parliament Bus

Direct access from Quayside to the Bloor-Danforth subway line would make it possible for many Torontonians to access jobs and entertainment options at Quayside. The 65 bus currently links the Castle Frank subway station to the Esplanade, just on the north side of the railway from Quayside. Sidewalk would seek to explore with TTC the potential for a limited-stop version of the 65 to extend to Quayside as well as serve other stops on Parliament Street.

Technology-Enhanced Transit Service

TTC and the City have already undertaken to apply transit-friendly technology and street management techniques to speed transit service, most notably on King Street. Sidewalk would seek to work with TTC and the City to explore new technologies that could further improve travel times, such as traffic signals that incorporate artificial intelligence and computer vision to optimize traffic flows and prioritize transit and pedestrians over automobiles. For Quayside, the two most important such applications would likely be on King Street and up Parliament Street.

514 Cherry Street

A short extension of the 514 line underneath the railway and the Gardiner would significantly improve the neighbourhood's connectivity to both the east side and the west side of downtown. Although the current terminus of the 514 is only a short distance from Quayside, direct service is likely to increase ridership significantly. Further, the potential exists to integrate the 514 into the new waterfront route.

Reducing Dependence on the Private Automobile in Quayside

THE STRATEGIES OUTLINED HERE—expanding Quayside's transit connections to downtown Toronto, making it easier to cross the Gardiner, and mitigating weather conditions to make the area more hospitable to walking and cycling—will go a long way toward achieving Sidewalk's goal of reducing the share of all residents' trips made by privately-owned vehicles to 15 percent.

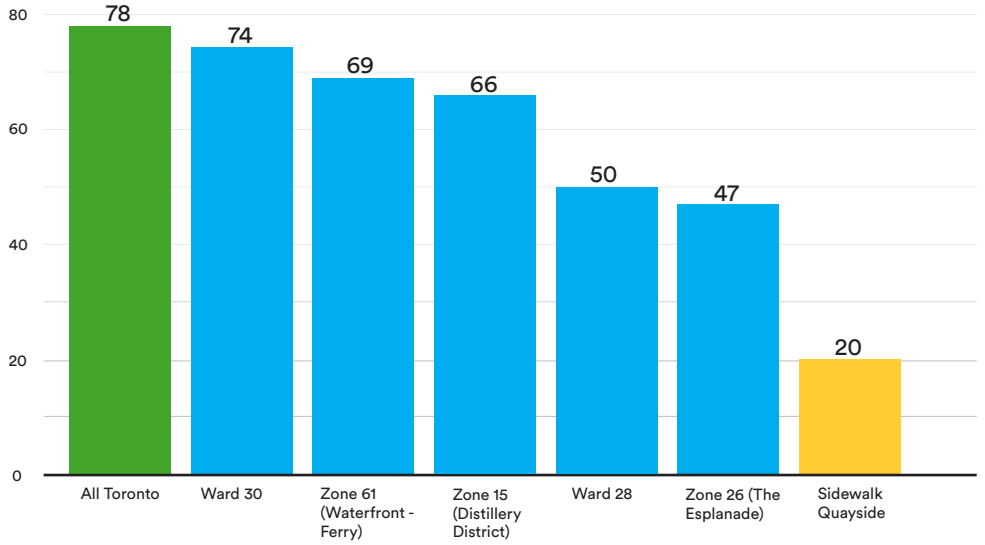
With this reduction will come a decline in rates of auto ownership. Citywide, 78 percent of Toronto households own a vehicle. The neighborhoods adjacent to Quayside have auto-ownership rates of more than 70 percent, due to their proximity to the highway and the availability of parking.

In the absence of a comprehensive mobility plan, it is reasonable to expect that Quayside will have similarly high auto-ownership rates. Even with good-practice efforts at integrating Quayside into downtown Toronto, it would be likely that Quayside would have auto ownership rates comparable to the Esplanade area, at 47 percent.

To drive the auto-ownership rate even lower—to Sidewalk's target of 20 percent—parking in Quayside will be limited and carefully managed, using a combination of Flow's technology and parking pricing strategies that discourage the discretionary use of automobiles. Further, it will be necessary to provide alternatives for those trips where people find an automobile to be genuinely useful, by offering shared rides and shared vehicles to ensure that giving up a car does not mean giving up mobility.

Reducing Auto Ownership

Percentage of households with one or more vehicles



Auto ownership levels in the current zones adjacent to Quayside reflect levels in Ward 30 rather than the rest of Ward 28, in which Quayside sits. Among other things, this reflects the proximity of the highway and the availability of parking. With Sidewalk's approach to making shared rides and shared vehicles available, and to managing parking, it will be possible to expect auto ownership rates far lower than even in the neighbouring Esplanade. Based on Ward 28 data, roughly 10% of households have no alternative to owning a car for their mobility needs; it appears that the remaining 50%+ of households own vehicles for shorter trips around the city and occasional longer trips out of the city. Sidewalk believes the combination of nearby amenities, shared rides, and car sharing can make it unnecessary to own a car for the vast majority of these purposes, making it possible to reduce discretionary auto ownership rates to around 10%, yielding target of 20% auto ownership.

Source: Transportation Tomorrow (2011)

Innovative Parking Strategies

A critical determinant of the decision to own a car, or to drive to a destination, is the availability and cost of parking. Both as a result of Sidewalk's target auto ownership rate of 20 percent, and to help achieve it, Quayside will have less than half the number of parking spaces than would be included in areas of comparable size. Sidewalk will use technology to manage and vary parking pricing and to empower travelers with information that discourages facile reliance on cars.

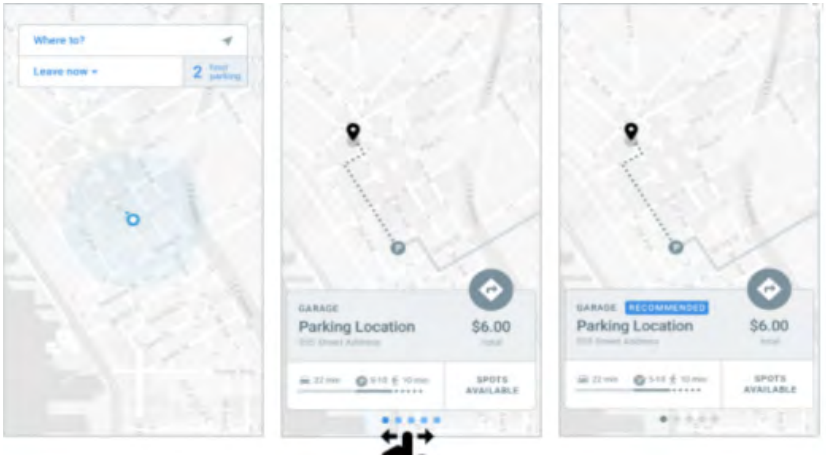
Traditionally, retail centres and attractions make parking inexpensive for all users, which inadvertently incentivizes driving even for those visitors who have a good transit alternative.

In Quayside, Sidewalk will pilot a program that keeps parking prices high, but offers discounts to people who are coming from areas, or at times, when transit options are limited. Technology will enable pricing to vary in real time based on transit availability.

Sidewalk's portfolio company, Flow, is developing products that present the true times and costs of trips (such as parking and tolls) to travelers through consumer navigation apps that they already use. This capability will be especially important when it comes to realizing the full effect of price-managed parking in Quayside.

Using Flow's technology, a user planning to travel to Quayside would see both transit and driving options, paired with all associated fares, tolls, and parking fees. Travelers would be empowered to make decisions based on the true economic costs–in time and money–of each transportation mode.

Flow's Parking Services



Information on the congestion of roads, as well as the availability and price of parking, will be communicated to the user in ways that help them make decisions that minimize frustration and driving, as shown in prototypes from Flow's Parking service.

Providing Access Where Transit Is Less Competitive

WHILE MAKING QUAYSIDE WALKABLE, BIKEABLE and transit-accessible will make it possible to conduct the vast majority of trips without a car, there will be some trips where transit is less attractive as an option. Some relatively short trips might require one or more transfers by transit, and thus driving would be much faster even in downtown traffic. A small portion of residents will have jobs or other commitments that require the frequent use of an auto. And many residents find that an automobile is useful even for occasional trips, which is why auto ownership far exceeds the number of households who rely on the automobile on a daily basis for the journey to work.

Reducing auto ownership will play a major role in ensuring that the automobile is only used for trips where it is distinctively valuable. But for those trips, enabling a car-free life requires providing options for people to get where they need to go without owning a car.

Sidewalk's vision for Quayside includes a heavy reliance on two such strategies. For short trips, shared-ride services are especially appropriate. For longer trips, car-sharing for residents can offer people the ability for the occasional trip without encouraging them to decide to buy a car.

EV Sharing for Residents

Many urbanites choose to own a car even when they use it infrequently. But owning an automobile encourages usage because many of the costs are fixed. Carsharing has demonstrated its ability to allow urbanites who do not own cars to have the occasional access they need without stimulating unnecessary driving trips, or occupying valuable land for parking.

Sidewalk's vision is to ensure that all residents have access to a fleet of shared, electric vehicles (EV). This will meet residents' needs with a fleet of vehicles only a tenth as large as if they owned cars at the rates of neighbouring areas. And by centralizing maintenance, and providing parking equipped with EV charging, the necessary transportation can be provided at a much lower cost and with little impact on the environment.

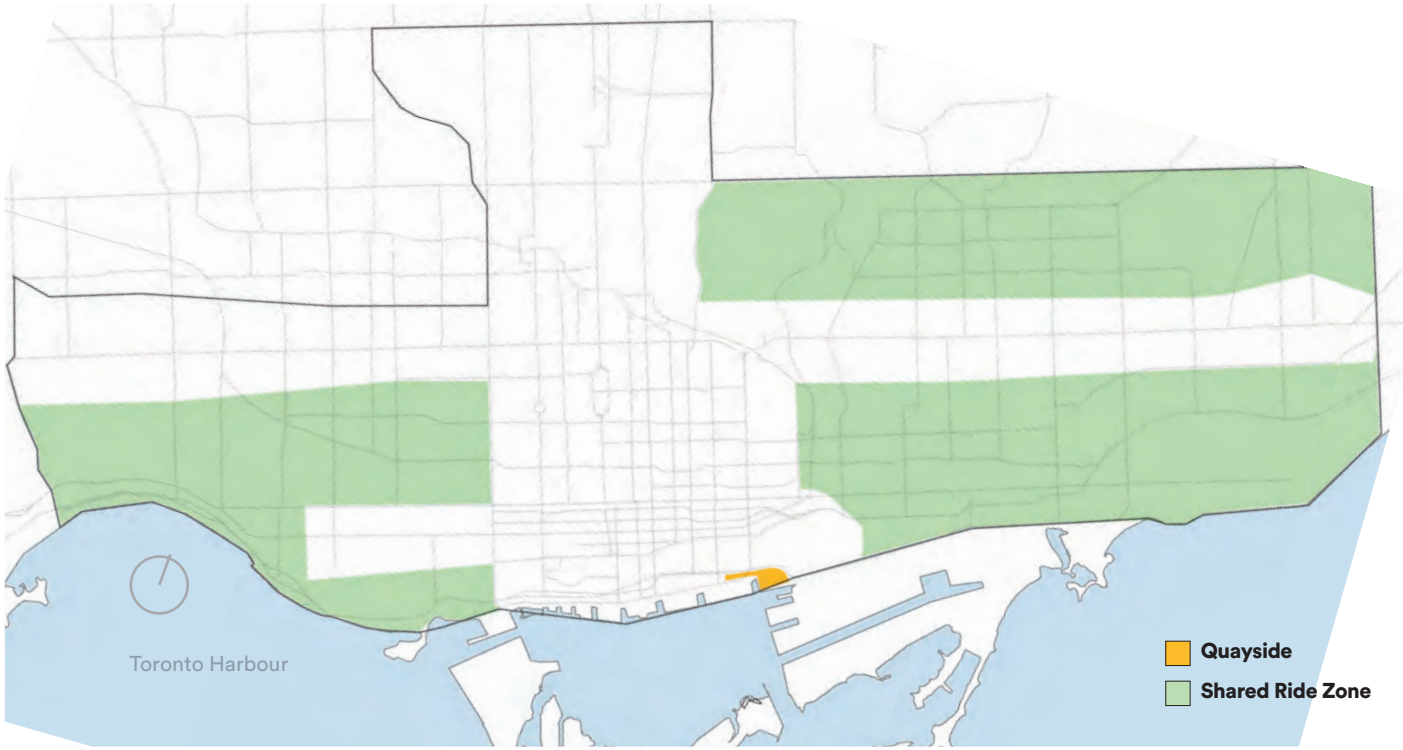
EV carsharing will provide a way for residents of Quayside to reach destinations beyond downtown easily while eliminating the incentive to own their own car.

Credit: Zipcar

The Power of Shared Ride Services to Replace Driving Alone

Many trips to and from Quayside are likely to involve destinations where there isn't enough volume to justify frequent direct bus or streetcar service, but which are less than 10 kilometers away. Today, driving would be an attractive choice for these trips. Technology offers a great solution in the form of shared ride services—such as Lyft Line, UberPool, and Waze Carpool—through which individual trips can be combined into efficient carpooling trips. In areas where enough trips occur to match trips reliably, shared-ride services can often match the bus service in terms of cost and environmental efficiency.

Sidewalk would also work with employers, retailers, and others at Quayside to offer targeted discounts and subsidies for trips when transit does not offer a high-quality option. The areas where subsidies would be offered would vary by time and day, in response to changes in transit services and demand. Users will choose the best travel mode using mobility as a service, a digital user interface showing travel times and costs for every option. Companies such as TransitApp, Google Maps, and CityMapper all offer this kind of service now, but with limitations; Sidewalk's app will ensure that users are not locked into one interface for all of their trips to and from Quayside.



For areas of downtown where ridership does not warrant direct new transit service, shared-ride services offer an environmentally friendly and cost-effective approach to high-quality mobility.

Making the Transition at Quayside to Self-Driving Vehicles

THE SELF-DRIVING VEHICLE is the most revolutionary transport technology under development, and it will be a key to making the Eastern Waterfront a global test bed for shared, urban mobility.

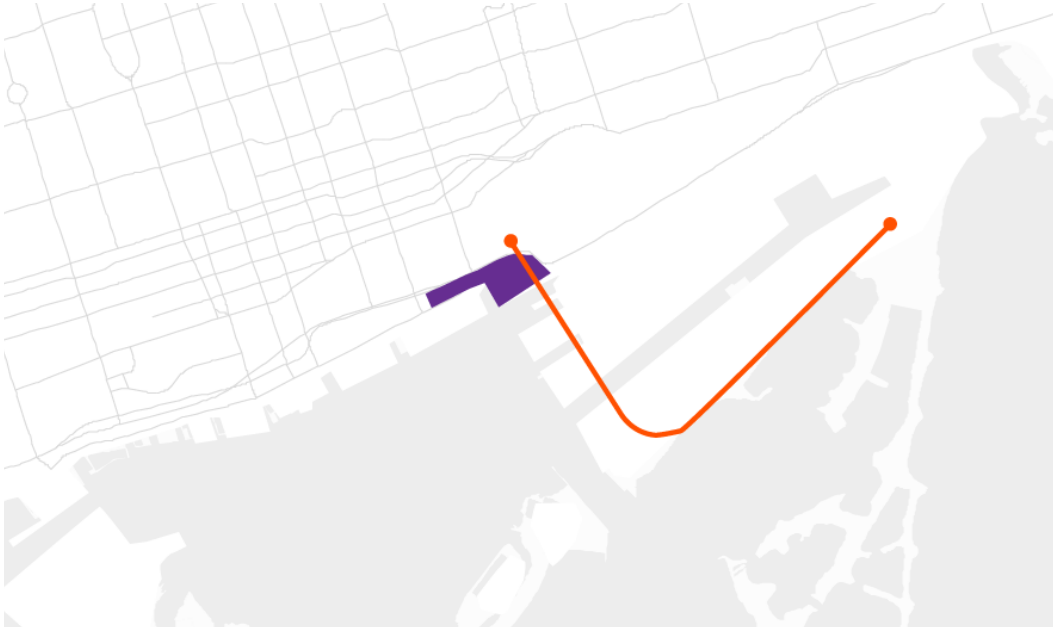
Quayside's intimate size will make it convenient to travel within the site without conventional cars—an ideal place to usher in a transition to a future without them. The street grid will be designed specifically for pedestrians, cyclists, and shared, self-driving vehicles. And the neighbourhood will immediately be open for controlled pilots of self-driving cars, including a shuttle between Quayside and Cherry Beach.

Through the design of the streets and the location of the limited parking that will be available, conventional vehicles will be restricted to a small zone that will serve as a transition, at first, to the rest of Quayside, and, ultimately, to the Eastern Waterfront—the first place in the world where conventional vehicles will be a thing of the past.

Introducing Self-Driving Technology to Torontonians

Sidewalk envisions testing self-driving shuttles on a route linking the Distillery District, Quayside, Cherry Beach and Tommy Thompson Park during the summer. Such a shuttle would alleviate parking challenges on beach days, while also linking beachgoers to retail and dining opportunities in the Distillery District.

This service would demonstrate the potential and the attractiveness of self-driving technology, and create an attraction in its own right on Toronto's waterfront, emphasizing the area's commitment to innovation.



Visitors will board an electric self-driving shuttle at the Distillery District to go to Tommy Thompson Park.

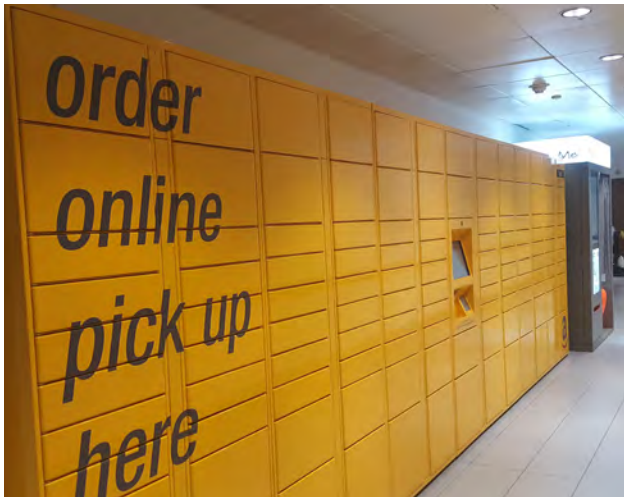
Getting Stuff When You Want and How You Want: Freight Transit

ClearPath and Amazon's Kiva have demonstrated that robots can effectively move freight in industrial and warehouse settings. The utility channels that Sidewalk plans for Quayside and the Eastern Waterfront would enable the application of this innovation to short-distance, intracity freight. A freight system that operates in the background means fewer trucks on the street, improving the experience of outdoor restaurants, cafes, plazas, and parks.

Pallet-shaped robots will be able to deliver a wide variety of items in standardized containers. At first, the system would deliver the post, which could arrive at a central mailroom; packages would be dropped off in safe, monitored zones (such as resident-only areas) or in digital lockers, located on the street or in common areas, which can only be opened by the intended recipient.

Freight transit would also be made available for the use of Quayside's businesses and residents. This would enable goods transportation 24/7, and the system would also be used to haul solid waste in sealed clear containers.

What is learned at Quayside will inform the reinvention of urban freight on a broader scale on the Eastern Waterfront. Few, if any, deliveries would arrive on traditional trucks; virtually all arriving deliveries would be routed into a consolidation or distribution centre that would sort packages and then distribute them on the underground robot network. Each delivery would be routed according to its level of urgency, perishability, or priority, and additional modes might be employed, such as delivery bikes and aerial drones. The urban freight system would make a significant contribution to reclaiming streets for pedestrians and cyclists with no loss of utility for businesses and residents.



Powerful, flat-topped delivery robots (such as the one pictured here, developed by ClearPath) can accommodate packages big and small, while sealed containers will mean that delivery of waste or food will be sanitary and dependable.

Credit: M P Hennessey

Distribution centres will consolidate deliveries, reducing the number of legacy truck and overall delivery trips in the Eastern Waterfront. The potential exists to make such parcel centres mobile, so they can be loaded in a mailroom and positioned by robot.

Credit: Lancaster University

The Future of Urban Mobility on the Eastern Waterfront

TECHNOLOGY WILL TRANSFORM URBAN MOBILITY ON the Eastern Waterfront, where traditional, privately owned vehicles will be a thing of the past.

Self-driving technology and shared-ride services will combine to create a new kind of transportation network. Functioning more like transit than like taxis today, self-driving vehicles will enable most trips within the Eastern Waterfront, and on key corridors into neighbouring areas, to take place on-demand, point-to-point, with little or no waiting time.

As a fleet of lightweight, highly-efficient vehicles, they will consume little energy; as a fleet of shared-ride vehicles, they will occupy far less space than traditional cars; and as they will be self-driving, the vehicles on the Eastern Waterfront will have fewer accidents, reliably travel at pedestrian-friendly speeds, and give pedestrians and cyclists the right of way at all times.

A ground traffic control system, using sensors to communicate electronically with vehicles, will help the system function efficiently. It will balance travel patterns, guide vehicles around areas with pedestrian traffic, and reallocate street space, as needed, to cyclists and others.

It is important to note that a new neighbourhood on the Eastern Waterfront will benefit immensely from the new Metrolink station proposed for Broadview Avenue, the further extension of streetcars, and the proposed relief line of the subway system. The Eastern Waterfront will also be home to unorthodox forms of transit. Lightweight materials and self-driving technology will combine to create a rapid transit skyway especially suited to crossing the waterways that divide the Eastern Waterfront from downtown. Those same waterways provide the opportunity for the expanded use of ferries at a smaller scale.

Few places in a major city anywhere in the world have as much potential to demonstrate the power of new technology to complement traditional transit and reimagine urban mobility. This transformation will begin in Quayside and be fully realized on the Eastern Waterfront.

The possibilities are endless for new mobility solutions on the Eastern Waterfont.

Taxibot Network: A New Form of Urban Transit

SELF-DRIVING VEHICLE USE will be expanded from a shuttle in Quayside into a shared, on-demand taxi service in the Eastern Waterfront. With door-to-door service and negligible waiting times, this "taxibot" system will combine the convenience of private cars and the efficiency of public transit.

Through mobility-as-a-service applications, passengers will be able to choose easily between nodes and will determine their own preferences, such as "ride alone" or "vehicle with roof rack." Passengers will also be able to schedule their travel, ensuring that a ride is always waiting. High-volume routes will be served by multi-passenger self-driving vans (vanbots).

Special features, such as discounted rides for low-income residents, will be enabled by settings on a given user's account and verified through the authentication system, much as a discounted transit pass today is verified by a photo ID. In the same way, employers and retailers may choose to pay for rides for workers and customers, much as restaurants and shops validate parking today.

Sidewalk Labs will work with companies such as Waymo to deploy the baseline fleet of taxibots and multi-passenger vanbots. Existing providers, such as Lyft, would be welcome to enter the market. A key goal of the taxibot system is to use competition to improve user experience, and individuals will be encouraged to include any privately-owned self-driving vehicles in the system as well.

Shared on-demand services realize the full potential of the autonomous vehicle.

Credit: DBOX

What the Taxibot Means for the Eastern Waterfront

Safer, More Pleasant Streets

The self-driving taxibot system will increase mobility within the Eastern Waterfront (and other points in Toronto, if allowed), reduce conflicts between cyclists/pedestrians and vehicles, and almost entirely eliminate the need for parking. Shared rides will dramatically cut both total vehicle-kilometers traveled (VKT) and the number of vehicles on the street at any given time, with an associated improvement in air quality and environment.

Shared Rides Means Fewer Cars

Together with other mobility solutions, taxibots are a critical means to reduce congestion and emissions in the Eastern Waterfront.

A part of the Greater Toronto Area equivalent in size and comparable density to what Sidewalk envisions for the Eastern Waterfront would have 37,600 private autos; by contrast, the Eastern Waterfront at maturity will require just 1,440 taxibots and 456 vanbots for transit, creating a far more transit-rich and auto-free environment.

	Greater Toronto Equivalent	Eastern Waterfront Projected
Automobiles	37,600 Private Cars	1,440 Shared Taxibots
Local Transit	59 Buses 8 Streetcars	456 Vanbots

Even Fewer Than Lisbon

The International Transport Forum has conducted some of the most advanced modeling to date on the potential for taxibots and vanbots to remake transportation in an urban context. Their studies of Lisbon suggest a potential reduction of vehicles by 60 percent.

On the Eastern Waterfront, the decline in cars and vehicle kilometers travelled is likely to be far more significant.

Taming Urban Traffic: Ground Traffic Control System

MAKING URBAN STREETS FLOW SMOOTHLY and safely is a rarely achieved goal in most densely populated cities.

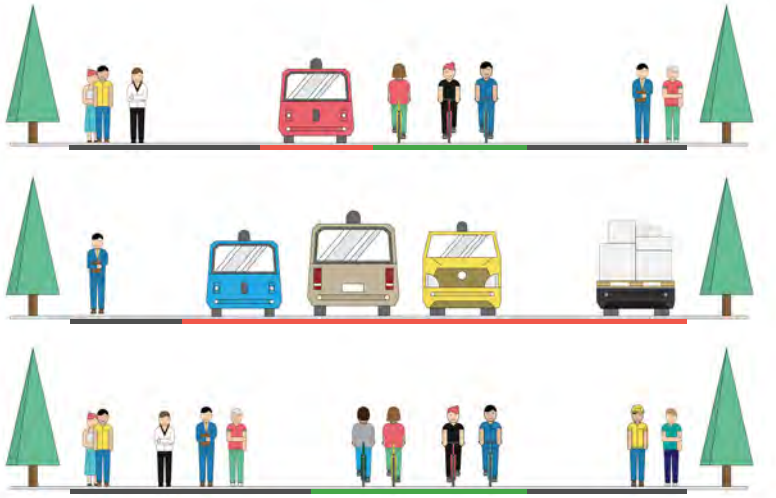
Today, our limited ability to optimize the way the streets work leads to poor performance. Pedestrians are trapped on narrow sidewalks, and crossing times do not adjust for the different needs of different people. Signals do not give priority to cyclists or transit vehicles. And even the smartest traffic signals optimize for an intersection or a corridor, not an entire district.

Sidewalk's vision for the Eastern Waterfront involves a new approach to urban traffic management, one that can draw from an exhaustive set of data inputs to optimize for safety throughput. Termed a ground traffic control system because it mimics the way air traffic control systems function, GTCS will coordinate movement in a way that takes into account the functions, capabilities, and needs of each user.

Building on Current Efforts

GTCS on the Eastern Waterfront would build on several systems Sidewalk would implement in Quayside. Sidewalk's Semaphore Lab is developing traffic lights that can identify cyclists and pedestrians, and calculate their speeds, to identify when potential collisions might occur and adjust signals accordingly. The efforts on parking management under way by Sidewalk's portfolio company, Flow, will lead ultimately to the ability to track the occupancy of all spaces on the road. Sidewalk's Model Lab is working on advanced, data-driven urban simulations that will enable a comprehensive, dynamic, and real-time traffic optimization to be developed and updated on a constant basis, re-timing signals to serve all users well. And the transportation platform that Sidewalk envisions for Quayside will gather a full picture of residents' travel preferences. Building on these capabilities, in the Eastern Waterfront, GTCS will create a new paradigm for urban transportation management.

Dynamic Streets That Collect and Respond to Data



LED lights, embedded in pavement, could enable street allocation to respond to changing needs across the day.

Magnifying the Effectiveness of Urban Mobility Policy

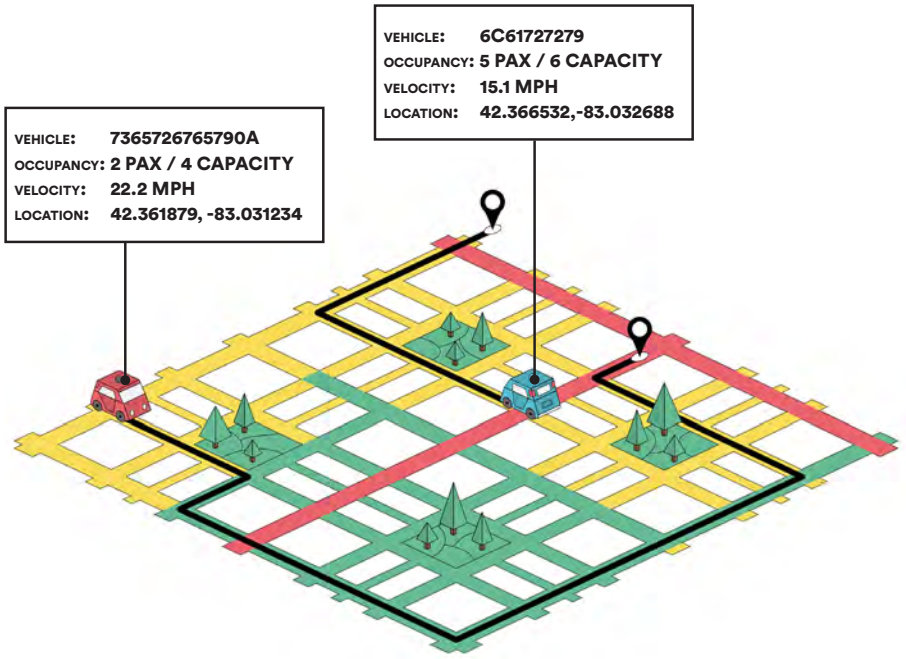
With these capabilities, GTCS would enable a number of powerful transportation policies:

Put people before vehicles. The throughput and performance of the urban street system is usually analyzed in its ability to move vehicles, rather than people. With detailed information on uses of the system–including, for example, the number of passengers in a taxibot–GTCS will be able to organize traffic so as to advantage the greatest number of users, rather than vehicles.

Emphasize reliability over speed. User research indicates that users value reliability in urban trip times over speed. In other words, trips are considered frustrating when they take 20 minutes one day and 40 minutes the next, while a reliable 30-minute travel time is easy to plan around. By maintaining consistent traffic speeds, even at lower, safer speeds, GTCS can make trips more reliable and predictable for cyclists, drivers, and transit riders alike.

Enable pricing and other incentives. While road pricing is a controversial topic in communities across North America, there is no question that incentives are important tools to influence people's mobility choices. GTCS would enable the introduction of a road pricing system that makes sense to travelers. Rather than imposing tolls on a fixed route, or charging vehicles for every kilometer traveled, GTCS would allow charging for specific, congested blocks, varied on a moment's notice, and sent to users immediately. In the context of a self-driving taxibot network, where rides involve some price already, the imposition of a road user charge would be far more acceptable than the imposition of tolls on roads that are traditionally free.

Real-time Data



With an understanding of current demand and future demands, the Ground Traffic Control System can dynamically allocate road and curb space as necessary.

Available Road Capacity

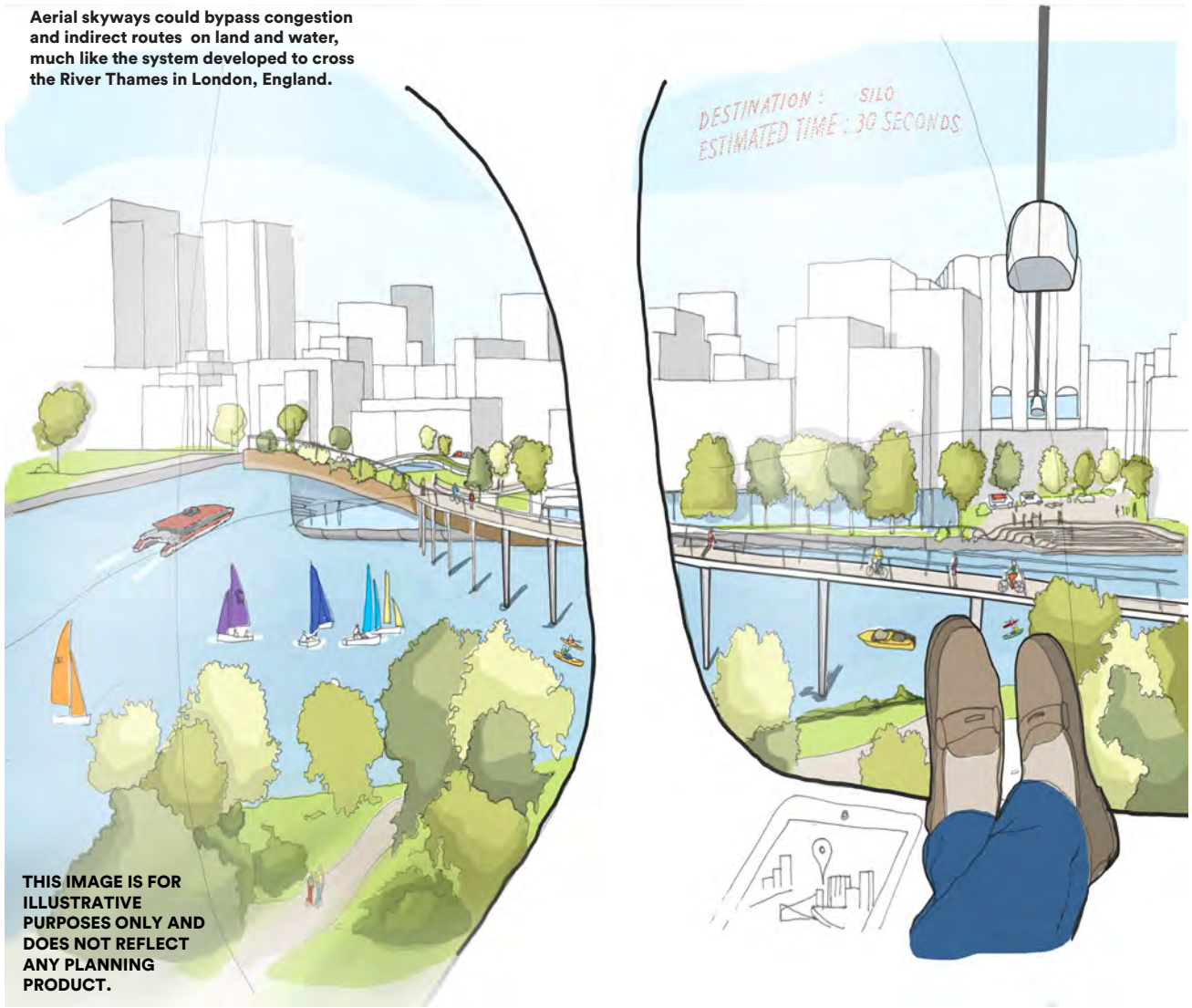
- **High availability, Low cost**
- **Medium availability, Medium cost**
- **Low availability, High cost**

Thinking Outside and Above the Box

AERIAL TRANSIT HAS LONG BEEN an objective of urban visionaries, beginning with the elevated steam railway of the nineteenth century.

From Rio de Janeiro to London, cities have already adopted the gondola as a way to offer transit, especially across barriers such as water. On the Eastern Waterfront, Sidewalk will pilot a personal rapid transit skyway system. It will combine overhead transport with lightweight vehicles and structures, and technology to make services personalizable.

This could take the form of individually dispatchable gondolas, self-driving pods, such as the Persuasive Electric Vehicle (PEV) under development at MIT, that might be able to travel on land and connect at tower-launching stations to aerial skyway cables or guideways. Advances in battery and material technology might also make it possible for lightweight overhead ramps to carry small-scale, self-driving vehicles as well as bicycles.



Aerial skyways could bypass congestion and indirect routes on land and water, much like the system developed to cross the River Thames in London, England.

THIS IMAGE IS FOR ILLUSTRATIVE PURPOSES ONLY AND DOES NOT REFLECT ANY PLANNING PRODUCT.

Taking Advantage of the Water: High-Speed Ferries

THE EASTERN WATERFRONT WOULD ALSO BE AN ideal place to make use of next-generation ferry service.

While the majority of Quayside's mobility needs will be met by Sidewalk's suite of land-based solutions, ferries will offer valuable service to the larger Eastern Waterfront site. Multiple small docks and smaller ferry vessels will allow "flex service" that deviates from fixed route service. Smaller ferries would also be useful for internal trips within the Eastern Waterfront.

High-speed ferry service from Jack Layton Ferry Terminal could provide a walk/ferry trip between Union Station and the Financial District; and ferry service to Billy Bishop Airport would enhance the district's competitiveness as a business location. New high-speed ferry vessels would be smaller and meet current damage stability criteria set by Transport Canada.

High-speed ferries could provide competitive travel times between Jack Layton Terminal (shown left), Billy Bishop Airport, and Eastern Waterfront destinations.

Credit: Mark Wickens

Thames Clippers River Bus Express, shown right, connects the London Eye and London Bridge Piers to the O2 Arena. The scenic service take 35 minutes and reduces congestion on London's bus and rail networks.

Credit: O2

Roadmap

	Product Development Strategy:
Ground Traffic Control System	Sidewalk will determine the existing and new set of data inputs that will enable the GTCS to optimize for throughput and safety. Directed parking and responsive traffic signals will form the basis during early stage development.
Self-driving Taxibots	Sidewalk will work with manufacturers of self-driving vehicles to identify and test a 6-10-person shuttle between the Distillery District and Cherry Beach, with a target operational date of summer 2018. Toronto-specific conditions will be closely studied, particularly the effect of snow on AV technology.
Personal Rapid Transit	Sidewalk will initiate discussions with proven firms in the PRT space as well as OEMs of self-driving vehicles. Several pilot projects will be conceived, including testing of new mode types like Persuasive Electric Vehicles (PEVs), so PRT transit options can be made available as soon as Quayside begins to populate. Siting work for aerial towers and cable material investigation will also begin.
Directed Parking	Sidewalk will partner with leading navigation apps to present parking availability to users. By making the data easily accessible, Quayside residents and visitors will be incentivized to switch modes, reducing congestion related to searching for parking.
Responsive Traffic Signals	Sidewalk will work with public and private partners to adapt sensor technology and develop computer vision tools that can identify pedestrians, bicyclists, and vehicles. Optimization algorithms will inform signal timing, adjusting to a wide variety of possible situations and edge cases at intersections.
Mobility as a Service	Sidewalk will either partner with an existing MaaS software provider or will develop the interface envisioned for its MaaS offering in-house. Additionally, Sidewalk will begin to conduct user studies on payment preference, comparing per trip fees to monthly fees.

Quayside Pilot:	Eastern Waterfront Manifestation:
Sidewalk will incorporate real-time parking availability and road use patterns in Quayside into a standardized data platform. Sidewalk will develop a single interface to measure levels of service across use cases, providing the foundation for a new transportation management system.	Sidewalk will transition the comprehensive "view" of road and parking use into a comprehensive "view and manage" toolkit for officials to monitor and adapt regulation to real-time parking and traffic conditions in the Eastern Waterfront.
Sidewalk will use Quayside's pedestrian-only zone as a testing site for self-driving vehicles, and the Cherry Beach shuttle will be a summer feature of the site. Depending on the progress of self-driving technology, self-driving shuttles may begin to connect Quayside with destinations in downtown Toronto, perhaps most logically to mid-Bay Street or the Castle Frank subway station.	The Eastern Waterfront will dedicate most streets for self-driving vehicle-only use, and taxibots will be a major source of urban mobility both within the Eastern Waterfront and to many destinations in downtown Toronto. Parking in the Eastern Waterfront will be dramatically reduced.
Sidewalk will pilot several approaches to PRT, soliciting feedback from residents and visitors about mode type and convenience. The findings from Quayside will enable Sidewalk and its partners to design a comprehensive PRT system that will serve the significantly larger population in the Eastern Waterfront. A prototype for aerial cables and towers will begin in Quayside or off-site.	Sidewalk will explore the development of a personal rapid transit skyway system that combines overhead transport with lightweight vehicles and structures. A route from the eastern end of the Eastern Waterfront, through Quayside, into downtown Toronto will be determined. PRT schedules and services will be surfaced to users via the MaaS platform.
Through the MaaS platform, Sidewalk will provide customized parking information and pricing to users based on their desired destination and the public transit alternatives to using a private vehicle. Realtime parking management will allow users to "book" time in loading zones in minute increments, increasing throughput and reducing inefficiencies in the parking process.	Roadway and curbside space will be charged in minute increments based on current demand and availability, setting the stage for congestion and usage-based pricing to better manage the network. With the introduction of self-driving taxibots to the Eastern Waterfront, several conventional vehicle parking facilities will transition to serve other uses.
Sidewalk will work with the City of Toronto to apply newly developed sensing technology on roads and intersections in Quayside and along Queens Quay. The sensors combined with state-of-the-art computer vision algorithms will generate new data sets on mode split, turn ratio, and analytics, paving the way for advanced signal adaptation.	Sidewalk will work with a car manufacturer or OEM partner to deploy responsive sensing technology to signal controllers for mode-sensitive, real-time traffic control and safety. At the Eastern Waterfront scale, Sidewalk expects to observe quantifiable improvements in throughput and safety.
Sidewalk will offer transport options and Quayside-related benefits via multiple MaaS providers, including subsidies for transit, rideshare carpool, bikeshare and carshare programs and information on parking. Quayside users will be able to choose the best trip based on cost, time, and other criteria.	Sidewalk's mobility-as-a-service interface will become the background layer for a taxibot dispatch service. Residents and visitors will benefit from the reliability of the service to get them to their destinations via various transit options.

A Note on Calculating the Environmental Impact of Better Transit at Quayside

ACCOUNTING FOR TRANSPORTATION-RELATED GHG emissions presents the challenge of whether to allocate a trip's impact to its origin or its destination. For a small area such as Quayside, where many trips will leave its boundaries, attributing to the neighbourhood the full emissions of every trip starting or ending in Quayside would overstate its emissions relative to the broader City of Toronto.

To solve this challenge, the relevant protocol for greenhouse-gas accounting offers two approaches.[1] The first is to allocate all trips to the place where the traveller lives. The second is to split each trip's emissions, regardless of trip purpose, between the origin and destination.

While each approach has its merits, Sidewalk has chosen the residential-allocation approach as the more appropriate to Quayside. This is for two reasons: first, because the neighbourhood will have a high proportion of residential use under most plausible programs, and second, because the programs and policies that Sidewalk adopts will likely have greater impact on residents than on workers and visitors. Thus, the residential approach is used in all of Sidewalk's greenhouse gas graphs and statistics.

We have conducted both analyses, and present them both here. Nonetheless, in both Quayside and on the Eastern Waterfront as a whole, the choice of approach to calculating the subset of GHG emissions related to transportation does not significantly change overall GHG performance. Using either approach, with all sources factored in, Quayside approaches but does not quite achieve carbon neutrality, and the Eastern Waterfront achieves Climate Positive performance.

[1] Global Protocol for Community-Scale Greenhouse Gas Emission Inventories, pp. 73-78

Transport-related GHG Emissions per Capita, Mt CO^2e per Year

	Residential method	Split-trip method	Discussion
Citywide average, 2013	3.00	3.00	
Average for Toronto waterfront based on expected auto ownership and travel patterns	2.18	3.11	Access of site to highways leads to journey to work by auto at a higher rate than Toronto average
Change from Waterfront Toronto-compliant transport demand management	-0.36	-0.52	
Waterfront Toronto expected performance	1.84	2.59	
Change from Sidewalk's mobility strategy for Quayside	-1.42	-1.03	Residents' behaviour is more affected by site-specific policies than visitors', particularly in adopting electric vehicles
Quayside performance with Sidewalk's strategy	0.42	1.30	

5.
Technical Appendix

Comments on "Toward a Regenerative Waterfront: Quayside Draft Vision Document"

Goal		Sidewalk's Responses	RFP Ref
Reactivated Waterfront			
Target	30,000 sq ft of arts and culture space	Sidewalk plans to exceed the 30,000 sq ft cultural and artistic space requirement and will bring a mix of cultural uses to the Eastern Waterfront.	A3-C
	Live-work targets	In Quayside, Sidewalk will work closely with Waterfront Toronto and local partners to provide a dynamic range of local, independent, and diverse amenities in close proximity to workplaces, meeting live-work targets.	A5-B
	70/30 use-type split	Sidewalk believes that flexible mixed use is better than a fixed-use-type split, which will create a mutually beneficial environment for residents, visitors, and business owners.	A5-B
	20% increase in resident and visitor participation in outdoor installations/areas	In addition to world-class parks and public plazas, innovations like reservable outdoor spaces will help maximize the personalization of public spaces, drawing activities outdoors.	A3-B
	>50% tree canopy coverage	Achieving greater than 50% tree canopy may prove difficult to reconcile with other spatial constraints; however, Sidewalk will obtain the benefits of tree canopy coverage through a mix of other types of greenery, physical shading, and stormwater management.	A2-D
Strategy	Urban and building design with seasonal variation (emphasis on year-round seasonal activity/winter activation, winter public gardens)	Sidewalk will mitigate uncomfortable weather conditions through physical layout, fixed and movable structures, and tree placement, while preserving the quality of being outdoors rather than indoors.	A3-B
	Flexible and seamless indoor/outdoor private amenity space and public space	Sidewalk will work with site planners to ensure that public and private spaces are closely woven together, creating a sense of neighbourhood and community.	A1-C
	Experimentation in public space through relaxation of regulations/controls to encourage transient and pop-up interventions (food, drink), micro-spaces, performance, and public artwork	Sidewalk will look to make certain outdoor spaces reservable for an array of short-term uses, such as pop-up shops or seasonal retailers, or even personal events, such as family picnics or school performances, to draw people outdoors. Additionally, Sidewalk is developing a "next-gen bazaar," a maker space with activity stalls that can be refreshed quickly and easily.	A1-C
	24/7 activation with emphasis on evening/night activity available year round	Sidewalk plans to facilitate a vibrant bar, restaurant, and nightlife scene, providing residents and visitors with ample options to celebrate, relax, or socialize.	A3-C
	Augmented reality Waterfront Toronto app with interactive information and gamification of participation in the area	Working with Google's Tango technology, inspired by the work of Playable City, and taking advantage of the urban digital platform, Sidewalk plans to experiment with the merger of the physical and digital worlds to improve the neighbourhood experience—without walling people off into their individual virtual worlds.	--

Goal		Sidewalk's Responses	RFP Ref
Adaptive and Inclusive Place			
Target	>30% affordable housing	Sidewalk believes that allocating 20-30% of housing units as affordable is an integral part of any solution, but that it still falls short of a comprehensive, sustainable strategy to deliver mixed-income housing.	A3-A
	Certification under International Living Future Institute's JUST program	Sidewalk will seek certification under the International Living Future Institute's JUST program.	--
	Rent capped at an affordable limit or pegged to income (RGI): (1) prices down to 25% of market value (2) rices chosen to be affordable for those earning 30-80% of area median income (AMI)	Sidewalk plans to develop new ways to increase housing affordability, whether through capping rent, providing rental subsidies, or other innovative approaches, but it will rely largely on the legal and financial agreement reached between Sidewalk, Waterfront Toronto and the relevant government agencies.	A3-A
	30,000—50,000 sq ft of adaptable use types	Sidewalk plans to meet these requirements through the flexibility enabled by the Loft building typology.	A3-A
	Mix of at least three different use types in single building/development	Radical mixed-use buildings combined with outcome-based code will ensure that multiple uses can coexist safely.	A3-A
Strategy	New formula to set affordable target prices based on market trends	Sidewalk's Investment Team will work with Waterfront Toronto to create innovative approaches for both the rental and residential markets.	A3-a
	Innovative affordable ownership program	A partial homeownership program, such as Options for Homes, might be a perfect fit for a family looking to settle down for the long run, whereas a retiree on a fixed income may require a rental subsidy.	A3-A
	Flexible land use and zoning permissions and built form/building types to allow multiple uses over the lifecycle of a building/community	New predictive modeling techniques and real-time monitoring can enable a shift to outcome-based building code. The outcome-based system would require buildings (regardless of use) in an area to conform to a series of safety and quality-of-place metrics that would be measured in realtime.	A3-A
	Provide full mix of housing types and tenures for multiple generations in single buildings/ development, with opportunity to adapt unit over lifetime	Sidewalk's Loft concept improves upon traditional loft buildings by planning explicitly for ongoing and frequent interior changes around a strong skeletal structure. Its structure would remain flexible over the course of its lifecycle, accommodating a radical mix of uses (such as residential, retail, making, office, hospitality, and parking) that can respond quickly to market demand.	A3-A
	Local food and employment strategy	Sidewalk will work with Waterfront Toronto to create a proposed set of standards for local food procurement and employment within the site.	--

Comments on "Toward a Regenerative Waterfront: Quayside Draft Vision Document"

Goal		Sidewalk's Responses	RFP Ref
Food Forward			
Target	Community farming/garden space available to all residents	Sidewalk will endeavour to offer residents garden space within the site to invigorate the community.	--
	Two acres of land reserved for agricultural uses	Two acres of land will have to be balanced against other desirable uses for land, but Sidewalk is eager to work with Waterfront Toronto and its team to ensure ample opportunities for urban agriculture in creative ways.	A2-D
	100% of residents will have access to food grown within the district	At the Eastern Waterfront scale, a measurable amount of onsite agriculture may be feasible, but Sidewalk also believes that Quayside should be fully integrated into the regional food and agriculture system of the Toronto area.	--
	Every resident within a five minute walk of a fresh food market	Sidewalk's concepts for flexible public space and flexible buildings should make it easy for greengrocers, farm stands, and other forms of fresh food providers to flourish throughout the neighbourhood.	A3-C
	Invest 2% of annual profit in sustainable food R&D fund	At this time, Sidewalk is unable to make specific commitments to a sustainable food R&D fund, which will depend on the nature of the financial partnership between Waterfront Toronto and Sidewalk, however Sidewalk is interested in working with WT to support sustainable food practices.	--
Strategy	Community gardens and agricultural farming (both horizontal and vertical)	Sidewalk's concepts for flexible buildings and flexible public space uses should enable a desirable mix of these approaches to emerge organically.	A3-c
	Food business incubators/co-working	Sidewalk would be enthusiastic about including food start-ups as part of the start-up ecosystem Sidewalk hopes to foster at Quayside and on the Eastern Waterfront.	--
	Pop-up restaurant / food prototype labs	Sidewalk's flexible building and public space concepts will be highly conducive to the emergence of experimental and temporary restaurants and food prototype labs.	A3-C
	Salvage grocers selling "uglies" and items that are past sell-by	Sidewalk will explore ways to encourage the sale of "uglies" in the site, and will seek to gather and redistribute useful waste in all forms as part of a holistic waste management program.	--
	Mobile app connects residents to locally sourced food delivery and to food sharing services to reduce food waste	Sidewalk's vision for a Neighbourhood Assistant application will facilitate collaboration and sharing of many forms, including food sharing; Sidewalk's vision for a freight transit system will also make food and meal deliveries within the site easier.	A3-C

Goal		Sidewalk's Responses	RFP Ref
High Performance Buildings			
Target	Architecture 2030 Challenge (site EUI)—see details	Sidewalk shares the same ideals of the Architecture 2030 challenge and is committed to planning and designing cities, towns, developments, and buildings to low-carbon/carbon-neutral standard.	--
	Green roof to cover 80% of available roof space	To satisfy Waterfront Toronto's target of 10% onsite power generation, Sidewalk estimates that 50% of roofs will need to be outfitted with solar PV, but the remaining 50% of roofs will be green roofs. Through material choices, storm-water management approaches, and public realm design, Sidewalk expects to realize most of the cooling and water retention benefits of green roofs.	A2-A
Strategy	Passive House design standards	For overall energy consumption, Sidewalk will plan to use the Passive House standard as a baseline. With a cluster of Passive House—inspired buildings, Quayside will have the potential to serve as a laboratory for the refinement of this standard to North American multifamily buildings.	A2-A
	All-electric buildings	As the centrepiece of a new approach to building energy at Quayside, Sidewalk will pilot a local thermal grid that taps multiple existing sources of energy for circulation and reuse for heating and cooling. Quayside will rely on its own microgrid with on-site renewable generation and the main grid for its electricity needs. As a result, the only fossil fuels used on the site are likely to be at the thermal grid energy centre as a rarely used backup supply, and potentially for cooking fuel.	A2-B
	Building level wastewater heat recovery	Sidewalk has incorporated sewer heat recovery into its thermal grid plan; whether the best scale for wastewater heat recovery is at the building or neighbourhood scale must be explored.	A2-B
	Database and platform for public sharing (open source) of development-wide building energy data	Sidewalk will develop clear data standards and a well-supported APIs so building energy data can be analyzed by anyone interested.	A1-F
	Smart grid laboratory with connected apartments	Sidewalk plans to outfit smart meters and controls in all buildings, which will be used to help manage the microgrid.	--

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Goal		Sidewalk's Responses	RFP Ref
Zero Carbon Energy			
Target	100% fossil fuel free	Through a sustainability strategy centred on thermal energy capture, Quayside has the potential to be nearly climate positive in its early phases, and the Eastern Waterfront can achieve climate-positive status—demonstrating a new frontier of urban climate innovation.	A2
	Net exporter of energy	The scale of the Eastern Waterfront makes it possible to incorporate massive sources of heat and cool into the system from Lake Ontario, the Portlands Energy Centre, and Ashbridges Bay Wastewater Treatment Plant, exporting significant thermal energy to the rest of the city and achieving climate-positive performance.	A2
	10% renewable energy production by cost (LEED v2009 3 points)	Sidewalk expects to generate 10 to 15% of electricity supply with 50% PV coverage and the potential use of biogas (biomethane).	A2-A
	Net Zero buildings or Net Zero adaptable by 2025	Sidewalk plans to achieve Net Zero buildings on an aggressive timeline.	A2-B
Strategy	Leverage existing, or develop further, zero-carbon district cooling and heating infrastructure (biomethane, hydrogen, natural gas, biomass, lake cooling, etc.)	Sidewalk plans to leverage sewage heat recovery, biomethane and geoexchange in Quayside. At the Eastern Waterfront scale, Sidewalk also plans to leverage lake source cooling, as well as waste heat from the Portlands Energy Centre and the Ashbridges WWTP. In both sites, natural gas boilers will be used for resilience purposes only.	A2-b
	Building scale waste-to-energy gasification	While Sidewalk is open to exploring all innovative technology, Sidewalk's current understanding is that building scale waste for energy gasification may be uneconomical because it will require a high level of presorting and a syngas engine.	--
	Power-2-Gas hydrogen storage system to store carbon-free electricity at night for use during the day	Sidewalk has incorporated onsite battery storage into the advanced microgrid concept, and is open to a variety of types of battery technologies. However, Sidewalk's current understanding is that power-2-gas storage is problematic because electrolysis is typically net negative, as it tends to use more electricity than it produces.	--
	Testbed for a range of energy generation and storage technologies new to market (e.g., glass-2-energy, hybrid hydrogen/solar panels, solar paint, carbon nanotubes)	Sidewalk is committed to encouraging innovation to more quickly realize Waterfront Toronto and Sidewalk's sustainability goals. Sidewalk anticipates piloting facade solar and other technologies as practicable.	A2
	Smart metering (smart grid) and control software to intelligently optimize energy production, to buy and sell energy to/from the grid, and to educate the public	There is limited experience in the marketplace with true multi-source district thermal systems, so Sidewalk expects to innovate around management software, ideally with a partner who has deep expertise in central thermal systems. Similarly, most microgrids have limited software and controls capability, so Sidewalk will partner and/or develop solutions to manage the two-way flow of electricity in real time.	A2-B

Goal		Sidewalk's Responses	RFP Ref
Total Connectivity			
Target	Minimum 80% reduction to regional average transport-related CO2 emissions/person	Sidewalk expects to meet this standard by encouraging non-personal automobile travel through pedestrian and cyclist-friendly infrastructure, new transit services (electric AV shuttles, pending extension of the 501 and 514 streetcars) and subsidy policies (e.g. transit pass for residents).	A3-B
	Minimum 80th percentile access to transit and access to destinations (particularly jobs) score relative to Union Station	Sidewalk has proposed a multifaceted mobility strategy, which involves AV shuttles and the extension of the 501 and 514 street cars, dynamically dispatched shared rides (such as Lyftline), and connections to major cycling routes. If implemented, Sidewalk expects to approach or meet this standard.	A3-B
	Achieve all transport-related LEED Neighbourhood Development (ND) prerequisites and 90% of credits available, and platinum-standard for transport variables under other LEED rating systems	Sidewalk expects to meet all LEED ND prerequisites and 90% of credits available.	--
	Walkscore, Transitscore and Bikescores ≥95	Sidewalk expects to meet Walkscore, Transitscore, and Bikescore ratings of 100 based on our concepts for site layout and our mobility strategy.	--
	Exemplar AV and EV-ready development for Toronto including all residential tenant parking being wired for recharging	Sidewalk plans to work with site planners to identify ideal locations for EV charging stations and will engage with AV manufacturers to ensure the site has necessary infrastructure for rapid AV deployment.	A3-B
Strategy	Autonomous shuttle scheme to supplement access to transit	Sidewalk hopes to pilot a self-driving shuttle between the Distillery District and Cherry Beach even before Quayside is developed. On the Eastern Waterfront, this can evolve into a next-generation autonomous transit system that provides point-to-point convenience without the safety risks and high costs of private cars.	A3-b
	Test-bed for autonomous vehicle trials (electric)	Working in partnership with Sidewalk's sibling company, Waymo, and perhaps others, Sidewalk would seek to use the Eastern Waterfront as a place to test two types of self-driving vehicles: a small personal vehicle and a 6—12 seat vehicle to provide shuttle service to Cherry Beach Park.	A3-B
	Install multipurpose infrastructure including self-lit, photovoltaic pedestrian and cycling surfaces	Sidewalk will pilot flexible space allocations using embedded LED lights, enabling a temporary bike lane to become a pedestrian laneway on demand.	A3-B
	'Next gen' real-time transit displays incorporating available capacity and travel time estimates	Sidewalk envisions real-time transit displays that surface announcements, delays and capacity; Intersection, a Sidewalk portfolio company, already provides these displays for the MTA in New York City.	A3-B
	Sensors to measure traffic, transit, emissions and/or pedestrian flows and generate real-time data in order to measure and test the impact of various initiatives	Sidewalk would pilot a mix of current and advanced sensor technologies (in development through its Semaphore Lab) that detect not only cars but also cyclists and pedestrians, collecting data that can be analyzed for a myriad of purposes, such as safety and traffic flow optimization.	A3-B

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Goal		Sidewalk's Responses	RFP Ref
Zero Waste			
Target	100% construction waste recovered	Material innovations, combined with off-site prefabrication, enable more eco-friendly developments that can reduce or eliminate construction waste.	A2-A
	Zero operational waste to landfill	Sidewalk expects to divert more than 80% of operational waste, working toward 100% diversion.	A1-E
Strategy	Automated (vacuum) waste collection system (e.g., Envac) with sensors	While a vacuum system is a promising solution, Sidewalk sees even greater benefit in using industrial robots to move solid waste to a central point through open utility channels. By putting waste into standardized containers that robots can move, neighbourhoods can adhere to the current three-bin approach (organics, recyclables, and landfill) while creating flexibility to accommodate any change in the sorting regime.	A2-b
	Building- or district-scale waste-to-energy (e.g., anaerobic digestion, gasification, pyrolysis, etc.)	At Quayside, Sidewalk plans to include an anaerobic digester at the central point to consume the neighbourhood's organic waste. Sidewalk would also pursue a similar strategy in the Eastern Waterfront.	A2-B
	Waste collection, processing, and energy generation from the wider Toronto area in order to be waste positive	At the scale of the Eastern Waterfront, Sidewalk will seek an onsite material recovery facility and perhaps some form of advanced waste-to-energy facility for the remainder.	A2-B
	Expansion of circular economy thinking with local manufacturers	Sidewalk will engage local manufacturers on circular economy concepts, devising pilot projects where appropriate, if it is determined to be a priority by Waterfront Toronto in the context of the overall project.	--
	Extended Producer Responsibility (EPR)	Sidewalk would be pleased to work with producers of goods and materials to identify areas to shape the behaviour of consumers and producers to help eliminate waste, if it is determined to be a priority by Waterfront Toronto in the context of the overall project.	--

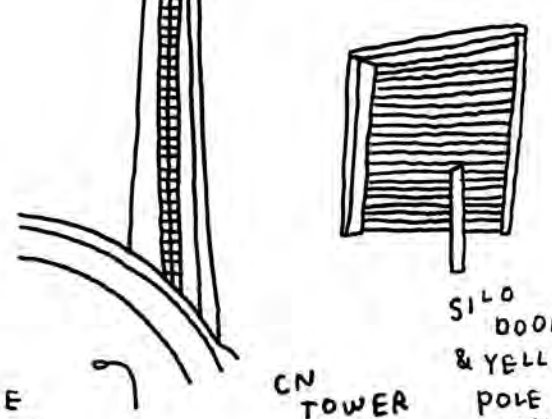
Goal		Sidewalk's Responses	RFP Ref
Material Innovation			
Target	Adoption of the Living Building Challenge Materials Petal or LEEDv4 Platinum	Sidewalk plans to achieve the LEEDv4 Platinum standard, especially given Sidewalk's focus on Passive House standards.	A2-A
	Timber structures for low-to-mid-rise buildings (remove regulatory barriers, fund testing of mass timber)	Sidewalk intends to experiment with timber structures, which offer both sustainability and cost benefits.	A2-A
	Meet LEEDv4 Low-Emitting Materials requirements for all building products and furniture	Sidewalk is committed to exploring a variety of new materials to reach the LEED standard, such as Shikkui plaster and a non-formaldehyde wood adhesive.	A2-A
	50% reduction of whole building embodied carbon	Despite challenges in accurately measuring whole-building embodied carbon, Sidewalk will consider embodied carbon and plans to incorporate advanced and natural materials.	--
	100% FSC-certified wood	Sidewalk is eager to adopt a target of using 100% FSC-certified wood, pending an analysis of availability and other potential constraints.	A2-a
	Vegetated, high-albedo, or permeable surfaces on all hardscape	Sidewalk plans to integrate vegetated and permeable surfaces on all hardscapes.	--
	1% of construction budget set aside for materials, systems, or method innovations for all building and infrastructure projects	Sidewalk expects that its aggressive agenda for building innovation will easily allow it to reach this target.	--
Strategy	Bio-based product innovations (mycelium, laminated structural bamboo, jute/flax-based FRP)	Sidewalk has already done work involving mycelium and Shikkui plaster as new, bio-based building materials, and is eager to continue this work and apply it in Quayside.	A2-a
	Facades Innovation (algae facades, photosynthetic glass)	Sidewalk plans to develop facade-based solar and facade insulation strategies to achieve Passive House and LEED standards.	A2-A
	Titaniumdioxide coatings on exterior surfaces (hardscapes and facades decompose air pollutants when exposed to UV radiation)	Sidewalk is actively researching photocatylic materials, such as Shikkui plaster, which cleans the air.	A2-A
	Policy requiring DfD and RFID/information tagging on reusable components	Sidewalk will explore approaches to tagging reusable components, if it is determined to be a priority by Waterfront Toronto in the context of the overall project.	--
	Setting embodied carbon targets for buildings and maintaining database for benchmarking	Sidewalk plans to set and monitor embodied carbon targets from a building performance perspective, however Sidewalk recognizes that there are significant challenges in monitoring from a construction material perspective.	A2-A

Comments on "Toward a Regenerative Waterfront: Quayside Draft Vision Document"

Goal		Sidewalk's Responses	RFP Ref
Water Positive			
Target	Net positive water	Sidewalk does not believe it will be feasible to make Quayside water positive; doing so would require on-site blackwater treatment, which is unlikely to be economical. However, Sidewalk's plans envision a thorough approach to providing purple-pipe water to all units.	A2-B
Strategy	Onsite wastewater treatment of building wastewater for non-potable water use—excess supply exported off-site (e.g., greywater or blackwater systems)	Sidewalk would plan to incorporate a "purple-pipe" nonpotable water feed into each building's system, which helps renters and apartment dwellers reuse water, dramatically reducing energy-intensive treatment needs.	A2-B
	Rainwater harvesting and treatment for potable water use—excess supply exported off-site	Sidewalk is eager to incorporate rainwater capture strategies into building and public realm design. Whether this water is treated on-site, used as nonpotable water, or treated at a central plant will depend on technological and economic feasibility.	A2-B
	Sewer mining of municipal collection system to increase non-potable water supply	While Sidewalk would be eager to explore onsite rainwater capture and treatment for potable uses, the Ashbridges Bay Wastewater Treatment Plant could easily supply the entire Eastern Waterfront (including Quayside) with nonpotable water, which would greatly simplify the water supply system and eliminate large amounts of energy-consuming treatment equipment at the building scale.	A2-B
	Smart water fixtures (toilets and hot/cold faucets feed information into the BMS)	Sidewalk will outfit all buildings with smart water fixtures to ensure best management of water usage, flagging abnormal or above average activity to appropriate parties.	--
	Submetering with connection to visualization dashboard	Sidewalk will combine cloud software, sensors, and controls into a new "active stormwater management" system that will reduce the size and cost of future stormwater infrastructure needed in the Eastern Waterfront.	--

Goal		Sidewalk's Responses	RFP Ref
Healthy Lifestyles			
Target	WELL Community—a Vanguard Pilot Project	Sidewalk is eager to incorporate the WELL community standard into its site planning; Sidewalk's approach to public space, active mobility, and innovative materials already incorporates many of its objectives.	--
	WELL Building Standard Gold or Platinum Certification for a proportion of buildings	Sidewalk is eager to work towards Gold or Platinum WELL Building certification for a proportion of the buildings on Quayside.	--
	Site-wide Biophilia Plan (e.g., 14 patterns of Biophilia —for indoor and outdoor use)	Sidewalk's visions for the site, especially with regard to attracting people outdoors, making nature visible, and designing around the water aspect of the site all embrace the concepts of biophilia. Sidewalk would be pleased to work with Waterfront Toronto toward a formal biophilia plan, if it is determined to be a priority by Waterfront Toronto in the context of the overall project.	--
Strategy	Biophilic design strategy	Sidewalk will work with site planners and Waterfront Toronto on a comprehensive biophilic design strategy, if it is determined to be a priority of Waterfront Toronto in the context of the overall project.	--
	Healthy materials strategy (also linked to Material Innovation Category)	Sidewalk has a track record of working with advanced, healthy, bio-based materials, and is eager to work with Waterfront Toronto towards a strategy for their use.	A2-A
	Digital platform / app promoting activity, healthy eating, relaxation, and connection to the environment	Sidewalk's overall digital strategy includes capturing a variety of data and facilitating residents' and others' uses of that data through existing and new applications.	A1-F
	Real-time sensors and transparency in operational data	Sidewalk will implement a core urban data platform governed by open standards and will open a well-designed, well-documented, and well-supported APIs to third-party developers.	A1-F
	Online platform/app for expressing views and being heard	At Quayside, Sidewalk will pilot an application called Neighbourhood Assistant to facilitate social coordination and public feedback. This platform enables Quayside residents to form new neighbourhood groups, crowd-source community needs, and access a peer-to-peer marketplace.	A1-C

A MITTEN SOMEONE LOST IN THE DISTILLERY DISTRICT



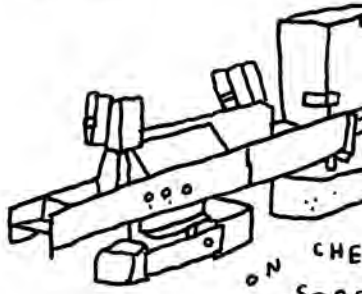
CN TOWER

SILO DOOR & YELLOW POLE ON CHERRY STREET

TWO WAVES AT SIMCOE WAVE DECK

METROLINX PRESTO KIOSK PAY STATION IN UNION STATION

FLAT SIGN ON CHERRY STREET



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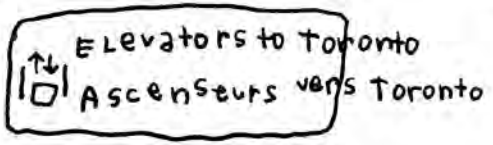
LITTLE GIRL IN TUNNEL BETWEEN AIRPORT & TORONTO

ROGERS CENTRE

PLACARD OUTSIDE SONY CENTRE FOR THE PERFORMING ARTS



PLANT IN TORONTO EATON CENTR

HEART IN THE DISTILLERY DISTRICT

BILLY BISHOP TORONTO CITY AIRPORT FERRY

ROLLED UP ROLLS (I'm NOT SURE WHAT THEY ARE) AT HARBOURFRONT CENTRE

THREE TIRES IN THE WATER AT CHERRY STREET

BARREL IN THE DISTILLERY DISTRICT

BOAT ON QUEENS QUAY EAST AND S MALL

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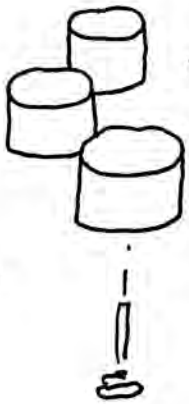

THREE SEATS IN CANADA SQUARE AT HARBOURFRONT CENTRE

BOX OF TIMBITS AT TIM HORTONS

CHEF IN RESTAURANT


SKATEBOARDER IN BERCZY PARK
SEAGULL (PLUMP)
Blue Jays Wy
Go-karts
SIGN BEHIND T&T SUPERMARKET ON POLSON
PRACTICE COURT
TWO YAMS AT T&T SUPERMARKE
BACK OF A DRIVE-IN MOVIE SCREEN IT'S GREEN ON CHERRY JUST ABOVE THE STRAUSS TRUNNION BASCULE BRIDGE ON THE FAR SIDE OF A GOLF DRIVING RANGE
TRAFFIC LIGHT IN FRONT OF CHERRY STREET BAR-B-QUE
WINDOW OF THE ROSALIE SHARP PAVILIO AT ONTARIO COLLEGE OF ART & DESIG ON McCAUL STREET
TORONTO
FIREMAN GETTING A COFFEE ON KING & SPADINA
CENTRE
MAN & WOMAN TAKING PICTURES ON THE ROD ROBBIE BRIDGE
A LEMON AT LOBLAWS
PUSH BUGGY OFF MOVATOR
SIGN AT LOBLAWS
KENSINGTON
TREE IN TOMMY THOMPSON PARK
WINDOW WASHER ON KIN STREE
Lee Valley
Tools for Life™
BIG JAR OF PEPPERS AT PARTS & LABOUR IN PARKDALE
ST. ANDREW JUST OFF SPADINA
EDGE