URBAN SUSTAINABILITY AND URBAN FORM METRICS

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INTRODUCTION

A significant milestone was recently passed, with the majority of humankind now living in cities. For the first time in the history of our species, the immediate human environment will primarily be the built environment. Accelerating urbanization does not change the fact, however, that human beings ultimately remain dependent on the environment. Cities and their growth will necessarily become major drivers of environmental and ecological change, and global sustainable development will therefore be inextricably tied to the development of cities.

As a global term, 'sustainability' attempts to balance myriad social, economic, and environmental factors, and is so complex in its application that a simple directive is useful to condense the discussion. As Wheeler succinctly describes it, sustainable urban development 'improves the long term social and ecological health of cities and towns.'[1] *As cities are the major consumers of natural resources and the major producers of pollution and waste, it follows that if they can be designed and managed so that resource use and pollution are reduced, a major contribution to the solution of the global problem can be achieved.*[2] *Urban areas will always be net consumers of resources, and major degraders of the environment, however, it may be possible to move toward a greater degree of sustainability.*

The question that this paper will address is whether the spatial built form of a city can affect its sustainability, what this relationship may entail, and what metrics might exist to help guide the growth of cities. Different points of view will be explored, illustrating the lack of consensus that exists on certain 'truths.' The relative sustainability of, for example, high and low urban densities is still disputed. Certain urban forms may appear to be more sustainable in some respects, for example in reducing travel, but detrimental in others, perhaps in harming the environment or producing social disparities. Some forms may be sustainable in a local sense, but not on a larger scale.

If advances in urban sustainability are to be made, then a connection between urban form and a range of elements needs to be established. How are issues of urban size, shape, density, and compactness, urban block layout and size, housing type, green space distribution, to be guided along a sustainable path? What is in fact sustainable urban form? How can it be achieved? I propose to investigate many of these questions by researching current debates and points of view, together with evaluating a popular and accessible urban sustainability metric to see if it can meaningfully guide sustainable urban form.

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LEED for Neighbourhood Development is a planning metric for urban sustainability and contains a normative set of 'building blocks' for sustainable urban form, in the form of a checklist of components. A review of this planning metric for community sustainability will be undertaken, as it relates to urban form, as well as inherent biases that may exist. Strengths and weaknesses of this system will be evaluated, with examples of designed and built communities broadly evaluated. The issue of how LEED-ND may be able to affect urban form will be explored, and whether it has a deep enough reach to be transformative. How this rating system can be used to measure and compare urban forms will be explored, as well as the ability of this rating system to encompass balanced social, economic, and environmental factors. A key issue is whether this, and other rating systems, can truly reverse dominant trends, or whether they are doomed to create 'sustainable islands in seas of unsustainability.'[3]

KEYWORDS
urban sustainability, LEED-ND, smart growth, new urbanism

SUSTAINABLE URBAN FORM

Sustainable urban form, as a 'pattern of human settlement,' is driven by a mix of forces broadly encompassing social, economic, and environmental factors. A consensus is needed to refine sustainability directives, as conflicts exist between many environmental goals. The complexity and contradictions of sustainability discussions requires the straining out of simple directives.

Current metrics for sustainable urban form are commonly understood to include: decreased energy use; reduced waste and pollution; reduced automobile use; preservation of open space and ecosystems; and a liveable and community-oriented environment. The relationship between energy consumption and urban form have been evaluated by Owens in some detail, who concluded that up to 70% of the overall energy used in the city could be susceptible to land-use planning.[4] Owens warns, however, that the relationship between energy systems and urban form is complex. It is difficult to predict how changes in one will affect the other, making spatial structure only one of the factors influencing energy consumption.

Wheeler identifies five holistic design values related to sustainable urban form: compactness; contiguity; connectivity; diversity; and ecological integration.[5] Jabareen similarly identifies seven core directives related to sustainability: compactness; sustainable transport; density; mixed land uses; diversity; passive solar design; and greening.[6]

There is a special role for discussions of compactness in these sustainability directives, as intensification uniquely drives urban form. Increased density is considered by many to be a key sustainability indicator. It is argued that the dispersal of cities, along with lower densities, results in increased car dependence, profligate energy use, and global pollution. However, these arguments are contentious and the evidence sometimes contradictory. Compact urban form, with the associated restrictions on car travel and the promotion of public transit, are relatively recent and contested ideas in North America.[7]

Other opinions have cautioned against the compact city 'orthodoxy' that presently prevails. Williams[8] concludes that intensification can produce urban forms that contribute to efficient land use; however, by itself it does not necessarily promote sustainability. Though the compact city does offer benefits, such as opportunities for public transport and land savings, these are not as straightforward as they might seem. Furthermore, there are considerable costs associated with environmental quality and acceptability which had not been foreseen by the advocates of the model. The greatest gains in reducing energy consumption have occurred where public transport provision is part of a major investment in green strategies of transport integration, car restraint, and enhanced pedestrian facilities. Williams concludes that simply providing transport itself will not make a difference.

Banister argues that some degree of urban containment is required,[9] that new residential development should be related to jobs and services, and that satellite developments close to and integrated with urban developments are likely to be energy efficient. While there is general agreement that compact cities can conserve land and reduce costs, other factors such as personal preference and livability need to be accommodated. However, he feels that singular objectives in the pursuit of greater energy efficiency are misguided, as a balance should be struck between transport and other social, economic, and environmental objectives.

Breheny cautions against the wisdom of going against the grain of well-established and powerful trends. For example, the suggestion that people should give up 'cherished' suburban lifestyles, for the compact city, may be unrealistic. The assumption that counter urbanism, which has been the dominate force since 1945, can be suddenly halted and even reversed may simply not be possible. He feels it may be better to redirect trends or practices, rather than try to beat them back, 'Canute-like.'[10] The compact city proposal requires a complete reversal of decentralization, which has been the most persistent trend in urban development in the last 50 years. The compact city solution does not necessarily accept that sustainability must balance environmental and other human aspirations, as there is little point in creating an alienated community for the sake of energy conservation from high densities.

Breheny concludes that policies on urban containment and urban form need to be adopted, based on the idea that certain urban forms are more sustainable than others. The following actions are recommended and have been widely adopted:

- Urban containment policies should continue.
- Extreme compact cities are unrealistic and undesirable.
- Various forms of decentralized concentration may be appropriate.
- Inner cities must be rejuvenated.
- Urban greening must be promoted.
- Public transport must be improved.
- People intensive activities must be deployed around transit nodes.
- Mixing uses must be encouraged.
- District energy systems should be promoted.

METRICS FOR BUILT FORM

In order to facilitate the widespread adoption of sustainable urbanism, benchmarks for design and development are essential. These benchmarks can give definition to the term 'sustainability,' which in its more general use has become an umbrella term that 'somehow encompasses

any altruistic thought about the environment.'[11] In particular, metrics and benchmarks are useful for the measurement and verification of civic action on sustainability. As Farr noted, '. . . our leaders trust technique . . . they require studies to provide them with 'metrics' that support 'accountability.'[12]

Three sustainability reform movements are noteworthy in that they define sustainability in accessible and complementary metrics: Smart Growth, New Urbanism, and the green building movement. While all share an interest in comprehensive economic, social, and environmental reform, they differ in their history, approaches, and focus. LEED for Neighbourhood Development (LEED-ND) is fairly recent sustainable metric, formally launched in 2009, that brings these three movements together, in the hopes that a sustainable urban design philosophy will be created. This philosophy holds that sustainable urbanism is essentially a walkable and transit-served urbanism, integrated with high performance buildings and high performance infrastructure.[13]

Some background is provided on Smart Growth, New Urbanism, and Green Building metrics, in order to further understanding of LEED-ND. Some overlap between directives is apparent, as many of the goals and initiatives are similar.

Smart Growth

Smart Growth is primarily concerned with growth management and attempts to use planning, policy, and regulatory techniques to influence the allocation of new development. Smart growth policies, as such, were first implemented in Maryland in the 1950s, and have since become codified and are increasingly viewed by regulatory authorities as a positive framework for directing development. Smart Growth is broadly defined as managed growth that attempts to fulfill the need to provide for growth while at the same time limiting the undesirable impacts of that growth. National Resources Defence Council (NRDC) defines Smart Growth as solutions that 'reinvigorate our cities, bring new development that is compact, walkable, and transit-oriented, and preserve the best of our landscape for future generations.' The goal of Smart Growth is to prevent the unplanned, haphazard, and undesirable effects of uncontrolled suburbanization. The main goals of Smart Growth include:[14]

- Open space conservation
- Boundaries limiting the outward extension of growth
- Compact, mixed use developments, amenable to walking and transit
- Revitalization of older downtowns, inner ring suburbs, and rundown commercial areas
- Viable public transit to reduce auto dependence
- Regional planning coordination
- Equitable sharing of fiscal resources

New Urbanism

The Congress for New Urbanism (CNU) views disinvestment in central cities, the spread of placeless sprawl, increasing separation by race and income, environmental deterioration, loss of agricultural lands and wilderness, and the erosion of societies built heritage, as serious problems which threaten community sustainability. Throughout the 1990s, the tenets of New Urbanism became an increasingly large part of mainstream development practice.

Peter Calthorpe, a New Urbanism spokesperson, defines sustainable urban design as follows: 'A well designed city is walkable. It's a place where your destinations are close enough to walk to and where you feel safe enough to walk. And it is a place that is interesting enough socially to make you feel that walking is perhaps something more than getting from A to B.'[15]

A basic tenet of New Urbanism is the idea of the bounded neighbourhood, defined by the radius of a walking circle. This idea was originally proposed by Clarence Perry in 1924, in his 'neighbourhood unit.' It called for an ideal neighbourhood size of 160 acres, bounded by major streets; a mix of retail, office, civic, and park uses connected by a street network; and a population large enough to support walking to school. This concept hinges on the idea of the neighbourhood unit as the basic unit of human settlement.

It is argued that the benefit of defined neighbourhoods is a finite social network, as the sidewalks and close quarters typical of urban neighbourhoods encourage sociability. The limited size of a neighbourhood increases the chance of being recognized or met by an acquaintance. People enlarge their circle of acquaintances and friends by contact on the street, and through local civic organizations and activities. The bounded neighbourhood form encourages neighbourhood identification and engagement, which is the underpinning of a true community.[16]

New Urbanist principles are in general alignment with Smart Growth principles, however, a fundamental difference is the lack of strict adherence to Smart Growth urban continguity and infill principles. Many New Urbanist projects are located in suburban or exurban areas, and as such are not particularly urban, with prescriptive urban form outcomes being the main focus. For example, New Urbanists are able to excuse a greenfield leapfrog development as long as it is designed well. This disconnect has been reconciled within the LEED-ND rating system by prioritizing the Smart Growth location principles.

Green Building Movement

LEED for New Construction (LEED-NC) is an industry established green building certification system that was created by the United States Green Building Council (USGBC) in 2003. LEED-NC has become an increasingly mainstream force that attempts to focus the building industry towards more sustainable practices in the construction of individual buildings. Energy efficiency is a core value of sustainable buildings, with the overall goal to reduce carbon emissions and related global warming. Categories in this credit-based rating system, which attempt to define a wide range of green initiatives, fall under the categories of: Sustainable Sites; Water Efficiency; Energy and Atmosphere; Materials; Indoor Air Quality; and Innovation.

LEED-ND RATING SYSTEM

Leadership in Energy and Environmental Design and Neighbourhood Development (LEED-ND) is a joint venture of the USGBC, the Congress for New Urbanism, and the Natural Resources Defence Council (NRDC), a proponent for Smart Growth policies. LEED-ND is intended to go beyond the well-established core LEED methodology of rating individual buildings, and is intended to certify entire development projects that consist of anywhere from a series of buildings to entire neighbourhoods. It is meant to be a voluntary approach, and is intended to ultimately 'transform the marketplace.' The LEED–ND pilot program

commenced in 2007, and was launched officially in 2009. It has since been adopted widely by various proponents and authorities, as standards to guide urban development.

The stated objectives of LEED-ND rating system are to improve energy and water efficiency, revitalize existing urban areas, reduce land consumption, reduce automobile dependance, promote pedestrian activity, improve air quality, decrease polluted stormwater runoff, and build more liveable, sustainable communities for people of all income levels.[17] This is consistent with the goals of Smart Growth and New Urbanism.

Because neighbourhood development projects may require long periods from inception through to construction, the LEED-ND system allows for three possible stages to certification. Stage 1 is certification based on a preliminary review, stage 2 involves certification of the plans, and stage 3 involves certification of a completed neighbourhood.

The rating system contains a number of mandatory prerequisites as well as optional attributes for which credit can be earned towards certification. A project must satisfy each prerequisite and earn a minimum of 40 credit points towards LEED-ND certification, out of a total of 110 points. Projects earning higher scores can be rewarded with LEED-ND silver, gold, or platinum certification, depending on the specific thresholds that they reach. There are four major categories in the LEED-ND rating system: Smart Location and Linkage; Neighbourhood Pattern and Design; Green Infrastructure and Buildings; Innovation and Design Process; and Regional Priority Credit. The first three categories have both mandatory prerequisites and optional criteria. The following is an overview of the categories.

Smart Location and Linkages

Smart Growth policies are expressed in this section of LEED-ND, and contiguous, dense development is a prerequisite, mandating project sites to be urban infill, brownfield, or largely urban-oriented development. This prerequisite excludes leapfrog developments and many semi-rural developments. The smart location and linkages restricts projects from being built on environmentally-sensitive sites, such as wetlands or agricultural land. This section also rewards projects further for the use of preferred locations and for locations with reduced automobile dependence.(27 points)

Neighbourhood Pattern and Design

This section is largely based on New Urbanist principles, and promotes the idea of 'creating community'[18] by implementing specific traditional neighbourhood design standards. Prerequisites include walkable streets, compact development, and a connected and open community, which disqualifies gated communities and lower-density projects from certification. The compact development prerequisite requires a minimum density of 7 units per acre (versus the norm of 2 units per acre). This is intended to both decrease the rate at which development consumes land and to concentrate population to create markets.

Prescriptive form-based criteria are included for bounded neighbourhood design, street network design, and walkable tree-lined streets. Community outreach, mixed uses, diverse income, affordable housing, universal design, local food production, and the provision of civic spaces are also promoted.(44 points)

Green Infrastructure and Building

This category requires a minimum of one project within the development to be fully certified as LEED for buildings, as well as requiring as a prerequisite that 90% of new building area be constructed with a 10% improvement in energy efficiency over a base-case building. Water savings within all new buildings must be 20% less than baseline. Solar orientation to maximize energy efficiency is encouraged. Stormwater management, construction waste management, recycled content, adaptive reuse, district heating and cooling, and heat island reduction are also promoted. (29 points)

Innovation and Design Process

The innovation category provides an opportunity to earn additional points for criteria that are important but not covered elsewhere in the criteria. This provides additional flexibility to the system. Points can also be assigned for exemplary performance in an existing credit (i.e., more water conservation). (6 points)

Regional Priority Credits

The regional priority credit gives extra points for credits that have been determined to be of extra significance locally. For instance, as Phoenix is a dry climate, extra points for water conservation are available. This category was assigned in the 2009 version of LEED-ND as a response to criticism that LEED-ND was regionally insensitive. (4 points)

LEED-ND CASE STUDIES

As part of the creation of metrics, successful demonstration projects can become a significant inspiration and motivator as a tool to learn from and evaluate. A range of solutions are needed to address the complexity and multiplicity of local conditions. As Farr[19] noted, 'there are few more powerful tools of local reform than excellent model projects.' There are presently about 24 pilot projects in Canada seeking LEED-ND certification and more than 100 in the United States. Following are two of the larger Canadian projects, West Don Lands in Toronto (unbuilt) and South East False Creek in Vancouver (built). Both projects used the LEED for Neighbourhood Development Pilot 2007 rating system, and as such do not incorporate the regional priority credits. These two examples will be broadly outlined to assist in the evaluation of LEED-ND as a sustainable urban metric

Waterfront Toronto—West Don Lands

The West Don Lands, one of the first precincts planned by Waterfront Toronto, is located on a brownfield site in the southwest corner of Downtown Toronto, with the community design initially created in 2005 by Urban Design Associates. It achieved Stage 1 LEED-ND GOLD in July 2009. It is envisioned as a high density mixed-use community with an emphasis on urban living that integrates natural and built environments. It includes high-order transit, alternate transportation modes, parks, community uses, and emphasis on design excellence. The stated intent is to provide a 'quality of place that can attract people to a lifestyle focused on walking to work, local shopping, and amenities; where living with a decreased footprint, less focused on the automobile, can be more attainable.'[20] The construction of the Don River Park and River View precinct of the development has commenced and will be fast tracked, as it will be used for the Pan Am games as the temporary Athletes Village.

West Don Lands Precinct Plan

Key Elements of the West Don Lands Precinct Plan include:

- 23 acres of parks and public spaces, including 18-acre Don River Park
- Public transit within a five-minute walk of all residences
- 5,800 residential units, including 1,200 units of affordable rental housing
- One-million square feet of employment space
- Pedestrian & cycling connections within the neighbourhood and to the city centre
- Elementary school and recreation centre, two childcare centres
- District Energy systems

The residential density is approximately 211 dwelling units/acre, with a non-residential density of approximately 4.4 Floor Area Ratio (FAR). Close to 90 percent of dwelling units will be within 1/4 mile walk distance of a transit ride and 86 percent of dwelling units will be within a 1/4 mile walk distance to a trail. Each dwelling is planned to be served by public transit within a five minute walk.

A survey of the West Don Lands LEED-ND chart shows that 61 points out of a total of 106 points are achieved, which achieves LEED-ND Gold. The breakdown is as follows (refer to Appendix for full chart):

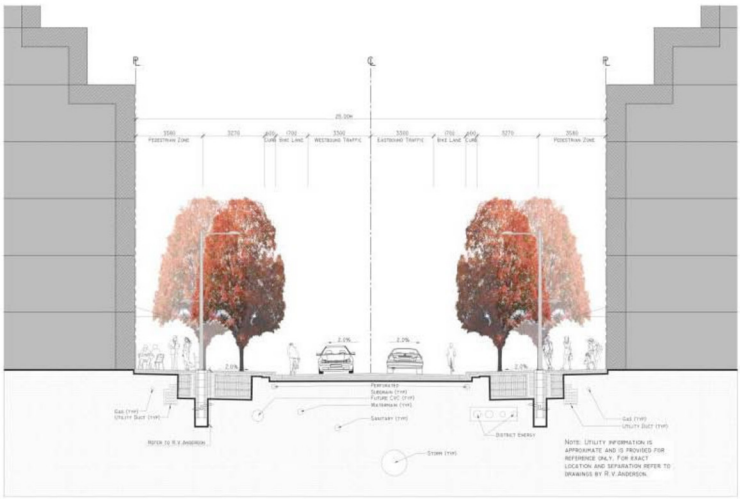
Category	Points Achieved	Possible Points
Smart Location and Linkages	26	30
Neighbourhood Pattern and Design	23	39
Green Construction &Technology	9	31
Innovation & Design Process	3	6
Total	**61**	**106**

The maximum points are assigned for the Smart Location, and a more moderate number for the Neighbourhood Pattern. A very high ratio of points are awarded for reduced automobile dependence, compact development, diversity of uses, walkable streets, reduced parking footprint, transit facilities. A very low amount of points are awarded for the Green Construction credits. It should be noted that, under the LEED-ND evaluation system, it is possible to get certified without incorporating many of the optional green construction features, which are often the most expensive and difficult to incorporate.

The built form of the development is reminiscent of traditional European city design, with mid-rise blocks, no high rises, and a dense street wall. Building heights at 6 to 10 stories on the major routes, incorporating setbacks at the upper levels, lower on the side streets. This mid-rise concept follows the idea that mid-rise is a human-scaled environment, and that the continuous rows of tree-lined building frontages form a strong sense of enclosure, a key goal of New Urbanist design. Density is quite high and is over 4.4 FAR, with 7 out of 7 possible points awarded for compact development. There is a hierarchy of street types, designed to stitch into the existing street structure, from the grand multi-laned Front Street boulevard, to the intimate mid-block residential mews. Block sizes are small, and are intended to serve as the foundation for a walkable environment. Land use is mostly residential, with retail planned for the main street frontages.

West Don Lands Streetscape

West Don Lands Street and Block Morphology



The project is oriented around the new 18-acre Don River Park, designed by Michael Van Valkenburgh, which provides a community focus. Other than that, green space is limited to the inner courtyards of residential uses and the tree lined streets.

Southeast False Creek

Southeast False Creek (SEFC) is built on a large tract of undeveloped brownfield waterfront land near downtown Vancouver, across from the False Creek Inlet. It was the site of the Vancouver Olympic Village during the 2010 Olympic and Paralympic Winter Games. The SEFC development was originally envisioned in 1999, with the final Development Plan by HBBH Architects adopted in 2006. The overall neighbourhood plan for the 80-acre site incorporates a mix of market-rate, affordable, and rental housing, with 16,000 residents and 6.5 million sf total. The Olympic Village portion of the overall development was completed in 2010, in an extremely compressed timeline. This development targeted the Stage 1 LEED-ND Gold designation, as a LEED-ND Pilot project. Ultimately the project was able to claim extra points to achieve LEED-Platinum Stage 2 certification. The high number of points is awarded based on proximity to the downtown core, mixed residential and commercial use, affordable housing, green buildings, and shoreline habitat restoration.

The project is intended to represent 'a strong civic statement with regard to housing mix, the quality of the public realm, and leadership in sustainable development. It is envisioned as a high-density mixed-use community with an emphasis on urban living that integrates natural and built environments.'[21] SEFC was developed at the highest density possible while meeting walkability, livability, and sustainability objectives. The public realm in SEFC, which includes open space, parks, streets, and pathways, is intended to connect the entire site and link the adjacent neighbourhoods, with a network of paths and streets designed for pedestri-

Aerial View of Southeast False Creek Model

ans, cyclists, and transit. A green building strategy was adopted, which requires that all individual buildings on City Lands be constructed to an objective of LEED Gold.

Key Elements of the Olympic Village completed portion of the Southeast False Creek Plan include:

- Eight city blocks on 18 acres, 16 buildings all LEED Gold minimum
- 1,100 residential units, including live/work units, total of 1.2 million sf
- 20% affordable units originally planned
- 68,000 sf commercial/office space
- 30,000 sf LEED Platinum Recreation centre completed, on the waterfront
- Pedestrian & cycling connections within the neighbourhood and to the city centre
- Elementary school, playgrounds, child care, grocery store, retail
- Salt Building—restored historic building as centerpiece of community
- District Energy systems using reclaimed City sewage heat

A survey of the LEED-ND chart shows that 71 points out of a total of 106 points are achieved, which achieves LEED-ND Gold. The breakdown is as follows (refer to Appendix for full chart):

Category	Points Achieved	Possible Points
Smart Location and Linkages	21	30
Neighbourhood Pattern and Design	24	39
Green Construction &Technology	24	31
Innovation & Design Process	2	6
Total	**71**	**106**

A consistent number of points has been awarded for the three main categories, including a very high number of points for green construction. A balanced ratio of points has been awarded for reduced automobile dependence, compact development, diversity of uses, walkable streets, reduced parking footprint, and transit facilities.

The built form of the development is reminiscent of traditional European city design, with mid-rise blocks and dense street wall. The development is midrise predominating, with a maximum of 12 stories, which is a departure from the Vancouver style point tower norm. Density is quite high and is over 3.7 FAR, which gave the development 7 out of 7 possible

South East False Creek Mid Block Mews

South East False Creek Mid Block Mews

points for compact development. The buildings are pushed to the edge of the narrow streets and courtyards. Plazas and inner courtyards create shared space and the streetscape design uses the woonerf concept of combined sidewalk/street, to encourage enhanced use of the street by pedestrians and cyclists. There is a hierarchy of street types, from the larger street to intimate mid block mews. Block sizes are small and are intended to serve as the foundation for a walkable environment.

The development is centered around the adaptive-reuse Salt Building, located in a large central plaza, and which is envisaged to become a community/retail space. Open space is largely located on the waterfront, which has a continuous boardwalk feature and community centre building. Greening is effectively located along inner block mews and is lushly represented in the streetscape landscaping, which favours large strips of soil along the street edge in which to plant numerous trees and plants. Green roofs are also abundantly located, albeit not noticeable from the street. The development that is built so far is mostly residential, with commercial use envisaged for the Salt Building and a few other locations.

LEED-ND EVALUATION

As LEED-ND has the potential to influence the world of planning and development, critical analysis of the LEED-ND certification process is needed to better understand outcomes and to evaluate the robustness of its standards in generating green neighbourhood development. LEED-ND is still very new, however, with very few built projects, so it is challenging to evaluate its effectiveness in promoting sustainable urban form in a comprehensive way. There are very few Canadian projects that are certified LEED–ND, with the Waterfront Toronto and Southeast False Creek projects being two exemplars of large-scale public-sector community projects. Both were, in fact, largely planned before the LEED-ND rating system was developed, and adjusted as the design proceeded to improve credit scores. As both projects have high LEED-ND scores, however, they are reflective of LEED-ND sustainable concepts in built form outcomes.

The reason why these public projects pursued the LEED-ND rating, even though the initial design was completed before the rating system existed, may have a lot to do with the value LEED-ND rating has for public relations, by assisting in putting the 'environmental seal of approval' on a project, and getting a 'third party' accreditation. This can assist with city processes and approvals as well as the public consultative process. In addition, the LEED-ND rating can generate considerable publicity, which can give the associated residential and commercial elements a marketing advantage.

These types of very large neighbourhood projects have an immense advantage in getting LEED-ND rating due to the scale. The LEED process may be too expensive, complex, and time-consuming for smaller projects, which may be why there are so few LEED-ND applications for smaller projects.

A traditional mid-rise European model of urban design is used in both case studies, with human-scaled, tree-lined streetscapes, consistent with the urban design goals of New Urbanism. This 'historicist' model may be questioned as the correct model for a sustainable city; however, as this traditional urban model has evolved over time to suit human needs and proven to work in many city contexts, it is perhaps unassailable as an appropriate response. However, LEED-ND would also be able to support other solutions, such as a street-based high rise project, so the flexibility exists to move in other directions.

Both case studies were able to garner many points by virtue of their inner city locations: West Don Lands had 9 out of 10 possible points for Preferred Location, and SEFC had 6 out of 10. The SEFC score was somewhat lower based on the problem that there was no existing development in the areas to be directly 'contiguous' to. Certainly the inner city project case studies presented in this report were able to maximize many of the Smart Location and Linkages credits essentially because they were already downtown, as infill locations are heavily favoured. These bonus points mean that a downtown may be able to fairly easily certify a project without incorporating many of the optional green construction points, and still achieve a LEED-ND Gold.

This inner city and urban bias is felt by some to be a bias specifically against suburban and exurban development, and that it is difficult for typical home builders to receive the LEED-ND certification[22]. There is heavy emphasis in LEED-ND on projects' location-related characteristics and much less emphasis on items in the green construction and technology categories.[23] Some critics say that that the preferred location bias is impractical; will actually increase housing costs without solving congestion or reducing automobile use; and simply displace growth to other communities that do not have similar growth-control policies.[24] Since LEED-ND and other related metrics are so new, and the timeline to see changes is so long, it will take some time to evaluate these criticisms.

Both case studies maximized the Compact Development credit, with 7 out of 7 possible points. The value of the compact development is to reduce land usage per capita and to reduce travel, and studies have indicated there are real savings possible. However, this increased density must be weighed against the need to respect the ecological carrying capacity of cities and the related liveability.[25] Garde feels that there is a fundamental conflict between the idea of dense urban form versus the desire to green the city, as well as a conflict between higher urban densities possibly reducing the quality of urban life.[26] It is possible therefore that the values of 'liveability' conflict with the values of sustainability on some levels. The compact development ideology holds to the idea of the social benefits of dense living, but again this is not proven. The implication is that tradeoffs may have to be made.

The ecological integration, or greening of the city, is very difficult to measure in a quantitative system such as LEED-ND. Greening is addressed in the rating system primarily in the credits related to tree-lined streets, habitat restoration, and reduced heat island effect, which rewards green roofs. However, the rating system overall is strictly focused on the hard built form of the city and much less focused on an underlying landscape urbanism approach, which seems to be far harder to measure in a prescriptive rating system. This relative paucity of greening and landscape planning incentives seems to be a gap in the rating system, in my opinion.

Both case studies had very high Reduced Automobile Dependence scores: West Don Lands 7/8, and SEFC 6/8. The Reduced Automobile Dependence LEED-ND credit rewards locations with multimodal transportation choices or otherwise reduced automobile usage, to reduce carbon emissions and related health effects. The compact city concept is directly related to this directive, as the compact city is considered more able to provide effective and convenient transit for users. Related advantages to this incentive include less land dedicated for parking. Studies have shown that one car owned in the city requires the provision of many supporting parking spaces located across the city to serve its parking needs, and that approximately 30% of land in the city is consumed by streets for automobiles. Therefore, the issue of reduced automobile use is quite significant and broader than carbon emissions alone. Less

land earmarked for automobiles, narrower streets, and reduced automobile use seems critical for sustainability in terms of increased land available for greening, for pedestrians, and other modes of transit.

LEED has been criticized as a set of broad national standards that are regionally and contextually insensitive. This is basically the 'the one size fits all conundrum.'[27] A rating system that is not developed for a specific region may be incompatible with local conditions, and therefore may not contribute to local sustainability goals. LEED-ND attempted to address this by adding four possible Regional Credits (out of a total of 110), but the gist of the issue remains. LEED can also be insensitive in certain site-specific circumstances, and may actually create a building that may inadvertently fail to benefit the environment. For example, a white cooling roof may be completely unnecessary in Vancouver, yet rewarded with LEED points. However, it may be argued that many of the values expressed in LEED-ND are intended to be universal and transcend regional importance, such as the social value of a walkable street.

A criticism of the LEED rating systems is that all points are weighted equally, even though some have far greater environmental benefits than others. However, it is difficult to determine the relative importance of the criteria. For instance, it is difficult to know whether solar orientation or heat island reduction will contribute more to the sustainability of a neighbourhood, even though it is known that addressing these criteria will help to some extent.[28] This lack of precise surety is, in my opinion, a necessary feature of a broad international points-based system and the benefits have to be weighed against the advantages. The inequity, or lack of precision of points, may not matter in the end as long as a balance of many points is obtained, which, as in a scattershot fashion, must hit the target at least occasionally. The flexibility of the selection of points is one of most appealing aspects to this credit system for developers, and this alone may be responsible for much of the popular uptake. A large basket of possible points, with a lot of flexibility and choice, will hopefully create a balanced representation of sustain ability, even with some anomalies.

This flexibility works well in the marketplace, allowing a project to incorporate only well-suited green building strategies. The voluntary approach probably encourages projects that are likely to achieve certification with minimal changes, but discourages projects that will require substantial changes in their planning and design. Items that are least cost-effective, therefore, are least likely to be addressed.

The rigidity of the prerequisites, which are credits that are determined to be imperative, may be an impediment to certain projects that may on the whole exhibit improved sustainability in other areas, yet will be overlooked and turfed from obtaining the rating. LEED criteria in this respect is specialized to fit a certain interpretation of sustainability, which makes it important to be sure that that is indeed the correct interpretation. As the LEED rating system is an ongoing process, and the rating system regularly updated with feedback, it is to be hoped that if there are issues that come to light, the system can be corrected and revised.

The focus on measurable and not intangible is a necessary feature of this third party, points-based system. The inherent disadvantage is that this quantitative analysis gives no credit to aesthetic factors, including the art of urban design. The huge number of LEED applications worldwide has made it impossible for the third-party assessors to carefully study each project, visit the site, or make any kind of qualitative assessment. As LEED is going global and spreading rapidly to other countries, this quantitative prescriptive bias may be the only approach that could work in this type of assessment.

CONCLUSION

Can a few 'sustainable' or 'smart' projects—such as LEED-ND projects—reverse dominant trends? Critics argue that such projects represent superficial attempts to achieve sustainability in a context where many cultural and economic factors conspire against it. Others contend that sustainability initiatives are promoted because they provide reassurance that present unsustainable patterns of growth can be maintained providing there are marginal shifts in behaviour, when what is needed is revolutionary shift in attitude. A significant contribution to sustainability can be made by putting urban infrastructure in place that offers urban residents the choice to live more resource-efficient lifestyles.

To be truly effective, urban sustainability planning must incorporate a holistic and interdisciplinary approach, and a balance of environmental, economic, and social objectives. Since there is a reasonable degree of consensus on general directions of urban sustainability planning—such as compact and efficient urban form, reductions in automobile use, and ecosystem protection—the question becomes, how to make progress toward these goals in the face of structural forces supporting unsustainable development.[29] Greater understanding and accommodation for the complex interrelation of forces that shape our cities, together with balanced and active planning, may be the way forward.

A range of coordinated policies is required, from a national to a local level, with integrated land use and transport planning. Institutional change will be necessary to achieve genuine integration of energy efficiency and other sustainability metrics into the urban development process. The creation of accountability associated to support these directions is therefore important. Rating systems models can be used as 'heuristic windows'[30] through which we can identify how policy and regulatory strategies interrelate with urban development practices. Any system of accountability and metrics also needs to identify the 'complex pathways toward different urban futures which may all claim to be sustainable.'[31] A single static notion of sustainable urban form cannot address true contextual sustainability.

Because sustainable urban form is unlikely to be contained within one fixed model, the ability of any planning system or policy directive to be adaptive to local conditions and promote flexibility and change is critically important. Changes in spatial form alone cannot determine sustainable cities. Social, economic, and environmental factors need to be woven into the mix together with massive shifts in attitudes and lifestyles. However, urban form directives and policies along with related spatial metrics have an important role to play in creating an urban form that can facilitate change and assist in adjusting our direction toward greater global urban sustainability.

The impact of LEED-ND on creating complete communities is likely to be incremental in the short term rather than transformative, as the length of time it takes to create entire communities is onerous, and the benefits and examples of complete communities take many years to become apparent. LEED-ND can assist if it can facilitate built form and lifestyle modifications and reduced demands on the environment. It is to be hoped that popular uptake in sustainability principles, with the assistance of sustainability metrics, will eventually reach a 'tipping point,' and mainstream adoption of sustainability principles will become entrenched in all levels of society.

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APPENDIX

Toronto Waterfront Area 1
Project # 10096747
Certification Level: GOLD
Stage 1
7/23/09

LEED® for Neighborhood Development Pilot

61 Points Achieved — Possible Points: **106**

Certified 40 to 49 points | Silver 50 to 59 points | Gold 60 to 69 points | Platinum 80 or more points

26 Smart Location & Linkage — Possible Points: 30

Y			
Y	Prereq 1	Smart Location, Option 1	
Y	Prereq 2	Proximity to Water & Wastewater Infrastructure, Options 1	
Y	Prereq 3	Imperiled Species & Ecological Communities, No Species	
Y	Prereq 4	Wetland & Water Body Conservation, Option 1	
Y	Prereq 5	Agricultural Land Conservation, Option 2	
Y	Prereq 6	Floodplain Avoidance, Option 1	
2	Credit 1	Brownfields Redevelopment	2
1	Credit 2	High Priority Brownfields Redevelopment	1
9	Credit 3	Preferred Locations	10
7	Credit 4	Reduced Automobile Dependence, Option 1	8
1	Credit 5	Bicycle Network	1
3	Credit 6	Housing & Jobs Proximity, Option 1	3
1	Credit 7	School Proximity	1
1	Credit 8	Steep Slope Protection, Option 1	1
	Credit 9	Site Design for Habitat or Wetland Conservation	1
	Credit 10	Restoration of Habitat or Wetlands	1
1	Credit 11	Conservation Management of Habitat or Wetlands, Option 2	1

23 Neighborhood Pattern & Design — Possible Points: 39

Y			
Y	Prereq 1	Open Community	
Y	Prereq 2	Compact Development	
7	Credit 1	Compact Development	7
4	Credit 2	Diversity of Uses	4
	Credit 3	Diversity of Housing Types	3
1	Credit 4	Affordable Rental Housing, Option 2	2
	Credit 5	Affordable For-Sale Housing	2
2	Credit 6	Reduced Parking Footprint	2
5	Credit 7	Walkable Streets	8
	Credit 8	Street Network,	2
1	Credit 9	Transit Facilities	1
	Credit 10	Transportation Demand Management	2
1	Credit 11	Access to Surrounding Vicinity	1
	Credit 12	Access to Public Spaces	1
1	Credit 13	Access to Active Spaces, Option 2	1
	Credit 14	Universal Accessibility	1
1	Credit 15	Community Outreach & Involvement	1
	Credit 16	Local Food Production	1

9 Green Construction & Technology — Possible Points: 31

Y			
Y	Prereq 1	Construction Activity Pollution Prevention	
3	Credit 1	LEED Certified Green Buildings, Option 2	3
	Credit 2	Energy Efficiency in Buildings	3
	Credit 3	Reduced Water Use	3
	Credit 4	Building Reuse & Adaptive Reuse	2
	Credit 5	Reuse of Historic Buildings	1
1	Credit 6	Minimize Site Disturbance through Site Design, Option 1	1
1	Credit 7	Minimize Site Disturbance during Construction, Option 1	1
	Credit 8	Contaminant Reduction in Brownfields Remediation	1
	Credit 9	Stormwater Management	5
	Credit 10	Heat Island Reduction	1
	Credit 11	Solar Orientation	1
	Credit 12	On-Site Energy Generation	1
	Credit 13	On-Site Renewable Energy Sources	1
1	Credit 14	District Heating & Cooling	1
	Credit 15	Infrastructure Energy Efficiency	1
	Credit 16	Wastewater Management	1
	Credit 17	Recycled Content in Infrastructure	1
1	Credit 18	Construction Waste Management	1
1	Credit 19	Comprehensive Waste Management	1
	Credit 20	Light Pollution Reduction	1

3 Innovation & Design Process — Possible Points: 6

Y			
1	Credit 1.1	Innovation in Design: Exemplary Performance in NPDc15	1
1	Credit 1.2	Innovation in Design: Exemplary Performance in GCTc1	1
	Credit 1.3	Innovation in Design	1
	Credit 1.4	Innovation in Design	1
	Credit 1.5	Innovation in Design	1
1	Credit 2	LEED Accredited Professional	1

LEED for Neighborhood Development Pilot Project Checklist

Project Name:
Primary Contact:

Instructions: In the Points Earned column, enter "Yes," "No," or "Maybe" for prerequisites and the expected number of points earned for credits. For prerequisites with more than one compliance path, enter the compliance path option # in column E, in the row under the prerequisite's name.

Points Earned			
21	**Smart Location & Linkage**		**30 Points Possible**
yes	Prereq 1	**Smart Location**	Required
		Option #: 1	
yes	Prereq 2	**Proximity to Water and Wastewater Infrastructure**	Required
		Option #: 1	
yes	Prereq 3	**Imperiled Species and Ecological Communities**	Required
		Option #: 1	
yes	Prereq 4	**Wetland and Water Body Conservation**	Required
		Option #: 3	
yes	Prereq 5	**Farmland Conservation**	Required
		Option #: 1	
yes	Prereq 6	**Floodplain Avoidance**	Required
		Option #: 3	
2	Credit 1	**Brownfield Redevelopment**	2
?	Credit 2	**High Priority Brownfields Redevelopment**	1
6	Credit 3	**Preferred Location**	10
6	Credit 4	**Reduced Automobile Dependence**	8
1	Credit 5	**Bicycle Network**	1
3	Credit 6	**Housing and Jobs Proximity**	3
1	Credit 7	**School Proximity**	1
1	Credit 8	**Steep Slope Protection**	1
0	Credit 9	**Site Design for Habitat or Wetlands Conservation**	1
0	Credit 10	**Restoration of Habitat or Wetlands**	1
1	Credit 11	**Conservation Management of Habitat or Wetlands**	1

24	**Neighborhood Pattern & Design**		**39 Points Possible**
yes	Prereq 1	**Open Community**	Required
yes	Prereq 2	**Compact Development**	Required
7	Credit 1	**Compact Development**	7
4	Credit 2	**Diversity of Uses**	4
2	Credit 3	**Diversity of Housing Types**	3
2	Credit 4	**Affordable Rental Housing**	2
maybe	Credit 5	**Affordable For-Sale Housing**	2
maybe	Credit 6	**Reduced Parking Footprint**	2
maybe	Credit 7	**Walkable Streets**	8
1	Credit 8	**Street Network**	2
1	Credit 9	**Transit Facilities**	1
1	Credit 10	**Transportation Demand Management**	2
1	Credit 11	**Access to Surrounding Vicinity**	1
1	Credit 12	**Access to Public Spaces**	1
1	Credit 13	**Access to Active Public Spaces**	1
1	Credit 14	**Universal Accessibility**	1
1	Credit 15	**Community Outreach and Involvement**	1
1	Credit 16	**Local Food Production**	1

24			
	Prereq 1	**Construction Activity Pollution Prevention**	Required
3	Credit 1	**LEED Certified Green Buildings**	3
2	Credit 2	**Energy Efficiency in Buildings**	3
3	Credit 3	**Reduced Water Use**	3
2	Credit 4	**Building Reuse and Adaptive Reuse**	2
1	Credit 5	**Reuse of Historic Buildings**	1
1	Credit 6	**Minimize Site Disturbance through Site Design**	1
1	Credit 7	**Minimize Site Disturbance during Construction**	1
1	Credit 8	**Contaminant Reduction in Brownfields Remediation**	1
3	Credit 9	**Stormwater Management**	5
1	Credit 10	**Heat Island Reduction**	1
no	Credit 11	**Solar Orientation**	1
1	Credit 12	**On-Site Energy Generation**	1
1	Credit 13	**On-Site Renewable Energy Sources**	1
1	Credit 14	**District Heating & Cooling**	1
1	Credit 15	**Infrastructure Energy Efficiency**	1
no	Credit 16	**Wastewater Management**	1
maybe	Credit 17	**Recycled Content for Infrastructure**	1
1	Credit 18	**Construction Waste Management**	1
maybe	Credit 19	**Comprehensive Waste Management**	1
1	Credit 20	**Light Pollution Reduction**	1
2			
1	Credit 1.1	**Innovation in Design: Habitat Compensation Island**	1
	Credit 1.2	**Innovation in Design: Provide Specific Title**	1
	Credit 1.3	**Innovation in Design: Provide Specific Title**	1
	Credit 1.4	**Innovation in Design: Provide Specific Title**	1
	Credit 1.5	**Innovation in Design: Provide Specific Title**	1
1	Credit 2	**LEED® Accredited Professional**	1
71			
	Certified: 40-49 points, Silver: 50-59 points,		
	Gold: 60-79 points, Platinum: 80-106 points		