Landscape Infrastructure Works as Catalyst in Urban Design: A Case Study Exploration of The Corktown Common Park in West Don Lands, Toronto

by

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ABSTRACT

Landscape Infrastructure Works as Catalyst in Urban Design: A Case Study Exploration of the Corktown Common Park in West Don Lands, Toronto

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The process of designing new urban infrastructure in an established urban context is described as "embedded process" in "plug-in" urban design. Due to the potential of urban infrastructure design to directly influence the quality of urban environments, embedded processes in "plug-in" urban design has become an issue worthy of consideration by landscape architects. Using an in-depth literature review of urban design theories--from both cultural and ecological perspectives-- and interviews as research methods, this thesis analyzed the effectiveness of landscape infrastructure in acting as a catalyst in "plug-in urban design." A set of design principles was deduced from the study and tested on the award winning Athletes Village for the 2015 Pan-American games at West Don lands, Toronto. The results of this thesis provide guidance for future improvement in landscape infrastructure and "plug-in urban design" projects.

Keyword: *landscape infrastructure; "plug-in urban design"; urban catalyst; comprehensive design principle;*

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1.0 Introduction

"Urban design becomes more like improvisational jazz.

Greenberg, (2009)

1.1 Background

The contemporary city is a complex, dynamic and expanding system. In order to meet the needs of the growing population and alleviate the pressure of population growth, the design, construction and upgrading of urban infrastructure creates increasing expectations by the public. As an integral part of the support system of the modern city, infrastructure is an important component in reurbanization in influencing the quality urban space. As Gary Strang (1996) argued, designers have most often been charged with hiding, screening and cosmetically mitigating infrastructure, in order to maintain the image of untouched natural surroundings of an earlier era. They are rarely asked to consider infrastructure as an opportunity, as a fundamental component of urban and regional form (Strang 1996). Since the 1990s, through the re-examination of traditional municipal infrastructure, many European and American cities found that the infrastructure is able to generate a positive impact on the development of urban public space; however, as a resource, the utilization of infrastructure to achieve this has been little explored. Beyond the traditional municipal function, by integrating it with multi-dimensional landscape, landscape infrastructure can also have social, aesthetic and ecological functions like the traditional park and plaza. Landscape infrastructure provides a feasible solution for urban intensification as it can serve to mitigate population concentration and the associated increase in demand for public urban open space.

Through comprehensive coordination and overall consideration of the layout of urban infrastructure and urban public open space, public space and infrastructure can be considered in an integrated, systematic manner, rather than the traditional single-function municipal project. This would result in a higher performance and dynamic form of urban infrastructure (Hung, Aquino,Waldheim 2012).

"Plug-in" urban design refers to the process of embedding a new urban catalyst, such as landscape infrastructure, into either older urban fabric or into new development, in order to accelerate the development of the surrounding area or subsequent phases of development. "plug-in" urban design is not a new paradigm; it is a new and systematic way of understanding contemporary urban design. Historically, there have been many successful "plug-in" urban design precedents in cities, such as Singapore's MRT subway system, and New York's High Line Park. Although, there are precedents of both plug-in urban design and landscape infrastructure, there is little documented in the literature that explores the combination of the two concepts in practice and no documentation could be found that explores the integration of these two strategies through the creation of design principles. This thesis explores the effectiveness of landscape infrastructure in acting as a catalyst in "plug-in" urban design.

1.2 Justification of Research

In today's urban design practice, design theories are not uncommon for mixed-use development. In practice, however, many urban designers do not align themselves solely with a single academic theory of urban design; rather, when crafting design solutions for given projects, they draw on relevant ideas from whatever theoretical

foundations seem to resonate most strongly for the project at hand. The real world of practice is in many ways, more flexible and adaptive than academic theory allows for, and the results can be very interesting. As Kenneth Greenberg states in his important recent essay "A Third Way for Urban Design," in practice "a great deal is happening" that lies between the extremes of theory (Larice, Elizabeth 2012). Further research in the area of "plug-in" urban design and landscape infrastructure because the strategies are being employed frequently in urban design practice but there is little documentation of these practices in the literature. This research undertakes an exploration of the evidence of the application of the strategies of "plug-in" urban design and landscape infrastructures in the case study of the Corktown Common Park in West Don Lands project. Results from this thesis can be used as guiding principles in the design of landscape infrastructure in the context of "plug-in urban design".

1.3 Research Goal and Objectives

Goal

The goal of this study is to explore the role of landscape infrastructure in current practice of "plug-in" urban design, and second to develop a comprehensive design principle that supports the integration of landscape infrastructure in the context of "plug-in" urban design.

Objectives

To reach this goal, the thesis will address the following;

1. Conduct a review of literature on landscape infrastructure and plug-in-urban design, and how these two design strategies can be integrated with each other within the context contemporary urban development.

2. Establish a model of design principles of Landscape Infrastructural design within an urban plug-in context, based on the results of the literature review.

3. Test the effectiveness of the design principles by applying them to the Corktown Common Park design of the West Don Lands Athlete Village as a case study through a series of professional interviews.

4. Reflection on the usefulness application of the comprehensive principle.

1.4 Thesis Organization

This thesis is organized into seven chapters. Chapter 1 depicts the general research background of this study, explains the justification of the research, defines the research goal and objectives, and presents the organization of the thesis. Chapter 2 reviews related literature on landscape infrastructure and "plug-in" urban design, and explores the role of landscape infrastructure and its contribution to the "plug-in" urban design process. Chapter 3 describes the research methods, including the methods used to develop the design principles. Chapter 4 introduces the fundamental design principles for both landscape infrastructure and "plug-in" urban design and the comprehensive design principle for both landscape infrastructure and "plug-in" urban design strategies, and then presents the results of the comprehensive design principles. Chapter 5 tests the comprehensive design principles of landscape infrastructure and "plug-in" urban design on the case study project. Chapter 6 discusses the major findings and addresses the limitations of the study. Chapter 7 highlights key findings and implications of the research, and provides recommendations for design professionals and future research.

2.0 Literature Review

2.1 Landscape Infrastructure

"Infrastructure is the spine of cities that ensures that they are functional, efficient, and effective."(Moon 2010, P.6)

2.11 Background

Cities consist of mutually interdependent systems, which are particularly important for great cities to uphold their status by maintaining efficient and effective infrastructure. Since the 1990s , through the re-examination of traditional municipal infrastructure in many European and American cities, infrastructure has come to be seen as a resource that has the ability to generate a positive impact on urban development, but this notion has not been fully developed (Belanger, 2010). In addition to the traditional municipal role, infrastructure has a larger role to play in the public realm, such as in parks and squares. Meanwhile, according to Zhai (2005), the global increase in urbanization has triggered three developments that have revolutionized the professional field of urban design, and the cooperation and integration of urban design and its related professions : first, the socio-ecological consciousness of urbanization has continuously improved since the 1970s; second, the crisis of public infrastructure funding which has been evolving since the 1980s ; third, since the 1990s, due to the of lack of repair and maintenance and the increase in severity and frequency of natural disasters, infrastructure is frequently damaged by the impact of natural disasters. These developments demonstrate that the traditional, single purpose, piecemeal and stop-gap approach to the municipal infrastructure programming model has reached its natural limits (Zhai, 2005).

In many respects, the concept of landscape infrastructure does not build only on the theoretical foundation of landscape architecture, but also draws from landscape urbanism. The interest of early theorists of landscape urbanism focused on the city as a landscape, overcoming the binary oppositions between the urban and the natural. (Carlisle, Pevzner 2013). Cultural and physical geographers have focused their analysis primarily on the physical components that constitute a city including blocks, buildings, parks, watersheds, flood plains, and habitat to name just a few. They are also concerned with the social and economic forces that drive change in the background context of the urban landscape (Waldheim 2006). James Corner (1999) believes that 'the promise of landscape urbanism is the development of a space-time ecology that treats all forces and agents working in the urban field and considers them as continuous networks of interrelationships.' As the famous economist John Kenneth Galbraith(1967) said, "In the last century, capital and power became more important than land " and the phenomenon of putting the cart before the horse indicates that we are on the turning point of the global ecology. The ecological processes and natural resources as part of the regional landscape of the overall system should not, and cannot, be separated out from the urban infrastructure in the planning and urban design process (Pierre Bélanger 2009).

The indivisibility of landscape and urbanization shows that in order to better respond to ecological, social and economic challenges, we need to consider landscape infrastructure design as part of land planning in public policy. The notion of landscape infrastructure has emerged within this socio-economic and ecological approach to urban planning and design.

2.12 Landscape Infrastructure Concept

"We will eventually formulate a new definition of landscape: a composition of man-made or man-modified spaces to serve as infrastructure or background for our collective existence; and if background seems inappropriately modest we should remember that in our modern use of the word it means that which underscores not only our identity and presence, but also our history (Morrish, Brown 2008)."

Landscape Infrastructure is a new term that emerged in recent years in American academia, and was first proposed by Gary Strang in 1996 (Belanger 2010). Strang proposed that "the potential that infrastructure systems have for performing the additional function of shaping architectural and urban form is largely unrealized (Strang 1996)" Over the past decade or two, scholars have worked to provide a definition for landscape infrastructure.

Julian Raxworthy (2005) in his book The Mesh Book: Landscape/Infrastructure sets up a theoretical position on 'landscape as infrastructure' (Raxworthy 2005); however, the critical discussion in the book about landscape infrastructure was not definitive, and as an open-ended book, a clear definition was not reached in the end (Blood 2006).

Stefan Darlan Boris (2007) describes that typically infrastructure is understood as something in which, or on which, something else runs or moves, as an underlying structure that disappears into the background of other activities. With his understanding, landscape can be characterized as the most basic infrastructure by literally being the surface upon which all the objects and activities of nature and culture take place (Boris 2007).

Another position is that landscape infrastructure is simply one way in which to focus one's attitude toward solving complex problems facing the profession. As previously mentioned, landscape infrastructure posits a set of distinct principles framing a project-- a strategy-- within a defined point of view. This emerging field takes into account green infrastructure and its problem-solving based approach, but also broadens the area of consideration to include other infrastructure-related areas (Aquino, 2009).

Zhai Jun (2010) explain that a landscape infrastructure inherits the basic principles of green infrastructure and advances it from multiple perspectives to explore the possibility of combined landscape and infrastructure, such as “landscape as infrastructure,” “infrastructure as landscape,” “landscape of infrastructure” or “landscape infrastructure”. Although the meanings vary somewhat, they all focus on the inherent relevance and possibility of integration between landscape and infrastructure (Zhai, 2010). Landscape infrastructure could be “green”, may also be a concrete, natural manifestation of the process; it may be linear, and it may be changed based on the change of characteristics of the site. It is more and more involved in a variety of basic building blocks of our society, such as health, agriculture, energy, waste and socio-economic factors. In brief, landscape infrastructure is a broader and comprehensive concept, and it goes beyond the range covered by "green" or "sustainability" (Aquino, 2009).

Based on the in-depth understanding of the role of urban infrastructure through professional practice in the design of landscape infrastructure, the designers of SWA group explain landscape infrastructure as a methodology that expands the performance parameters of a designed landscape to a multi-functional, high performance system, including those systems originally ascribed to traditional infrastructure. Similarly,

traditional urban design is oriented towards building massing and urban fabric. Urban design based on principles of landscape infrastructure is focused on landscape-based integration of the built and natural environments—seeking out innovative opportunities for building nature and public amenities into the infrastructure of a city（SWA 2011）.

2.13 Paradigm of Landscape Infrastructure

There has been considerable research in urban municipal infrastructure and green infrastructure. However, faced with the demands of increasing urban density and sustainable development, it is imperative that infrastructure delivery move away from the single function approach towards the integrated, systematic investment of landscape infrastructure development. Further research on the integration and co-ordination of "gray infrastructure" such as roads, bridges , sewers, water lines , and communication cables on the one hand, and " green infrastructure " such as ecological corridor, the green way , river networks and parks and open spaces on the other hand, needs to be carried out.

Comprehensive Collaboration

The comprehensive collaboration of landscape infrastructure is reflected in two aspects: multidisciplinary collaboration and planning content collaboration. First, due to increased popularity of a multidisciplinary approach to design, infrastructure design is no longer approached as just an isolated engineering problem undertaken by engineers with single discipline backgrounds, but is dependent on the strengthening and the integration of multiple forms of planning organization during the planning process. Through the cooperative participation of relevant professional experts of urban design and construction, integrated project design solutions can be achieved that address the

spectrum of landscape infrastructure content (Zhai, 2010). Through the use of modern means of science and technology, such as GIS, a comprehensive plan could be employed to improve coordination and overall system efficiency. Second, the planning content of landscape infrastructure embodies the integration of social, economic, environmental and urban spatial structure and morphology within an integrated, collaborative planning model. The value of this model is not only in meeting the requirements of simple technology, but also in combining social needs, economic efficiency and ecological and environmental security. Through comprehensive collaboration, landscape infrastructure can serve as a bridge between lifeless "gray infrastructure" and "green infrastructure". Such integration is conducive to the creation of exciting urban complexity and richness (Wall, 1999).

Overall coordination

The overall coordination of landscape infrastructure first refers to the coordination of the network functions within the landscape infrastructure system. A city's transportation, transmission, communication, and other municipal infrastructure are all situated within networked features (Hung, 2009). Similarly, from the consideration of ecological laws, the isolated single park, plaza, green, protected areas or other important natural or cultural resources in the urban condition are not conducive to supporting landscape ecology processes. Ecological processes also need to be supported by a network system. This common ground within the network that is shared by gray infrastructure and green infrastructure indicates a definite link between the two systems, which provides the possibility for the synergistic integration between them. Secondly, the overall coordination of landscape infrastructure also includes coordination of its internal

functions and construction (Zhai 2010). It is necessary to sort out and integrate various components of gray infrastructure and ecological elements, in order to make them work as an overall system, rather than independent of each other. It is also important to coordinate the construction, implementation and management of landscape infrastructure design to build an integrated development model (Zhai 2012).

Strategic coordination

Landscape urbanism opens conversations with developers, planners, designers and policy makers to give landscape a defined role in shaping urban growth. The multifunctional urban landscape infrastructure network system is seen as the framework for the basic strategy of urban form's generation, development and evolution. Meanwhile, the overall landscape infrastructure planning belongs to the macro-level strategic planning. In the context of regional integration and rapid urbanization, the coordination of urban and regional collaboration strategies and landscape infrastructure layout should serve as the overall program for urban development (Waldheim, 2006).

From a planning perspective, landscape infrastructure is a complicated systematic project. It is necessary to consider the relationship between land use and other public systems, collaborative implementation of the land use, construction plan coordination and arrangements, and the overall implementation of the plan in engineering design intent. Meanwhile, integrated development strategies should be considered at the level and scale of landscape infrastructure, overcoming the insufficiency of single, isolated landscape infrastructure design (Zhai,2010).

Coexistence

In 1987, the famous Japanese architect and architectural theorist Kisho Kurokawa published the book “The Philosophy of Symbiosis ". He applied the symbiosis concept to the field of architecture, as his main philosophy of urban design. He believes that in the 21st century, the term symbiosis will be the keyword of the era (Hei, Xu, 2006). His symbiotic philosophy covers all areas of social life, and its core is the concept of inclusive coexistence.

To study the comprehensive landscape infrastructure of urban systems in the context of symbiosis is to identify the basic characteristics of each of its components, as well as the symbiosis among their interdependence and mutual cooperation, emphasizing the common adaptation, common development and optimization (Pierre, 2009). On the one hand, as a dynamic, open, diversified community, the urban landscape infrastructure is not a simple sum of multi- functions, but coordination, promotion and inspiration between the various functions. Though symbiotic mechanisms, each system component interacts and collaborates, forms a variety of functional, structural and ecological relationships. Symbiosis leads to ordering, diversity leads to stability, and the various systems complement each other (Zhai, 2010). On the other hand, the urban landscape infrastructure in the urban context is not a closed space system, although it can be a more independent part of hosting urban function (Zhai, 2010). More importantly, it is the cooperative urban development of social, economic, cultural and ecological promotion of efficient cities that creates high quality urban open space systems within the symbiotic environment.

2.14 Landscape Infrastructure Elements

Table 2-1 lists the elements of landscape infrastructure, and compares them with traditional infrastructure.

Table 2-1 Landscape infrastructure elements **Source: SWA, 2012**

	Traditional Infrastructure	**Landscape Infrastructure**
Streets	Engineering and maintaining city streets based solely on the needs of automobiles.	Re-designing streets, streetscapes and pedestrian connections in ways that beautify and revitalize. Incorporating paving materials that offset heat island effect and help with storm water management.
Highways	Engineering and maintaining highways for peak-traffic efficiency.	Using highway corridors as opportunities for restoration of native habitat, re-vegetation, civic art, and storm water management.
Waterways	Channelizing or altering waterways for storm water management or roadway development.	Naturalizing disturbed, neglected creeks, rivers, bayous and other waterways for storm water management, public spaces, and urban wildlife habitat.
Alleyways	Identifying and using land on a utilitarian basis.	Creating usable parks and open space as part of a larger urban plan from opportunities presented by alleyways, power line corridors, waterways and other traditional infrastructure venues.
Railways	Maintaining or converting established rail lines.	Repurposing railway corridors for hiking and biking trails. Creating additional opportunities for parks, open space and habitat.
Parks and Open Space	Generally not considered as part of infrastructure.	Utilizing parks and open space to nurture a respect for nature provide recreational venues and link communities.
Urban Design	Focusing on location of structures and connections.	Synthesizing buildings, streets, corridors and natural systems. Integrating public spaces and nature into the city.

2.15 Summary

In the field of education, many schools have conducted studios and seminars to focus on the pattern of future urban infrastructure. In 2012 The landscape infrastructure Symposium at the Harvard Graduate School of Design, invited a group of architects, landscape architects, historians, engineers, and ecologists to explore “the future of infrastructure and urbanization beyond the dogma of civil engineering and transportation planning” and “to propose responsive strategies that address the predominant challenges facing urban economies today” (Carlisle& Pevzner 2013).

"The structure and forms of urban infrastructure, has been extended to become the functional structure, spatial layout and self-regulation and guiding factors of urban development. The successful resolution of ambitious and challenging urban development will depend on sound and integrated infrastructure improvement (Chen, Zhang, Zhou, Yu, 2007)." Clearly, the simple centralized grid and hierarchy system of urban infrastructure under modernism is no longer effective, and will be replaced by a more comprehensive, efficient, economical, open and more sustainable infrastructure – landscape infrastructure.

As a vehicle and conduit of versatile function of the modern city, landscape infrastructure has the ability to provide a symbiotic interface between the green infrastructure led by various ecological processes and gray infrastructure led by public works, and mediate the collaboration, interaction and linkage between them through cooperation, exchange, and creating a mosaic between each other, until common adaptation is achieved with the co-optimization of the collective development. Only in this way could it form maximized efficiency and minimized costs overall between the

various elements of urban infrastructure features, achieving the synergistic coexistence and integrated operational landscape infrastructure development paradigm of regional ecological networks, transportation networks and outdoor recreational networks (Pierre, 2010). The goal of this new paradigm is to achieve the “comprehensive arrangement of urban open space system development". It is no longer a city machine which meets only the high performance goal, but a living, versatile hybrid. It no longer succumbs to simplified modernist principles, but expresses a higher level of complexity, and expresses the intention of "civic" services, both physical and social (Zhai, 2010).

Needless to say, the theory and practice of landscape infrastructure is still a new field, and it is still in the process of formation. The concept of landscape infrastructure is still frequently intersected with other concepts. (Such as ecological infrastructure, green infrastructure). Nevertheless, the idea of landscape infrastructure is a challenge of traditional urban infrastructure through an in-depth reconsideration after centuries of industrialization and urbanization (Zhai, 2010). The paradigm of landscape infrastructure reflects cross-disciplinary thinking and collaborative partnerships. It not only provides a new perspective, but also implies a new methodology of integration.

2.2 Plug-in urban design

2.21 Plug-in as a concept

With regard to the origin of the concept of plug-in urban design, there are two major urban design trends that contributed to its development. One, based on the pragmatic notion of seeing urban infrastructure as the catalyst of integrated urban

development; the other, associated with the concept of the Archigram group in the 1960's. This research explores the first concept, the notion of urban infrastructure as catalyst, however, the ideology of the Archigram is also considered relevant to some degree (Lang, 2005).

The idea of the Archigram group paints a picture of the paradigm of urban infrastructure based on a throwaway society. Within this concept, precincts of cities could be plugged into the existing framework of a city, as needed. and moved away to another location as needed. This idea is far-fetched within the urban context being explored, but may be applicable on a small scale for temporary accommodations. What is important, however, is the more general thinking behind the concept of plug-in urban design, the insertion of a piece of new urban fabric within a larger, existing urban context (Lang, 2005).

In his book "Urban Design", Jon Lang (2005) proposed a classification methodology of urban design and the concept of "plug-in" urban design, and further described "plug-in" urban design, where the design goal is to create the infrastructure so that subsequent developments can 'plug in' to it or, alternatively, where a new element of infrastructure is plugged into the existing urban fabric to enhance a location's amenity level to serve as a catalyst for development (Lang, 2005).

Based on Attoe and Logan's understanding, "A catalyst is an element that is shaped by a city and then, in turn, shapes its context. Its purpose is to create incremental, continuous regeneration of the urban fabric. The important point is that the catalyst is not

a single end product but an element that impels and guides subsequent development." (Attoe and Logan, 1992).

2.22 Type of "Plug-in urban Design"

The category of the product of plug-in urban design is based on the scales of urban fabric (city level, precinct level, and architectural complex level), the embedded sequence of infrastructure (1, where the infrastructure has preceded building and 2, where it has been plugged into an existing built environment).

Based on the understanding of the urban design process, Jon Lang divided "plug-in" urban design into two categories: The first type involves the provision of the infrastructure of, usually, a precinct of a city or suburb, and the selling of sites onto which individual developers can plug in buildings. The examples include urban links such as highways, roads, heavy- or light-rail links, and pedestrian and cycle-ways. They are embedded into the old urban infrastructure, linking cities into units. The second type involves plugging the infrastructure (catalyst) into an existing urban fabric to enhance its amenity value. Examples are specific civic building investments such as museums, schools, art galleries, new residential development, and expositions (Lang, 2005).

From Attoe and Logan's (1992) point of view, the urban catalyst has the following characteristics:

1. The introduction of a new element (the catalyst) causes a reaction that modifies existing elements in an urban area. Although most often thought of as economic (investments beget investments), catalysts can also be social, legal, political, or

architectural. The potential of a building to influence other buildings, to lead urban design, is enormous.

2. Existing urban elements of value are enhanced or transformed in positive ways. The new intervention does not obliterate or devalue the old but can redeem and enhance it.

3. The catalytic reaction is contained; it does not damage its context. To unleash a force is not enough. Its impact must be channeled.

4. To ensure a positive, desired, predictable catalytic reaction, the ingredients must be considered, understood, and accepted. (Note the paradox: a comprehensive understanding is needed to produce a positive, predictable and contained effect.) Cities differ; urban design cannot assume uniformity.

5. The chemistry of all catalytic reactions is not predetermined; no single formula can be specified for all circumstances.

6. Catalytic design is strategic. Change occurs not from simple intervention but through careful calculation to influence future urban form step by step. (Again, a paradox: no one recipe for successful urban catalyst exists, yet each catalytic reaction needs a strategic recipe.)

7. The goal of each product of a catalytic reaction is better than the sum of the ingredients. Rather than a city of isolated pieces, a holistic city is imagined.

8. The catalyst need not be consumed in the process but can remain identifiable. Its identity need not be sacrificed when it becomes part of a larger whole. The persistence of

individual identities—many owners, occupants, and architects—enriches the city (Attoe & Logan 1992).

Jiaming (2010) further developed the idea of plug-in urban design. His viewpoint is that the object embedded into the urban fabric (the subject) enhances a location's amenity level and can be viewed as the accelerant. He summed up a series of spatial forms of the catalyst based on Jon Lang's study. The three different forms of the catalysts are shown in figure2.1, 1.Linear plug-in, 2. Annular plug-in, and 3.Node plug-in.

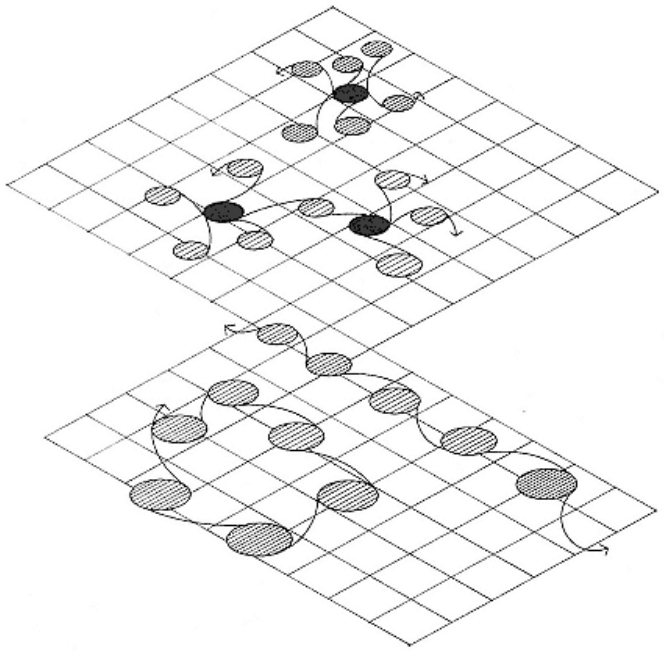


Figure 2-1: Catalytic reactions can take several forms: Node plug-in. (top), multi- node plug-in, Linear plug-in, and . Annular plug-in (lower left). (Attoe & Logan 1992).

1. Linear plug-in usually represents a liner open space system, that includes mobile traffic systems such as rapid bus transit systems, metro, highways, and linear recreational open space systems such as greenways and pathways. Integrating a series of points along the linear infrastructure accelerates city revival.

2. Annular plug-in generally refers to the annular public space at the architectural complex level, such as the skyway system in the city center, annular pedestrian systems, and annular bicycle trails. It is able to connect the old and new area, and form an integral, open loop system.

3. Node plug-in is often used in the beginning of the new town development, to prepare infrastructure for the subsequent constructions of plug-in urban design, such as schools, rail systems, but it is also frequently used in the renewal of downtowns, and brownfield redevelopment projects. Through the construction of infrastructure entities that are functionally complementary with the surrounding, both environmental and economic benefits are realized (Jiaming 2010).

2.23 The principle of plug-in urban design

Hierarchy and strategy of plug-in

As previously documented, Plug-in urban development can be divided into three levels: city level, precinct level, and architectural complex level. In general, the development of the city level will bring a subsequent development of precinct level and architectural complex level. As an example, the MRT system of Singapore consists of a loop MRT with seven major nodes/new towns varying in size from 100,000 to 400,000 people, being plugged into it (Lang, 2005). Construction of stations along the MRT has caused a surge of construction of the surrounding CBD areas and high density functional building. Generally, the level system is irreversible, but occasionally, the dominant level system will be challenged by the differing interventions in the radius of the embedded

plug-in. Therefore, the impact of level and radiation intensity should be considered, based on the actual situation of the plug-in and specific site considerations.

Similar to the catalyst in chemical reactions, different types of catalysts may either accelerate or slow down the reaction. Different amounts of catalyst can also lead to differences in the nature and extent of the final product. The type, level, magnitude, location and other factors of plug-in are important considerations. Therefore, choosing the design of the plug-in should focus on strategic considerations. It should focus on how much the subsequent reaction is desired, rather than the spatial equilibrium and amount of the quantity.

Persistence and limitation of plug-in

When a region promotes regional development through infrastructure construction, the force generated by the plug-ins is often sustained, and with the follow-up of subsequent developments, the promoting effect of the individual plug-in will be relatively diminished.

The city is an intricate and diverse complex and the specific role of the numerical range of plug-ins is difficult to quantify. The sphere of influence of a plug-in cannot be assigned an absolute value. Rather, the radius of each plug-in depends on its level and nature. For example, the impact of a museum of notoriety (architectural complex level) will not be less than the impact of a subway system (city level). The impact of a landmark is usually stronger than other elements on the same spatial level.

Inheritance and identification

For any successful embedded urban design, it is essential that the design of the plug-in intervention considers contacting with local cultural circumstances, natural conditions of the site, and economic development considerations. Only in this way, can the plug-in intervention integrate with the city as an organic whole, and give full play to the role of a catalyst. The spatial and functional identifiability of plug-in is important. Both of them are central to the catalytic effect. For the spatial identifiability, it is not only the spatial expression of the inner meaning of the plug-in that is important, it is also a means to enhance the attractivity of physical space.

2.24 Summary

The proposition of plug-in urban design is based on a creative notion with a profound understanding of the way of urban space and the urban fabric operates. "The goal of infrastructure projects is to have a catalytic effect on their surroundings– social and physical (Lang,2005)." As Attoe and Logan (1992) believe, rather than simply resolving a functional problem, creating an investment, or providing an amenity, urban catalysts have a greater purpose. Although Jiaming (2010) has tried to explore a series of catalyst based interventions in his study on design precedents, the results indicate further exploration of completed projects is required to assess outcomes of catalyst interventions. The catalytic theory prescribes essential characteristics for urban developments to realize the power to kindle catalytic action. The focus is on the interaction of new and existing

elements (infrastructure) and their impact on future urban form, not the approximation of a preordained physical ideal (Attoe and Logan, 1992).

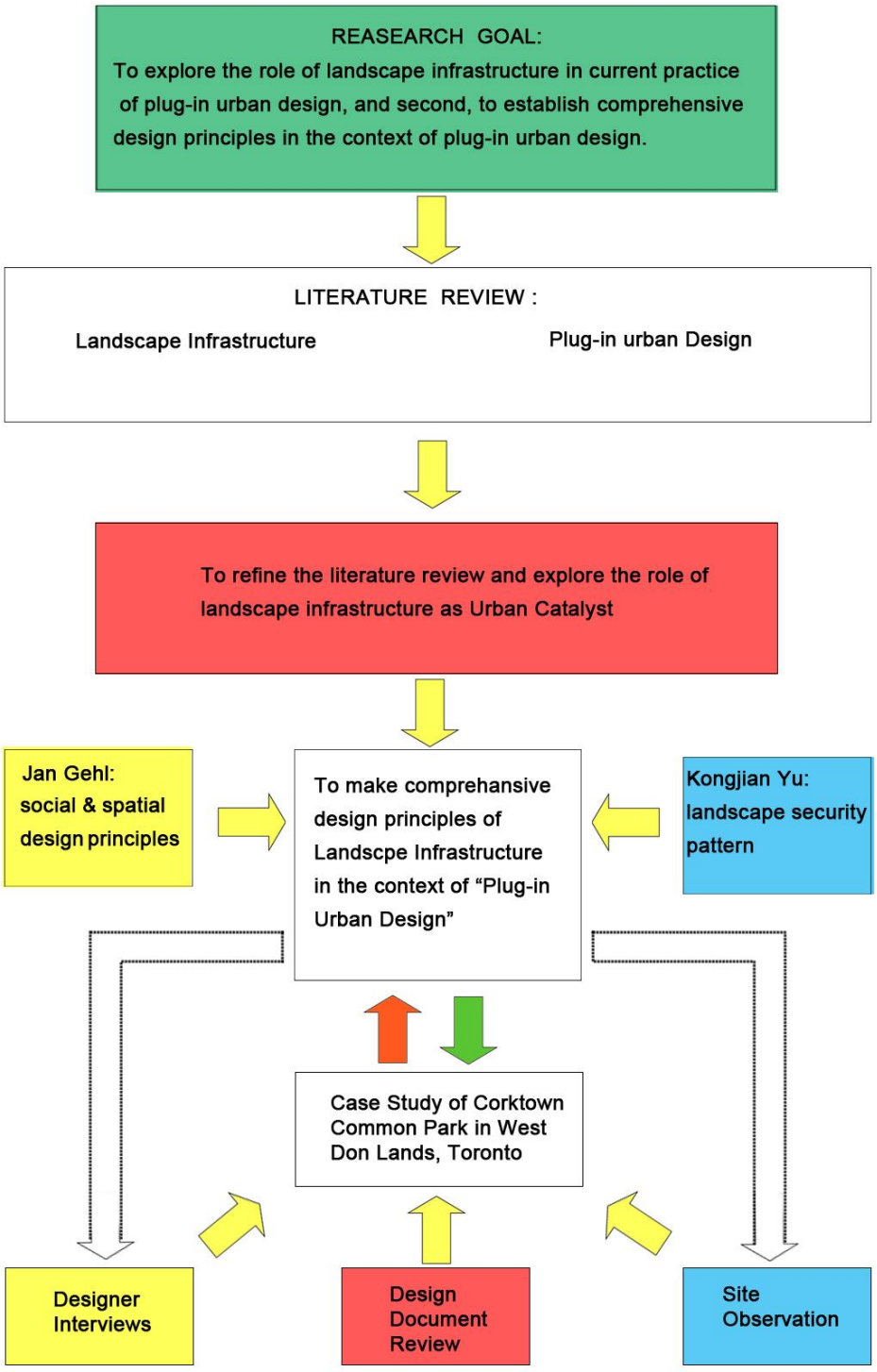
Compared to the "find-it and fix-it mentality," the focal point of the "plug-in urban design" theory is more focused on the discussion and analysis of the relationship between the components in the network of various urban functional areas. This has been reflected in its emphasis on accelerating the surrounding environment; paying attention to careful catalyst selection according to local conditions, emphasizing identifiable and sustainable catalysts; paying attention to the reasonable guidance of forces and influences on the results, noticing synergies between the design components, and forming the understanding of the characteristics. In the context of "plug-in urban design," landscape infrastructure can be seen as the urban catalyst.

In order to achieve the research goal, a comprehensive set of design principles is needed, based on the characteristics of landscape infrastructure, integrated with the strategy of the of urban catalyst.

3.0 Research Method

This research was undertaken to illuminate the factors that guide and influence the planning and design of landscape infrastructure. The thesis utilized four qualitative methods. First, basic terminologies of landscape infrastructure, "Plug-in Urban Design" and urban catalyst, were defined and the relation between these terminologies in existing literature was examined. Second, fundamental theories from both ecological and cultural aspects were deduced from the literature review to assist in developing comprehensive principles of landscape infrastructure design. Third, a case study of Corktown Commons was then conducted and the design principles deduced from the second step were applied. The case study project has been popularly acknowledged by communities locally internationally by planning and design professionals as an achievement that successfully embeds landscape infrastructure in the initial design phase of infill urban development within an existing highly urbanized area. Following a detailed description of the case study based on the design documents review and field observation, design attributes and design responses were summarized for the project. Lastly, the design ideas and principles deduced from the case study were used as background information to conduct a series of semi-structured interviews with the primary designers and planners for the project which focused on key design aspects, design attributes and design processes. Based on the information gathered from the first three steps, similarities and the differences between the proposed and existing design principles were distinguished and used to develop guidelines for landscape architects in the design of landscape infrastructure in "plug-in" urban design.

Table 3-1 Research Methodology Flowchart



4.0 Comprehensive Design Principle

The urban design field has an abundance of theory to draw on; both seminal theories that helped establish the field and more recent theories directed at establishing new approaches. The older theories helped shape the evaluation of the field (Larice, Macdonald, 2013). Since the definition and nature of Landscape Infrastructure and plug-in urban design has been successfully explored, in order to evaluate the Corktown Commons project, and to establish the criteria for landscape infrastructure design, three fundamental design theories are explored from, cultural, ecological and plug-in urban design aspects.

4.1 Life between buildings

Based on the analysis and understanding of the requirements of people and their activities on the physical environment, Jahn Gehl (1971) in his book "Life Between Buildings" has extracted a series of characteristics of ideal outdoor space. Gehl sorts the human outdoor activities into 3 categories: necessary activity, spontaneous activity and social activity. The successful design of outdoor space depends on providing appropriate conditions for the intended activities to achieve spaces that enjoy a high degree of utilization.

He believes that the urban structure, which is the planning layout of buildings, should support the ideal social structure both visually and functionally. Visually, the buildings and material urban form which locate around the squares or streets should express the social structure. Functionally, the establishment of indoor and outdoor public

spaces should be established at all levels of the urban hierarchy to support these social structures.

By summarizing the design attributes from Jan Gehl's theories(2011), the following design principles have been established:

1, From the public space to private space, create a spatial hierarchy to establish a gentle buffer zone.

2, To create a compact civic space system, establish road networks with high convenience and accessibility.

3, Reduce car speed, and carefully arrange parking spaces to support civic space.

4, Through the comparative study of different special scales, design a pleasant outdoor space with human scale.

5, Create a multifunctional and integrated layout of uses and activities to enhance the vitality of the street interface.

6, Design irregular and varied building facades to support the creation of a flexible street and civic space interface.

7, Design the space for social activity along the street or the boundary of large space.

8, Set support elements in the public space to enhance the comfort level for people to encourage extended use.

9. Design space to increase human comfort in sheltering users from adverse weather, and design space to take advantage of good weather (Gehl, 2011).

4.1 Landscape Security Pattern

The Landscape security pattern utilizes the theory and methods of landscape ecology as a foundation, based on the relationships of landscape processes and patterns, through the analysis and simulation of landscape process to determine the landscape pattern which identifies the key importance for the health and safety of these processes (Yu, 2005).

With Steinitz's model shown in figure 4-1 The Frame Work for Planning, Kongjian Yu provides an activate framework for the landscape security pattern. This framework shows that planning is not a passive process entirely based on natural processes, resources and conditions to pursue the most suitable and optimal solutions. In many cases, it can be a bottom-up process that clarifies the problem that needs to be solved in the planning process, identifies the primary objective, then using this as a guide, collects data, looking for answers. The first 2 steps of the framework are the process of problem analysis and the last 2 steps are the process of problem-solving (Yu,Li,2005).

Step1 Representation of the Current Site Status

The focus of the investigation was on the natural, historical, and cultural features of the site. With layer-cake cognitive site models as the foundation representations, information was derived from the site map, and meteorological, hydrological, and geological statistical data was obtained from the Arc GIS, Scholars GeoPortal and analyzed. Interviews and site visits formed a key component of the investigation.

Step2 Site Process Analysis---Establish processes of landscape security pattern

The characteristics of the natural and cultural processes of land use planning to determine the major landscape uses include abiotic processes, flood and storm water management, biological processes, the conservation of biodiversity and cultural processes including local cultural heritage, and cultural landscape conservation. In analyzing the three primary types of analytic processes which have the closest relationship to the existing context, the purpose of the undertaking is to establish a landscape security pattern which promote positive processes and mitigate negative impacts.

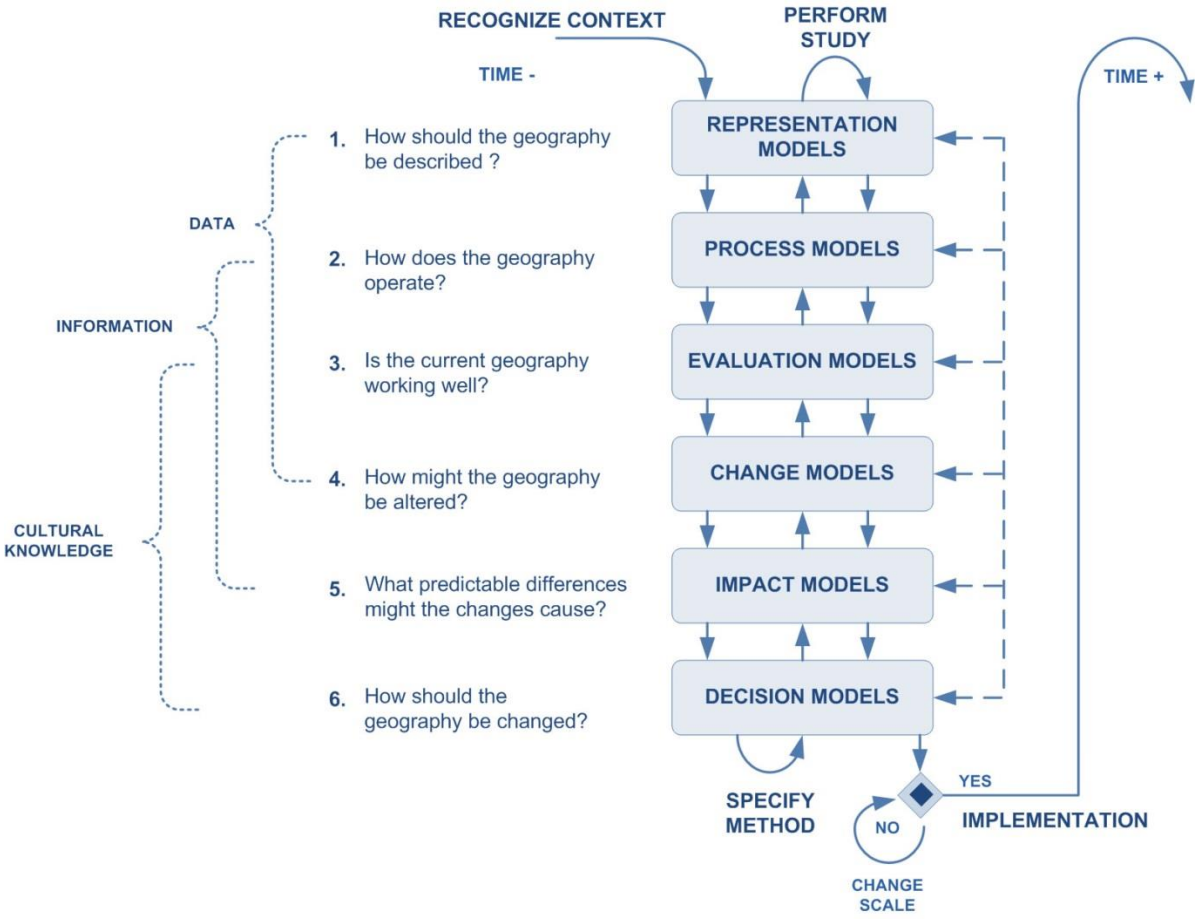
Step 3 Site Evaluation and compatibility with existing plan

This step will focus on assessing the value and significance of the meaning of the actual landscape pattern within these landscape processes. That is, whether it is favorable or detrimental to the health and safety of the landscape processes. Simply put, it is to assess how the functions of the actual landscape ecology and social service are affected, and the degree of compatibility between the landscape pattern and landscape processes.

Step4 Landscape Change

This step will answer the question of how to plan and improve the status quo, in order to improve the health and suitability of landscape processes (Yu, Li, 2005).

Figure4-1 The Frame Work for Planning



Source: Steinitz, C., H. Arias, S. Bassett, M. Flaxman, T. Goode, T. Maddock III, D. Mouat, R. Peiser, and A. Shearer. 2003. *Alternative Futures for Changing Landscapes: The Upper San Pedro River Basin in Arizona and Sonora*. Island Press, Washington, D. C.

4.2 Urban Catalyst

As addressed in the literature review above, from Attoe and Logan's (1992) point of view, the urban catalyst demonstrates the following characteristics:

1. The introduction of a new element (the catalyst) causes a reaction that modifies existing elements in an area. Although most often thought of as economic (investments beget investments), catalysts can also be social, legal, political, or architectural. The potential of a building to influence other buildings, to lead urban design, is enormous.

2. Existing urban elements of value are enhanced or transformed in positive ways. The new need not obliterate or devalue the old, but can redeem it.

3. The catalytic reaction is contained; it does not damage its context. To unleash a force is not enough. Its impact must be channeled.

4. To ensure a positive, desired, predictable catalytic reaction, the ingredients must be considered, understood, and accepted. (Note the paradox: a comprehensive understanding is needed to produce a good limited effect.) Cities differ; urban design cannot assume uniformity.

5. The chemistry of all catalytic reactions is not predetermined; no single formula can be specified for all circumstances.

6. Catalytic design is strategic. Change occurs not from simple intervention but through careful calculation to influence future urban form step by step. (Again, a paradox: no one recipe for successful urban catalysis exists, yet each catalytic reaction needs a strategic recipe.)

7. A product better than the sum of the ingredients is the goal of each catalytic reaction. Instead of a city of isolated pieces, imagine a city of wholes.

8. The catalyst need not be consumed in the process but can remain identifiable. Its identity need not be sacrificed when it becomes part of a larger whole. The persistence of individual identities—many owners, occupants, and architects—enriches the city (Attoe & Logan 1992).

4.4 Comprehensive Principles

By synthesizing the information from these three different design theories, a set comprehensive design principles for landscape infrastructure has been established as shown in Table 5-1.

Table 5-1: Comprehensive principles: **Source：Author 2014**

social and spatial	
	1, From the public space to private space, based on the spatial hierarchy establish a gentle buffer zone.
	2, Create a compact public space systems—road system with high convenience and accessibility.
	3, Reduce car speed, and carefully arrange the parking spaces
	4, Through the comparative study of different space, design a pleasant outdoor space with human scale.
	5, Create a multifunctional integrated layout to enhance the vitality of street interface
	6, By design irregular and varied building facades to provide possibility for the design of the flexible interfaces.
	7, Design the space for social activity along the street or the boundary of large space.
	8, Set support elements in a public space to enhance the comfort level for people to encourage extend use.
	9,Designed space withstand adverse weather, and take advantage of good weather
Ecological	
	1, basic representation model data derived from: A: site map, meteorological, hydrological, geological statistical data B: interviews and site visits, and the focus of the investigation are on the natural, historical and cultural features of the site.
	2, determine the major landscape processes: A: abiotic processes: flood and storm water management; biological processes: the conservation of biodiversity; B: cultural processes: including local cultural heritage and cultural landscape conservation and recreation processes.

	3, determine the value and significance of the meaning of actual Landscape Pattern to these landscape processes--- what is the functions of the actual landscape ecology and social service, and how is the compatibility between landscape pattern and landscape process.
	4, to establish principles to determine how to plan and improve the status quo, in order to improve the health and suitability of landscape processes.
Urban Catalyst	
	1. The introduction of a new element (the catalyst) causes a reaction that modifies existing elements in an area.
	2. Existing urban elements of value are enhanced or transformed in positive ways. The new need not obliterate or devalue the old but can redeem it.
	3. The catalytic reaction is contained; it does not damage its context. To unleash a force is not enough. Its impact must be channeled.
	4. To ensure a positive, desired, predictable catalytic reaction, the ingredients must be considered, understood, and accepted.
	5. The chemistry of all catalytic reactions is not predetermined; no single formula can be specified for all circumstances.
	6. Catalytic design is strategic. Change occurs not from simple intervention but through careful calculation to influence future urban form step by step.
	7. A product better than the sum of the ingredients is the goal of each catalytic reaction. Instead of a city of isolated pieces, imagine a city of wholes.
	8. The catalyst need not be consumed in the process but can remain identifiable. Its identity need not be sacrificed when it becomes part of a larger whole.

5.0 Testing of Design Principles

The public realm and open space network of the West Don Lands project in the city of Toronto was chosen to test the design principles developed. The open space design work of this award-winning new urban development project was under taken by renowned landscape architects from around the world. The strategy of landscape infrastructure was used during the design process of the design of the open space system of the West Don Lands project. This chapter begins with an introduction to the project background of physical conditions and context information. A detailed analysis which combines a design literature review, site visit information, and a series of interviews with designers and planners on the culture, history and ecological environment and urban catalytic effect is then provided. After a review of the design attributes based of this project, recommendations for future improvements are provided.

In this case study, the public realm and open space network of the West Don Lands project refers to 9.3 hectares (23 acres) of parks and public spaces and roads (Waterfront Toronto 2012).

The open space network of West Don Lands was chosen as a case study because it is a typical Plug-in urban design project, containing a number of Landscape Infrastructural subprojects. The West Don Lands was designed by renowned designers, who also contributed to the interview process to test the design principles. The data for the project was collected from key designer and planner interviews, secondary documents and site observation. The semi-structured interviews with the key project designers and planners were undertaken in face to face interviews and telephone interviews. The study

of the design documents involved the West Don Lands precinct plan and the West Don Lands Block Plan. In order to better understand the design intention, site visits were conducted in October, 2013, a season well suited for outdoor activities in the City of Toronto and February, 2014, which is representative of winter conditions. The observations focused on the site context and physical conditions, the design elements of the built environment, and the activities of people on the site.

Figure 5-1: Publicly-Accessible Open Space **Source: West Don Lands precinct plan 2005**

5.1 Introduction of the Design Project

Encompassing a 32 hectare (80 acre) area that runs from Parliament Street in the west to the Don River in the east, and from King Street down to the rail corridor, the West Don Lands is being transformed from former industrial lands into a sustainable, mixed use community. It will feature 6,000 new residential units, ample space for employment and commercial uses, at least one elementary school, and two child‐care centers ‐surrounded by 10 hectares of parks and public spaces. Toronto's winning bid for the 2015 Pan/Parapan American Games greatly accelerated plans for development of the West Don Lands because it was chosen as the site of the 2015 Pan American Games Athletes' Village. Originally the area was planned to be built out in three phases over a number of years; now more than half of the West Don Lands will be completed for the Games in June 2015. Following the Games, the Athletes' Village will be converted into a range of housing options based on Waterfront Toronto' s award‐winning Precinct Plan. The new waterfront community will combine design excellence with environmental sustainability in a neighborhood created for families of all sizes and income levels. Largely owned by the Provincial Government, the West Don Lands occupies a unique site at the original mouth of the Don River. While the river has been channelized and the shoreline has shifted south, the essence of the site remains a low-lying river delta. The area is a brownfield site in a flood plain that required extensive site remediation and flood protection before any development could occur. Infrastructure Ontario (formerly the Ontario Realty Corporation), on behalf of Waterfront Toronto, is constructing the area's massive flood protection landform, which when complete will protect 209.6 hectares (518 acres) of Toronto's downtown east, including Toronto's financial district, from

flooding during a significant storm event. Constructing the flood protection landform and implementing flood protection measures has allowed development to proceed (Waterfront Toronto 2012).

Figure 5-2: A Birds Eye View From Don River to Corktown Common Park and West Don Lands Project **Source: Water Front Toronto 2013**

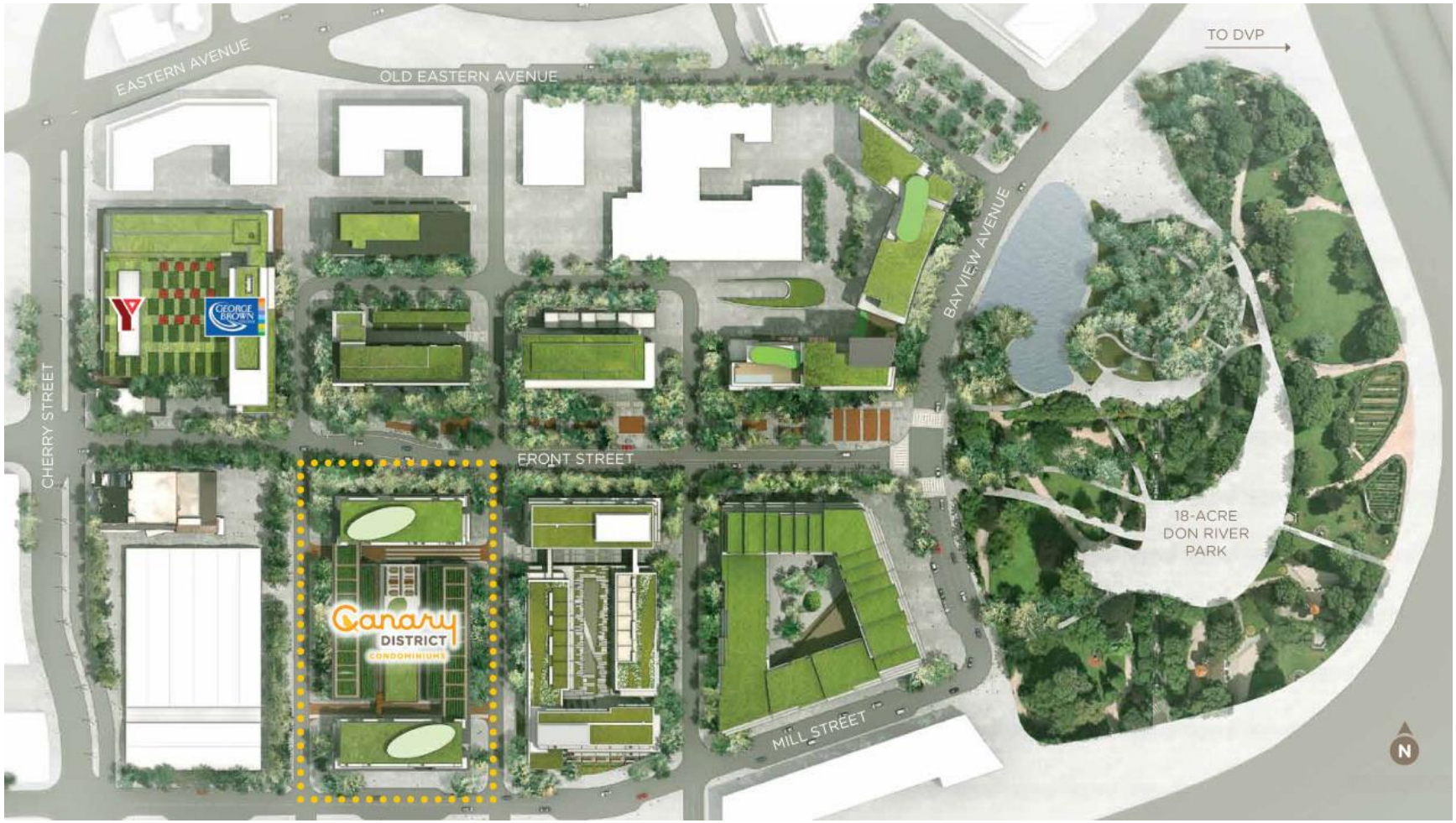


Figure 5-3:Master Plan of West Don Lands Athlete Village **Source: Waterfront Toronto 2013**

5.2 Analysis Using the Key Aspects

5.21 Field Investigations

The purpose of the field investigations was to assist in understanding the context, and to explore the degree of consistency between the design of the West Don Lands project and the proposed comprehensive design principles.

Based on the comprehensive design principles, the results of the site observation are discussed in 3 areas:

Social and spatial:

As the largest part of West Don Lands public space system, Corktown Common Park is located in the easternmost point of the entire project. It borders on the railway and the Don River at the east; faces the West Don Lands community on east and is connected to the main building area by Front Street. As the primary visual landscape axis, Front Street connects with the main entrance of Corktown Common Park and the core urban space in Downtown Toronto. Through observation of the partially completed project, the researcher found that the facades of the buildings were designed in a variety of styles. On the west side of Corktown Common Park, the building facades facing towards the open park, along the streetscape, provide an opportunity to create an active interface between the park and the built form. The trail system within the park was designed following the terrain, except for a small number of areas, such as the steps connecting back to the riverside trail. Most of the footpath system provides accessibility for multiple abilities. As one of the main facilities, the multi-function pavilion integrates the function of washrooms, education, information dissemination, security, and many other services.

Other support elements include flexible sports venues, play equipment, and outdoor barbecue pits. However, due to the physical separation of the rail, the connectivity on the east side of the park with the Don River edge is weak. Only one path through the southeast railway tunnel connects to the riverside trail system. This limitation results in creating a condition where the entire project site is relatively isolated from the Don River. Because the park area is 5-8 meters higher than the surroundings, people can stand on the elevated terrain to see the Don River corridor. Observations conducted by the researcher during the winter found that there were no evergreens planted at the site, creating a feeling of exposure.

Because the north area of the community is separated by a viaduct, in order to improve connectivity and to fuse isolated areas, the space under the viaduct has been designed as an Under Pass Park which serves to keep out wind and rain, and moreover, the facilities in the park offer varied choices for outdoor activities serving a broad demographic programmatically.

Ecological:

As a demonstration of ecological design, Corktown Common Park is designed to be composed of a variety of landscapes, and planted with the vegetation corresponding to the landscape typologies. The Park is located on a flood protection land form. This reflects that the design is based on the careful analysis of the flood process of the site. The design of the Marsh land in the park provides a perched place for birds. The design

itself is also a microcosm of the Don River estuarine ecosystem. It reflects the designers' understanding of the site's ecological processes.

Urban Catalyst:

As the catalyst, the landscape infrastructure was developed earlier than other development components in order to provide a platform for the public to understand the subsequent phasing of the development process. It not only provided an infrastructure foundation and enhancement for the subsequent development, but it also provided leisure, social and civic space for the surrounding residents. Interviews with the park security personal during the field survey, revealed that the city has established 24 hour security as a component of its programming support. This measure is to ensure security and the safety of the park users, and maintain order in the park.

Figure 5-4: Site Photo of Corktown Common Park and Constructing Site of the West Don Lands Athlete Village **Photo: Zhang, 2013**

Although the core of the study area during the research period was under the process of construction, most of the construction of Corktown Common Park and Under

Pass Park had been completed. While the larger site has not been fully put into use, the data of space distribution characteristics is the easiest to get though the site investigation, and the consideration of ecological aspect is obvious as well; however, the initial catalytic effect of landscape infrastructure has been initiated.

5.22 The Primary Design Literature Review

Precinct plan and block plan

The Precinct Plans are intended to outline development principles and guidelines at a level of detail not possible within the broader Secondary Plan. These principles and guidelines form the bridge that will allow the City to move from Official Plan policies to Zoning By-law provisions (DTAH Urban Design Associates, 2005). The block plan was established based on the precinct plan. The following summarizes the main design principles of the Precinct Plan and block plan：

Social and spatial:

1. Create a pedestrian-friendly street network that connects the West Don Lands with the adjacent communities.

2. Reduce reliance on the automobile by providing access to a high-quality range of transportation options.

3. Transform Eastern Avenue into a pedestrian-friendly street.

4. Develop Front Street as a primary entrance to the West Don Lands as it is a landmark street in the City, connecting its major parks.

5. Limit auto-oriented land uses to sites with high access and/or to locations where the impacts are minimized.

6. Provide appropriate community facilities in accessible locations related to open space.

7. Use a variety of building types and styles to create a varied, eclectic, organic, and creative community

In order to distinguish the space hierarchy and function, many elements describing urban form are used throughout the Block Plan and Design Guidelines, such as front fa çade zones, setback zones.

ecological(cultural and natural):

1. Design the flood-protection landform as an amenity to accommodate usable open space and recreation options.

2. Re-vegetate the river's edge as part of the Don River Park system, linking the City to the waterfront.

3. Create multiple points of access between the community and the River's edge.

4. Create both active and natural open space along the Don River.

5. Establish a range of architectural guidelines (massing, materials, and proportion) that reflect the range of scales and characters of surrounding communities.

6. Retain heritage resources wherever possible.

7. Respect the heritage of the area; however, create a “living” community with contemporary buildings, not historical replicas.

urban catalyst:

1. Create a street and block pattern that reflects the eccentricities of surrounding neighborhoods.

Preserve the capacity of the street network.

2. Provide a mix of land uses appropriate for an urban neighborhood which include residential, retail, and employment and public uses.

3. Create parks for both the local community and the City.

4. Balance open space for the local community, the City, and the Region.

5. Provide building types that are flexible and can accommodate a range of land uses depending on market demands.

5.23 Interviews with Designers

Since the idea of urban catalyst has not been mentioned in the design literature of West Don Lands development, the researcher's interviews of the designers focused on this aspect. The questions were developed based on the comprehensive principles proposed by author earlier in this paper, and with the specific focus of the aspects of the urban catalyst. The insightful responses from the designers and planners contributed significantly to the research, and informed both the theoretical and site specific aspects of the design.

It is clear through the interviews that the strategy of urban catalyst has significantly guided the thinking of the designers in the planning and design process of this project. After the soil on the site had been cleaned and the development plan approved by City of Toronto and other regulatory bodies, Waterfront Toronto enacted the overarching strategy of the project, which was to install the civic space such as street network, open space networks, parks and design elements to create excitement over the initial development phase (See Figure 5-5). As the project manager Andrew Tenyenhuis stated, "We installed these elements to service as a catalyst with in the larger context in order to transform the land and make the land more valuable and attractive---we have the mandate to use the landscape infrastructure as a catalyst." The other explicit representation was made by the primary designer of Corktwon Common Park, Emily Celis, from Michael Van Valkenburgh Associates who stated that "the short term goal was to build a public park which could show people the connectivity between the site and its larger context and serve as a generator for the subsequent development of the West Don Lands community and the city; the long term goal is to merge and fuse the park into

a bigger ecosystem." With that important common agreement, between the designers these comments demonstrated that the core intention of moving forward first with significant civic components of landscape infrastructure as a project catalyst has the potential to result in positive influences on the surrounding environment as well.

To ensure a positive, desired and predictable catalytic reaction, the ingredients of landscape infrastructure have been considered and employed in this project and the information from the designer interviews shows that based on the nature of landscape infrastructure, the Corktown Common Park has the ability to satisfy and support the requirements from different aspects. First of all, the park itself also serves as a flood protection landform, which is protecting downtown Toronto from the 500 year flood. Therefore, if this landform hadn't been built, the development plan would be merely a designer showpiece with no ecological service to the site and environs. Secondly, since the Corktown area had very little civic open space, Corktown Common Park has become a tremendously important civic space for the entire neighborhood. Moreover, the park is located in an ecologically sensitive area, so one of the design goals was to reestablish a very rich ecological complex on the brownfield and enhance the natural landscape to reconnect the Don Valley and the Portlands habitat. Emily Celis stated that " Waterfront Toronto" could have done something else on the top of the landform, such as to construct more buildings which would diminish the landscape at the edge of this development. Instead, they chose to embed the park into the core of the mixed use community to help the regeneration of the community, and to enhance the quality of people's lives and the environmental quality of the site. They started off with clear intentions, by stating that the

landscape is the framework around which everything else would evolve, and they laid the foundation for the subsequent implementation."

As above, the "chemistry" of the "catalytic reaction" in West Don Lands has adjusted measures to local conditions. Another example of the tailored landscape infrastructure design solution is that the designers created 8 acres of meadow and high prairie which reflect the indigenous landscape of Toronto. The unique urban landscape becomes a catalyst that reaches out culturally to Toronto at large and engages citizens in this larger cultural landscape that makes apparent the original Toronto landscape and demonstrates how this landscape can exist or re-exist again in the city.

Through a thoughtful planning process, the landscape infrastructure is going to influence both the physical development of the space and cultural experience within it. In Andrew Tenyenhuis's opinion, the short term benefit will be the public perception; the park could enhance the general happiness of the public, also influence ownership and democracy. For example, the name of Corktown Common Park has been changed by public collective discussion of the Don River Park. The new name better reflects the local cultural and public will. The long term goal is that the park will become a regional park within the Ontario context and that the park will also serve as a significant flood protection facility. Benefiting from the park, the community will experience continual development and evolution that will contribute positively to community health, and that the desirability of the area will increase, with the associated increase in land values. As a successful precedent, Corktown Common Park will influence similar subsequent landscape infrastructure development which means there will be continued investment in public space, and an associated increase in people's ecological awareness.

By integrating the views from the planner and designer, a systematic strategy has emerged from the small scale to the larger scale, to ensure that all the urban components of the West Don Lands plan and the city are integrated. Under the coordination of Waterfront Toronto, the designers of the park and the designers of the public realm worked very closely to ensure that the park is responding to the street and buildings of the community and the city. Also, each group collaborated with each other to try to reach the overarching development goal which is to integrate the landscape and the public realm. The sense of wholeness also comes from the community design scale. The wholeness achieved is apparent in the use of the same street widths and replication of materials that reference and reflect the feeling of the materials employed in the area historically. The signage system has also been designed to show where the original TTC lines were located, to identify the industrial heritage locations and to enhance the connectivity throughout the district. These interventions enhance the spatial experience and service to make apparent the cultural and historical context.

Results from the interviews indicate that the catalyst need not be consumed in the process but can remain identifiable. Andrew Tenyenhuis elaborated that the catalyst in this sense is not as it is in a chemical reaction. This is because landscape is not static, it is always changing. The job of landscape designers is to build enough flexibility into the program to allow for a change to happen. He said: “In this context I cannot say whether the identity could be sacrificed or not.” The view of Emily Celis on this issue is that when people consider the identity of the catalyst, they should look at it in different scales: community scale, the scale of overall park system and ecological scale. As a catalyst, the Corktown Common Park has one identity as a community park for Corktown and the

West Don Lands community. From the larger scale, it is a part of the Toronto park system. From an even larger ecological scale, Corktown Common Park is an ecological node that was previously a brown field site and has been naturalized. It used to be a scar in the urban fabric, but now it is an important node on the bird route, a flood mitigation devise, and a major civic open space. Therefore, depending how people look at it, it has multiple identities for different constituencies and how people experience the park. Because of the multiple roles that the park is playing, the comprehensive identity of the park cannot be easily sacrificed.

The interviewees also agreed on the fact that the catalytic reaction should be contained, and the impact should be directed. The setting of security staff in Corktown Common Park will be a good example in this situation, based on the interview with the security of the park; the author learned that one of the major works of the security staff is to remind the increasing numbers of visitor to use the public facilities in a reasonale manner. Andrew Tenyenhuis also emphasized that "we have designed the best landscape infrastructure we possibly can, and created a balance of uses fully utilize the public infrastructure."

However "something really interesting about landscape is that you don't know in the end how it will look. A good landscape design builds enough flexibility in the program, to allow for change to happen. Andrew Tenyenhuis added. The nature of landscape infrastructure has the function to collaborate the natural with the cultural, in the embedded design process."

5.3 Summary

Through the testing of the spatial and ecological aspects of the design, the ideas from the design documents are consistent with the comprehensive principles developed. Through the interviews, respondents and the author reached agreement about the main role of landscape infrastructure as the catalyst that contributed to the "plug-in urban design." The responses from the interviewees have demonstrated alignment with most of the items identified in the comprehensive principles, but the responses still have some unclear aspects, such as the matter of the control of the catalytic effect and the maintenance of the identity of the catalyst. Although there was no specific reference to the urban catalyst concept in the design briefs, the somewhat elusive concept clearly guided the thinking of designers in the planning and design process. Although not mentioned specifically in the design briefs of Waterfront Toronto or the design proposal by MVV Design, all respondents referred to landscape infrastructure catalyst as a central notion of the plans to install a landscape infrastructure foundation as the first phase of the larger project, with the expectation that this would serve as a catalyst for future phases and evolution of the project and urban fabric.

Table 6-1 illustrates the degree to which the purposed comprehensive design principles were met with the evidence derived from the design documents for the West Don Lands Precinct Plan and Block Plan, Site observation and designer interviews contributed to the case study.

Table 6-1: Design Attributes in West Don Lands, Toronto, Canada. **Source: Author, 2014**

Applied ●, Partially Applied◎, Not Applied○

Key Aspect	Design Attributes	West Don Lands
social and spatial	1, From the public space to private space, based on the spatial hierarchy to establish a gentle buffer zone.	●
	2, Create a compact public space systems—road system with high convenience and accessibility.	●
	3, Reduce car speed, and carefully arrange the parking spaces.	●
	4, Through the comparative study of different space, design a pleasant outdoor space with human scale.	●
	5, Create a multifunctional integrated layout to enhance the vitality of street interface	●
	6, Design irregular and varied building facades to provide possibility for the design of the flexible interface.	●
	7, Design the space for social activity along the street or the boundary of large space.	●
	8, Set support elements in a public space to enhance the comfort level for people to encourage extend use.	●
	9,Design space to withstand adverse weather, and take advantage of good weather	◎
Ecological	1, basic representation model data derived from: A: site map, meteorological, hydrological, geological statistical data B: interviews and site visits, and the focus of the investigation are on the natural, historical and cultural features of the site.	●
	2, determine the major landscape processes: A: abiotic processes: flood and storm water management; biological processes: the conservation of biodiversity; B: cultural processes: including local cultural heritage and cultural landscape conservation and recreation processes.	●
	3, determine the value and significance of the meaning of actual Landscape Pattern to these landscape processes---what is the functions of the actual landscape ecology and social service, and how is the compatibility between landscape pattern and landscape process.	●
	4, to establish principles to determine how to plan and	●

	improve the status quo, in order to improve the health and suitability of landscape processes.	
Urban Catalyst	1. The introduction of a new element (the catalyst) causes a reaction that modifies existing elements in an area.	●
	2. Existing urban elements of value are enhanced or transformed in positive ways. The new need not obliterate or devalue the old but can redeem it.	●
	3. The catalytic reaction is contained; it does not damage its context. To unleash a force is not enough. Its impact must be channeled.	◎
	4. To ensure a positive, desired, predictable catalytic reaction, the ingredients must be considered, understood, and accepted.	●
	5. The chemistry of all catalytic reactions is not predetermined; no single formula can be specified for all circumstances.	●
	6. Catalytic design is strategic. Change occurs not from simple intervention but through careful calculation to influence future urban form step by step.	◎
	7. A product better than the sum of the ingredients is the goal of each catalytic reaction. Instead of a city of isolated pieces, imagine a city of wholes.	●
	8. The catalyst need not be consumed in the process but can remain identifiable. Its identity need not be sacrificed when it becomes part of a larger whole.	◎

6.0 Discussion

Landscape infrastructure has the dual nature of natural and cultural aspects. This attribute makes landscape infrastructure an inherently suitable catalyst for "plug-in" urban design. However, because of the overlap between nature and culture in landscape infrastructure, it is hard to separate these two aspects in and discussion of landscape infrastructure in "plug-in" urban design.

Landscape Infrastructure can be multi-functional and also serve as a framework that focuses on both preservation and development of the city. West Don Lands public realm is an example of landscape infrastructure; it is the landform serves as flood protection, civic space and habitat for migratory birds. The project also offers flood protection to subsequent developments, improves the quality of outdoor civic space, and raises the ecological consciousness of the public. Typically, the catalytic reaction initiated from various functions can overlap; this intensifying the catalytic reaction can serve to accelerate land development.

Landscape architects should consider the future implications of catalysts in plug-in urban design, and incorporate them in their designs. In the West Don Lands project, designers and planners gave very thorough consideration to the site condition, and chose appropriate catalysts to help further develop the project beyond the initial phase. In the interview, respondents addressed clearly their intention to create a catalytic reaction during the initial phase of the project, but did not address strategies to manage future catalytic reactions. Given the results of the West Don Lands case study, it appears that management strategies to direct the catalytic process are necessary to achieve the full

potential of the initial catalytic investment. The initial consideration was not sufficient to manage future catalytic influences at different scales, and did control the future catalyst reaction. Although the control and management of the subsequent influence of the built sections of the project will be undertaken by the province and waterfront authority, designers should also consider taking control of the catalytic process and directing it to achieve specific outcomes throughout the continuum of the long term development scenario. By integrating the catalyst process within the design process, the ongoing design development and implementation could be more effective as this would enable greater control of subsequent interventions.

Regarding one of the principles of the urban catalyst, that the identity of the catalyst not be sacrificed during the process of integration within the larger whole, the respondents' answers seemed to be both unclear and inconclusive. One respondent pointed out that the landscape is constantly changing. He seemed to want to use this point to emphasize that there is a dilemma regarding the maintenance of the identity of the catalyst in the practice of landscape infrastructure due to the inherent nature of change in the landscape. While the characteristics of landscape infrastructure are that it changes over time, is flexible and is self-healing, it is also essential that the identity of the catalyst be retained. The response from Miss Clies proposed that landscape infrastructure could coordinate the urban space throughout different spatial scales. In her opinion, landscape infrastructure has multi-identities; not only because of the various characteristics of the multi-functions, but because its identities are rooted in different urban spatial scales. (figure 6-1).

Figure 6-1：The range of the catalytic effect of Corktown Common Park

During the interview, Jeffery Staates pointed out that to establish the streetscape earlier than the buildings is a particular urban design strategy for this project, and "this is an unusual case where the building needs to actually respond to the landscape." In this scenario is the streetscape referred to series as a connecting link to Corktown Common Park, and was installed in the first phase with the park. This scenario and discussion shows that the complete design principles of landscape infrastructure within the context of "plug-in urban design" are needed to guide the practice of urban designers and landscape architects.

Through the interviews, the author found that the concept of landscape infrastructure working as an urban catalyst has been used commonly by urban designers. Through informal agreement, designers and planners have no doubt about its actual benefit, however, the concept is not addressed or documented as a formal part of the urban design process. Designers speak of it frequently, have written about it in the popular press and, presented project examples utilizing the strategy to professional

groups but curiously, do not adopt it as a formal design and development strategy within their professional documentation. The literature and the interviews indicate that this concept is guiding many urban design projects, and it seems likely that it will be applied to projects beyond urban design in the future. However, in the absence of sufficient theoretical support, and lack of formal documentation on completed projects, landscape infrastructure as an urban catalyst can only be explored within the realm of urban design practice. While the benefits of landscape infrastructure as urban catalyst are generally highly supported by the urban design community, and demonstrated through both completed and ongoing projects, objective assessment of the outcomes of catalytic interventions have not been undertaken to date. In the interview process, while all respondents believed the catalytic process to be effective, they differed in their opinions as to the degree of effectiveness of the catalytic process. While the respondents all supported the concept and principles of landscape infrastructure as urban catalyst, there was significant variation in the degree to which they thought it was an effective strategy. Although the consistency of respondents contributes positively to the research results, their differing viewpoints also reflect a lack of a unified theory that currently exists in the field of landscape architecture and urban design.

7.0 Conclusion：

7.1 Summary

As a catalyst and carrier of versatile functions of the contemporary city, landscape infrastructure has the ability to provide a symbiotic interface between the green infrastructure led by various ecological processes and gray infrastructure led by public works. landscape infrastructure can also help facilitate the interaction and linkage, cooperation and exchange, between each other, to achieve common adaptation, co-optimization and integrated development. Only in this way can efficiency be maximized and costs be minimized between the various elements of urban infrastructure. People's lives consist of a series of complete, continuous activities; they rely on the natural and social environment, rooted in history and culture. Designed urban civic spaces are the reflections of people’s life pattern in the physical world. Meanwhile, rational planning，municipal infrastructure and public space systems will positively react to people's daily life. As an example, based on reasonable integration and re-definition of traditional municipal infrastructure with civic space and ecosystems, landscape infrastructure is no longer content with simplified principles of modernism. As an expression of life, it exhibits a higher level of integration and complexity, and greater diversely in responding to contemporary social and environmental diversity. “Plug-in urban design” is a design approach that is based on a comprehensive consideration of natural ecological processes, historical and cultural processes and living systems. As a catalyst which synthesizes various components of the social and natural environment, landscape infrastructure has a high degree of compatibility with the local context, through the efficient integration of

space, filling the missing elements of people's living spaces and ecological systems, and then scaling synergistically to various scale and dimensions in the urban fabric, providing a catalytic action for subsequent development.

7.2 Implications for Landscape Architecture

This research points out the intention behind, and the direction of landscape infrastructure design at different scales within the urban fabric, particularly in the discussion of landscape infrastructure as urban catalyst, which could contribute significantly to the planning and design process, by embedding the catalytic concept within an integrated design process. As an urban supporting structure， landscape infrastructure could spawn and coordinate integration and flow of mutual exchange between varieties of physical and natural ecological processes. To engage in the design of landscape infrastructure, landscape architects should have a broader and systematic perspective so as to participate within the integration and coordination of the design process. Also, landscape architects need to have more communication and interaction with other related disciplines such as planners and architects. The result and discussion shows that the complete design principles of landscape infrastructure within the context of “plug-in urban design” are needed to guide the practice of urban designers and landscape architects. In addition, the measurement of the results of the catalytic effect needs to be undertaken. The collection of such data will help the designer to accumulate the experience and learned on the same type of project, and provide a more accurate reference and base line for future projects.

7.3 Recommendation for future research:

The contemporary practice of urban design is increasingly embracing comprehensive and flexible use of multiple theories, with both new and established theories being utilized in isolation and in combination. In this research, the concept of landscape infrastructure and the comprehensive use of this within the theory of plug-in urban design were explored. This trend requires designers to have the ability to coordinate and understand projects from multiple angles and multiple scales, while requiring the designer to demonstrate a thorough understanding of the living needs of the park project user. In order to make more flexible and responsive design solutions that fit in the urban context. Because of limitations, such as time and limited documentation of the subject, this paper has identified a significant urban design and development strategy that is apparent in many significant urban design projects and that is a driving force influencing the scale and sequencing of urban infill development, and the nature and timing of infrastructure investments. However, the research also indicates that this exploration is pioneering the vast expanse of additional work to be done in this area, both in understanding the scope of work that is being undertaken under the umbrella of landscape infrastructure as urban catalyst, and in measuring the outcomes achieved through this process. The establishment of more specific design guidelines that evolve from analysis of implemented projects should be developed that demonstrate comprehensiveness and flexibility, and are based on specific projects and their local conditions. Moreover, as the case study analysis for this research is still under construction, the outcome and effect of the catalytic reaction cannot be measured. However, the research has identified a new area of exploration within the practice of

urban design for future researchers. As well as other theories, the theory of landscape infrastructure as an urban catalyst should be developed further and improved as a viable urban redevelopment strategy.

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Appendix:

Interview questions to Planners

1. Was an overarching concept developed for landscape infrastructure in the West Don Lands? What was it? How did it guide the planning process?

2. What were some of the reasons why you introduced landscape infrastructure into the context of West Don lands. For example, what goals and objectives did your organization set with regard to the landscape for building the Corktown Common Park or Underpass Park here?

3. What was the biggest challenge from the cultural aspect during the planning process with regard to integrating with the existing urban fabric?

4. What was the biggest challenge from the natural aspect during the planning process?

5 How has the city positioned the Athlete's Village relative to the Don River? The connectivity now between the Athlete's Village and Don River trail seems not as strong as it in the precinct plan from my perspective.

6. In your opinion, what is the expected impact of the landscape infrastructure on existing urban elements? For example, how will the landscape infrastructure serve as an catalyst ?

7. What was the rationale for building the park first and why do you think a park can best serve as a catalyst to embed landscape infrastructure in this plug in design. Are there alternative vehicles for this strategy?

8. Have you considered any long term impact of introducing this landscape infrastructure in this urban context? Is there any careful calculation of how this might affect future developments?

9. What strategies have you used to ensure all the urban design components of the plan are integrated, to achieve the principle/goal that the integrated product is better than the sum of the parts?

10. When the elements work as a whole, is possible that the identity of the landscape infrastructure could be sacrificed when it becomes part of a larger whole?

11. Could the force initiated by the catalytic reaction of landscape infrastructure impact negatively on the existing context of the urban fabric?

12. What are some of the positive lessons that could be used in future landscape infrastructure design project like this (Corktown Common Park)?

13. To what extent do you believe park/civic space management and programming are important to the success of the design?

Interview question to Designers

1. What was an overarching concept developed for landscape infrastructure (Corktwon Common Park) in the West Don Lands? What was it? How did it guide the design process?

2. What goals and objectives did your organization set with regard to the landscape for building the Corktown Common Park?

3. What was the biggest challenge from the cultural aspect during the design process with regard to integrating with the existing urban fabric?

4. What was the biggest challenge from the natural aspect during the design process? How did you deal with this issue during the design phase?

5. How has the designer positioned the park to the Don River? The connectivity now between the Athlete's Village and Don River front seems not as strong as it in the precinct plan from my perspective.

6. In your opinion, what is the expected impact of the landscape infrastructure (park)on existing urban elements? For example, how will the landscape infrastructure serve as an catalyst ?

7. Why do you think a park can best serve as a catalyst to embed landscape infrastructure in this plug in design. Are there alternative vehicles for this strategy?

8. I have visited the site both in summer and winter, and the park was beautiful. What principles have been made to achieve the goal of four season using? it seems like the evergreen haven't been used on the site, are there any special consideration about this?

9. What do you think the short term and long term impact will be as a result of building the landscape infrastructure early in the process? Is there any careful calculation of how this might affect future developments?

10. When the elements work as a whole, is possible that the identity of the Park could be sacrificed when it becomes part of a larger whole?

11. Could the force initiated by the catalytic reaction of landscape infrastructure impact negatively on the existing context of the urban fabric?

12. What are some of the positive lessons that could be used in future landscape infrastructure design project like this (Athlete's Village)?

13. Could you tell to what extent you believe park/civic space management and programming are important to the success of the design?

14. During design phase what strategies have you used to ensure the park will integrate and cooperate with other urban design components in west don lands even the city, to achieve the principle/goal that the integrated product is better than the sum of the parts?