

*Integrating Stormwater Runoff & Open Space  
in the Development of a Residential Neighborhood*

by

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A Practicum submitted to the Faculty of Graduate Studies  
In Partial Fulfillment of the Requirements for the Degree of  
MASTER OF LANDSCAPE ARCHITECTURE

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Winnipeg, Manitoba

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**THE UNIVERSITY OF MANITOBA**

**FACULTY OF GRADUATE STUDIES**

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**A Thesis/Practicum submitted to the Faculty of Graduate Studies of The University of**

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**Of**

**MASTER OF LANDSCAPE ARCHITECTURE**

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## ABSTRACT

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The intent of this practicum is to re-examine the residential neighborhood and the effects of conventional development practices on the quantity and quality of stormwater within urban environments. The goal of the neighborhood design is to reconnect people with the natural environment. A literature review and series of case studies examines alternative methods of stormwater management as well as alternative neighborhood layouts that could be applied to the specific project site. The final result is the design of a residential neighborhood within the City of Winnipeg that integrates stormwater management and open spaces. It is this open space network that becomes the framework around which the entire neighborhood is designed. Within this network stormwater is brought to the surface of the residential development as a means of reconnecting people with the natural environment and dealing with some environmental issues that are relevant in the contemporary urban environment.

*"We have spent the past 6000 years learning how to get water off the land as fast as possible, to permit us to get our crops in the ground and to protect our dwellings, while nature has spent the past 600 million years learning how to keep water on the land for as long as possible. There can be life without oxygen but there is no life without water."*

- Wm. Patrick Lucey, Freshwater Ecologist, Aqua-Tex Scientific Consulting Ltd.

## ACKNOWLEDGEMENTS

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This document has taken a long time to complete. I presented my preliminary while eight months pregnant and my final with my three year old daughter by my side. Many years have passed and many advisors have come and gone, but one has stuck with me from the beginning. I would like to thank the head of my committee, Professor Jean Trottier, for sticking with me throughout this process and for always helping to get me and this project organized. Thank you to Professor Ted McLachlan, my internal examiner, for his confidence in my work and persistence in my completion of this practicum. Thank you to Derek Murray, my external examiner, who kindly offered his experience and expertise on this subject. I would also like to thank Professor Alan Tate, who was my first advisor but due to timing was unable to complete the project with me. It was in his design studio that my passion for this subject began.

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Landscape Architecture is a profession which I seemed to have flowed into, a type of natural progression. I certainly did not start out my university journey with the destination of becoming a landscape architect in mind. I had never even heard of the landscape architectural profession before entering the faculty of Architecture. It seems almost a contradiction in terms to think that I started my journey believing I was heading in one direction but ending somewhere entirely different to be considered fluid, but thinking back it certainly was. When you take your wealth of experience and knowledge and bring them together directing them towards a certain point all of a sudden it all makes sense.

The residential neighborhood has always been something that has intrigued me. I grew up within a Winnipeg neighborhood called Norwood. This is a place in which the majority of my time was spent from age 5 to 14. I slept there, played there, worked there, shopped there, and learnt there. A neighborhood is comprised of more than houses, yards and streets. It is a learning ground where we learn to interact with other people, where we learn to

make friends, learn to play, and learn about our environment. The majority of my interaction with plant and animal life occurred within this neighborhood. I watched young trees grow into beautiful boulevard trees. I watched the buds of trees and shrubs leaf out in the spring. I remember every summer waiting for the pods of the *caragana* hedges to form, which my friends and I would serve as the main course in our summer tea parties. Rain storms would be so much fun, wading in the large puddle that formed at the bottom of our street, or making witches brew in my friend's tire swing using the water that had been stored within the tire from the rain the night before. An older neighbor would invite us to sit on his porch and feed the squirrels. We were so excited that they would eat right out of our hands.

So much time is spent where we live, in our neighborhood. So much growing and learning occurs there. This is why the design of a residential neighborhood was chosen as my area of study: it encompasses so much more than simply roads, houses, and yards.

When I think of growing up, I think of my neighborhood. Something with that much of an impact deserves extra special attention.

The intention is to bring present day issues into the design of a residential community. When designing we must look at issues that are significant at this time and those that will most likely be significant in the future. One of these includes that of water quality. When looking at residential subdivisions, especially within the city of Winnipeg, water quality is a subject that is not sufficiently dealt with. Since I have started this practicum a number of years have gone by and a couple of neighborhoods within and surrounding the City of Winnipeg have begun to deal with the quality of stormwater in a more significant fashion (such as the

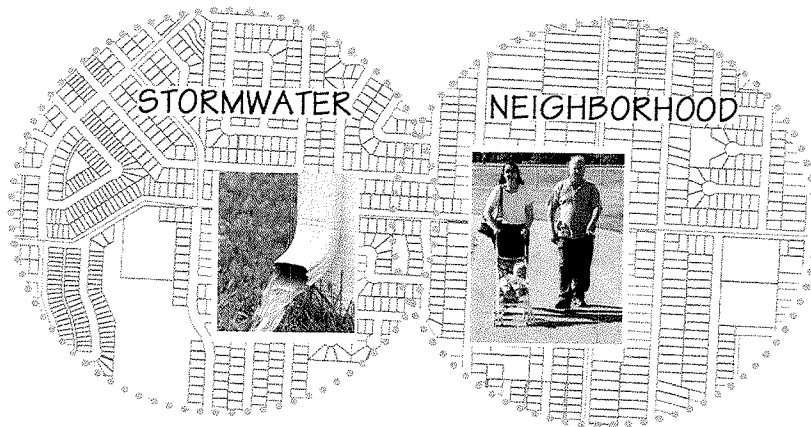
recent stormwater wetlands within the neighborhood of Royalwood), but by no means is this subject of high priority for the majority of new developments.

Why design more of the same? Each new subdivision has something unique to offer either within its bounds or adjacent to it. Why not determine what is special about the place and use that to guide the design? The city is a wonderful place. It is full of action, excitement, and diversity. Diversity ensures everyone and everything belongs, and neighborhoods should be designed to celebrate and ensure that this diversity can thrive.

## ii.

## INTRODUCTION

The primary intent of this project is to RECONNECT people with the natural environment. The method chosen to do this is the integration of stormwater and open spaces within the design of a residential neighborhood.



**Figure 1: Integration of Stormwater and Neighborhood**

The methodology completed in order to accomplish the above task includes: general background research, such as a literature review and a series of case studies; and site specific research and design, such as site inventory and analysis, concept development, and final site design.

The reason why the intent of the project is to reconnect people with the natural environment is that our current North American civilization has completely separated itself from natural processes and the natural environment. Of course we live within the natural environment, we are a part of it, but we have created our own systems that take the individual out of the process. No longer does one individual, or one family, take part in finding a stream with clean, drinkable water. We instead have water shipped from far away lakes through underground pipes. Because it is not the water we drink, who then concerns themselves with the water in their immediate vicinity?

With the advancement of technology we continue to widen the gap between the natural world and ourselves, yet we depend so much on its very entity for our survival. Instead of physically traveling the world and experiencing the environment with all of our senses, we focus more on the visual or auditory senses to see the world through various means, such as television, radio and computers.

*"...for the millions of us who live in cities or suburbs and have transitioned from working the soil to*

*working at computer keyboards, our link to ecosystems is less direct” (United Nations Development Program, 2000, 5).*

In the attempt to reconnect people with the natural environment, the design of this project aims to bring some contact with natural processes back into our daily lives. Drastically changing our current lifestyle is not the solution. The intention is to make small changes. This refers to water flowing across the land and feeding wetlands where ducks and birds nest and feed and protecting our forests, which absorb runoff from our developed areas, provide wood for our homes and for heating, and provide habitat for our animal relatives.

*“It is only through an understanding of the interactions of living beings with their habitat in our own backyard that we can understand the significance of nature as a whole” (Hough, 1989, 171).*

As mentioned, this does not indicate a radical change in the way we live, and to which we have become attached. This is the only way of life that most of us know and understand. It simply means small modifications and giving value to what we take for granted.

Water is the natural element that has been chosen to be returned to our daily lives. Stormwater will be brought to the surface of the residential development both literally and figuratively as a means of reconnecting people with the natural environment and dealing with some environmental issues that are prevalent in the contemporary urban environment. The quality of the earth’s water is decreasing rapidly. Polluted runoff from residential areas impacts the quality of the water bodies into which stormwater flows. It is too easy to disregard the effects of current development practices when the movement of water is quickly drained out of sight. For the typical development, water is expected to drain quickly and if it puddles, it is considered a nuisance.

As mentioned, this project aims to design a development that brings stormwater to the surface. Instead of relying on conventional practices of underground stormwater sewers and stormwater detention ponds with monocultured plantings and mown grass edges, a more integrated, ecological approach was studied and incorporated within the project site.

*“The solution to these problems lies in creating an infrastructure and a system for distributing water that will be sustainable over the long term. This will require that communities work harmoniously with nature, creating an infrastructure that works synergistically, not just as a set of single-purpose functions” (Corbett, 2000, 65).*

In order to bring stormwater to the surface of a development, and to integrate it within the site’s open spaces, it was necessary to research the residential neighborhood. Incorporated in this research is the study of how neighborhoods are conventionally developed as well as alternative methods available that allow for the creation of a more integrative community. The design of the residential neighborhood directly influences how rainwater interacts with the land. The more road and roof surfaces, the more impermeable surfaces that stormwater quickly runs off, and thus this reduces the possibilities for water absorption, filtration, and/or storage. By cutting down forests and filling in wetlands to build more housing, valuable areas for stormwater absorption, air pollution filtration, and wildlife habitat are lost.

*“The special places that give our rural and semi-rural communities their distinctive character need not all be cleared, graded, and paved over just because they contain flat, dry, buildable land, although that has been the fate of countless similar natural areas in virtually all suburbs built up to this time” (Arendt, 1996, xviii).*

The first component to the literature review includes a study and compilation of relevant information pertaining to “how rainwater interacts with the land.” This contains information on the ecology and engineering of stormwater and the effects of current land development practices on the hydrology of stormwater in urban conditions.

The second component to the literature review includes the study of the neighborhood, both in terms of conventional development practices as well as a number of Alternative Development types, such as Traditional Neighborhood Design and Cluster Development.

Next, six alternative residential developments were researched and relevant information pertaining to this particular project is included within the Case Studies

section of the document. The developments found in this section all deviate in form from the conventional development pattern and the majority of them deal with stormwater infrastructure in an unconventional but successful manner.

The final step, before the description of the project site and the project itself, is the accumulation of all of this research into a set of Design Principles that were used to guide the design for the project site.

The final outcome for this project is the residential community layout and design for the project site. The

design includes an inventory and analysis of the site and an investigation into alternative concepts in three significant areas: roads, open spaces, and drainage. From there a master plan of the site was created focusing on road layout, residential densities, and open space features. Next, a complete drainage plan for the site was devised, and finally a detail area within the site was investigated and designed in further detail, providing a sense of what it would be like to live in this neighborhood from an individual household perspective to a broader, more public, neighborhood wide view.

### **iii. HOW WATER INTERACTS WITH THE LAND:** *The Ecology & Engineering of Stormwater*

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This section deals with the interaction between rainwater and the land. A discussion and summary of key points regarding the ecology and engineering of stormwater as well as the effects of current land development practices on the hydrology of stormwater in urban conditions will follow.

Water is an element that people have struggled with since the beginning of civilization. It has awed us, inspired us, cleansed us, and nourished us. When contained, water can create a remarkable sense of calming and reflection, yet water can also be a strong powerful force that will terrorize anything in its path if it overflows its banks.

Urban and agricultural areas have significantly changed the historic movement of water on the region's landscape. The combination of filling in depressions, streams and wetlands, as well as the massive drainage systems of large urban and agricultural areas, has increased the rate and flow of runoff as well as decreased the opportunity for groundwater recharge. There are fewer areas for runoff to remain until the soil is ready to absorb more water.

Instead this runoff is quickly conveyed off site. This eliminates the chance for water to percolate into the ground, thus permitting the vegetation and soil to filter out the sediment and pollutants. Runoff moves more quickly into streams and rivers because of the drainage system in place that diverts the water immediately into these areas, either through mown grass ditches or concrete pipes, the former allowing some percolation, the latter none at all.

The stormwater detention ponds that have become a fixture in Winnipeg's suburban landscape create a place for this water to sit and wait until the rain event has ended, thus reducing the immediate rate of runoff. These areas create a recreational and aesthetic opportunity for the community and alleviate initial flooding concerns, therefore dealing with water quantity, but not significantly with water quality. They are designed to accomplish one function and do not take advantage of the natural system that it can become. Historically the Winnipeg region would have depressions that hold water during rain events. These depressions would remain saturated over long periods in wet years and over shorter periods during dry years. The

depressions are similar in theory to Winnipeg's detention ponds, but they never included gravel sides with mown grass right up to its edge. They were systems with vegetative buffers along the edges that would filter out debris and sediment as the water ran down to the lower ground. This vegetation would take advantage of any moisture available. There was a symbiotic relationship between the runoff and the vegetation. The water would enable the vegetation to grow and survive, while the vegetation would cleanse and absorb excess water as it would move through it. Natural systems are so complex and have so many layers, that to design a system to simply hold water negates its performance capabilities.

When it comes to water many factors are guaranteed: water moves downhill and water follows a certain cycle. This cycle is known as the hydrological cycle and includes such aspects as precipitation, infiltration (subsurface flow & deep percolation), conveyance, storage, transpiration and evaporation. When looking at stormwater, the type of soil on a site is an important factor in determining how water that reaches the ground will behave. The composition of the soil dictates whether the water will percolate into the ground quickly or if some water will percolate slowly into

the ground while the remainder runs off in search of lower land.

The levels of perviousness vary greatly when examining different types of soil as well as the type of vegetation found growing on it. A forest will absorb a much greater amount of water than will turf grass. In a forest the water falls first on the canopy layer. The leaves absorb some water and what is not absorbed is released into the atmosphere through transpiration. The same process occurs within the shrub and herb layers. The remaining water, which finds its way to the ground plane, is either absorbed into the soil and moves underground as subsurface flow or it filters downward as deep percolation. Once the soil is saturated, any remaining water on the ground plane will runoff to lower land and flow into a depression, which may be permanent, such as a lake, or only temporary, such as a puddle.

*"In the native landscape, rainfall excess is determined by climatic factors, the rate and intensity of precipitation, the infiltration capacity of soils, and the amount of surface storage allowed by topography" (Graham, 1984, 26).*

The earth has developed its own natural filtration process and by quickly sending stormwater through pipes, we are negating the amazing natural capabilities of the elements that surround us. There are four primary natural means of water filtration and purification, and none of these includes a Brita filter. They include soils, vegetation, freshwater bodies (including streams, rivers, and lakes) and wetlands (United Nations Development Program, 2000). Organic material, feces, and other toxins are consumed and recycled by microorganisms that live within soils. Some types of vegetation are capable of absorbing pollutants through what is referred to as phytoremediation. The root layer of all vegetation aids in the absorption of water into the soil by holding the soil in place while the water filters through. These roots are also capable of breaking through solid chunks of soil, creating cavities through which water can percolate. This is especially pertinent within clay soils. Prairie grasses, with their extensive root systems, have historically broken up large chunks of clay creating openings through which water would percolate into the soil.

Freshwater bodies have the ability to dilute pollutants, and therefore what would otherwise be toxic in concentrated amounts becomes relatively safe once diluted. The ability of wetlands to cleanse water has long been acknowledged. Wetlands enable sediments to settle before water continues along towards freshwater bodies. They are also capable of removing nitrogen and minerals from runoff (United Nations Development Program, 2000).

In summary, the key aspects to the hydrological cycle - precipitation, infiltration, conveyance, storage, transpiration and evaporation - as well as the primary components enabling the natural filtration of water - soils, vegetation, freshwater bodies and wetlands - work in combination to create a sustainable system. These are the important processes that must be recreated to design a successful stormwater system within the project site.

## ***HOW DEVELOPMENT HAS CHANGED THE HYDROLOGY OF STORMWATER IN URBAN CONDITIONS***

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*“Urbanization typically involves building and paving vast areas, then directing runoff into pipes that quickly carry all of the collected rainfall to streams and rivers. The resulting increases in volume and velocity of water entering natural water systems coupled with up to 70% increases in diffuse pollution has a number of negative impacts on water quality. These include eroded stream banks, increased eutrophication, increased stream temperatures, decreases in available oxygen for fish and other aquatic life, and increased sedimentation among other things” (CHI, 2000, 65).*

As people begin to develop land, houses are built, roads are constructed, and infrastructure is installed. Increases in technology have led to our ability to create large, air tight structures, functional circulation routes, and infrastructure that serves us well and is hidden from view. Each of these advancements in civilization changed the way in which the pre-developed land functions. The houses and circulation systems created large amounts of impermeable surfaces covering the soils. This negated their ability to perform

tasks of water infiltration, purification and filtration, since they replaced previously vegetated areas. Whether these areas were grasslands, forests or wetlands, they all had a role in the hydrological cycle for that location, and thus the larger ecosystem.

*“Grading, the construction of buildings, and the laying of pavement typically affect the hydrologic budget by decreasing rates of infiltration, evaporation, transpiration and subsurface flow, reducing the availability of natural storage, and increasing runoff. In a natural condition such as a forest, it may take 25 to 50 mm (one to two inches) of rainfall to generate runoff. In the developed condition, even very small amounts of rainfall can generate runoff because of soil compaction and connected impervious areas. The result is a general increase in the volume and velocity of runoff” (DOD, 2004).*

The effects of increased impervious surfaces on the larger environment include increases in the quantity and decreases in the quality of stormwater runoff. A larger

quantity of stormwater runs off these surfaces into receiving water bodies because there are less natural areas available to absorb the rain or snowfall. This increase in quantity affects the larger environment by increasing the amount of water that enters a water body at one time (peak runoff discharge) and thus creates problems with bank erosion because of the increased speed with which the stormwater moves across the land into the receiving stream. When large amounts of water move quickly into a receiving water body, this creates more frequent "bank full" events. It is these events that are crucial in channel forming; therefore, increased stormwater can affect the shape of receiving streams. With runoff from many points entering the same water body at the same time, this increases the amount of flooding events. Because a great deal of the stormwater is not able to infiltrate into the ground, this lowers the base flows and thus affects the amount of water available within the receiving stream in dry years (MSSC, 2005).

The quality of stormwater decreases in developed areas because as water moves across impervious surfaces, pollutants and sediments attach themselves to the water. Freshwater bodies, as mentioned, are able to dilute

pollutants, and they are also able to allow sediments to sink down to the bottom, enabling cleaner water to move above them. These sediments, though, have a negative effect on the stream structure and habitat, as the increases in sediment cause the channel depth to decrease. This also covers important habitat for certain fish and organisms that live at the bottom of a stream bed and require an undulating surface for survival. As water moves across urbanized areas, increased pollutants - from non-point pollution - move with it. Included in these types of pollutants are sediments; oil, grease, metals, and salts from roads; fertilizers, herbicides and pesticides from lawns, agriculture and garden areas; air pollution particles; and added nitrogen, phosphorous and bacteria from pet feces (as well as from fertilizers and pesticides).

*"Nonpoint source pollution is now the No. 1 cause of water quality impairment in the United States, accounting for 50 percent of water problems in the nation's water bodies" (Metro, 2002, 21).*

The increase in nitrogen and phosphorous can amplify the growth of algae within the receiving water body, as is currently a major problem within Lake Winnipeg. An increase in impervious areas can also cause stream

temperature warming, creating a reduction in dissolved oxygen levels (MSSC, 2005; CHI, 2000; Darby Creek, 2001). The decrease of surface water within urban areas creates a more comfortable, cleaner setting for us to live, but it decreases the ability for other living creatures to survive. All living creatures require water for survival and most do not have access to a tap to acquire this.

By moving stormwater quickly underground, another aspect to urban development is found to be lacking: that of the comprehension of the movement of water, and the fundamental nature of the hydrological cycle. This is the essence behind what happens to water once it has fallen on our roofs and streets. Water is so important to survival, to reflection and to inspiration, yet we do not have time to enjoy its presence unless it is within the acceptable edges of rivers, streams and ponds.

I was recently walking with my daughter down a back lane near our home. The rain had just stopped before we headed out. All of a sudden my three year old daughter stopped transfixed on something. I had no idea what. I looked down and she was staring into the catch basin in the middle of the lane, watching water flow into it, watching

and listening to every little drip that fell to the pool at the bottom. She had no idea where this water had been or where it was going, but she was in awe of this new dripping process that she had never seen before in our many walks down this back lane. The only way I would ever notice this small event was if I crouched down, to the child's level, close to the ground and inspected the catch basin. The movement of water is such a natural occurrence, but is rarely noticed by the average urban citizen.

## **SUMMARY**

One of the most negative aspects to urban development is the effect of increased impervious surfaces. This causes an increase in the rate of runoff as well as the amount of pollutants that are contained within it. Through this research I have determined that it is important to minimize the amount of impervious surfaces within the design of the project site. A second design implication is to allow water to sit and pool for short periods of time within the project site, thus allowing water to slowly infiltrate into the ground, be absorbed by vegetation, and to nourish wildlife. This also enables people to enjoy the presence of water for a little longer and to make visible the movement of water

within the neighborhood. The areas through which water moves can become multi-use zones, recreational and wildlife corridors that can become the heart of the entire community.

*“Design must be multi-faceted. Single-purpose solutions to problems tend to create other problems. So when the design and management of the urban water system are integrated with other objectives – the improvement of climate, creation of wildlife habitats, consideration of social and aesthetic needs – it leads to valid design solutions” (Hough, 1989, 95).*

## ***THE ENGINEERING OF STORMWATER – CONVENTIONAL METHODS***

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As stated, the quality of the earth's water is decreasing rapidly and residential development has had a considerable impact on this decrease in water quality.

Since the project site is located within the City of Winnipeg, it is the stormwater infrastructure found within this city that will be discussed in this section.

Since the 1960s, all new residential subdivisions in the City of Winnipeg have combined the traditional curb and gutter drainage system with the stormwater detention pond in order to deal with water quantity control. The curb and gutter system would quickly remove water from yards and streets, and the stormwater detention pond would act as a detention facility for large storm events, preventing flooding of an overtaxed system. This type of system is able to mitigate the impacts of large storm events, dealing with stormwater quantity and also, unintentionally, dealing with stormwater quality to a certain degree. These detention systems were first built for cost savings. By ponding water for a predetermined amount of time, it was possible to utilize smaller pipes to convey runoff to the storm sewers (Lovelace, 1996). These ponds were also found to make

housing subdivisions more marketable, creating waterfront properties within what would otherwise be flat, dry land.

While this combined approach is certainly an improvement to the single curb and gutter strategy, it nonetheless ignores the basic hydrological implications of overland flow and the quality of receiving water bodies.

*"In general, wet retention basins in the United States have been used for stormwater quality control, and are typically built to encourage the growth of wetland and aquatic vegetation. This is in contrast to Winnipeg where the primary focus of SRBs is flood or runoff control and any water quality improvements are of secondary importance" (Lovelace, 1996, 14).*

Stormwater detention ponds are the devices of choice because their effectiveness has been tried and tested throughout many years; the outcome is predictable and their maintenance has been regulated.

*"Stormwater retention ponds and the use of park waterways have proven to be very effective in*

*providing significant cost savings in land drainage and in permitting the development of areas remote from the major rivers. In addition, they provide a welcome diversity to the Winnipeg landscape, and have been integrated with the parks and recreation development of many communities” (Waterworks Waste & Disposal Division, 1980, 76).*

The City is skeptical of using a different type of stormwater system simply because its function has not been tested and its outcome has not been evaluated. There are many different means of managing and treating urban stormwater, which are being tested throughout North America, such as stormwater wetlands, infiltration practices, filtering practices, and open drainage channels. The City has recently allowed a residential development, Royalwood, to utilize a stormwater wetland system as a test subject and the developer has assumed high risk in order to do so. This is definitely a step forward and will possibly mean changes in the methods of dealing with stormwater within this city in the near future.

## **SUMMARY**

The City of Winnipeg has been an innovator in terms of stormwater with the introduction of stormwater ponds in the 1960s. Since then, however, the city has been conservative in its approaches and thus has not embraced the many other, more ecologically holistic, approaches that are being implemented by many other communities. There is an opportunity to create a much more sustainable, livable environment that is being overlooked. Within the design of this project a multifaceted approach to stormwater infrastructure will be the focus. The goal of this system is to not only deal with stormwater quantity and quality, but also wildlife habitat, education, and recreation. Within the following section alternative methods of dealing with stormwater will be discussed and the most appropriate ones for this site will be applied in the design of the project site.

## ***THE ENGINEERING OF STORMWATER – ALTERNATIVE METHODS***

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The process of urbanization impacts stormwater in two primary ways: by increasing the quantity of runoff and decreasing the quality of runoff. In order to develop urban areas in a more sustainable fashion, in terms of stormwater runoff, both of these issues must be addressed. What conventionally occurs within urban areas is that water moves primarily below the land in impervious pipes, therefore the natural processes of the hydrological cycle are ignored and essential components, such as infiltration, evapotranspiration and conveyance are not present.

In order to determine the best methods of dealing with runoff for the project site, a literature review on alternative methods of stormwater management has been completed. Encompassed within this research is the study of Best Management Practices (BMPs), Low Impact Development (LID) techniques, and Green Infrastructure. Each of these techniques focuses on managing stormwater through natural processes. Out of the literature review, the following includes only the approaches relevant to the strategies I have applied to my design for the site.

### **BEST MANAGEMENT PRACTICES (BMPs)**

Best Management Practices (BMPs) for stormwater management have been developed as a method of reducing non-source pollution impacts. It is recommended that more than one technique be utilized for managing runoff, as each technique encompasses a different process within the hydrological cycle. The two BMP techniques included within this paper are wet detention ponds and stormwater wetlands. Similar to what has previously been concluded by Lovelace (1996), "The best BMPs to use in new developments are retention and detention basins with carefully planned surroundings that utilize complementary BMPs such as grass swales and buffer strips" (Lovelace, 1996, 37).

### **LOW IMPACT DEVELOPMENT (LID)**

According to Hager in the January/February issue of Stormwater Journal, the roots of Low Impact Development "arose in the early 1980s from nations, including Germany, France, and Japan, where cities were interested in applying distributed, integrated management techniques to reducing stormwater quantity to alleviate problems with

combined sewer overflow (CSO).” LID strategies were formally incorporated into North American practice in the 1990s by the Prince George’s County, Maryland Department of Environmental Resources (PGDER) (DOD 2004, Foss 2005). The first municipal LID manual was published in 1998, the first nationally distributed LID manual in 2000 and in 2002 the Low Impact Development Center created a feasibility study on how LID could be used in retrofit urban areas (DOD, 2004). The concepts of Low Impact Development, however, have been incorporated in previous projects under the design of Ian McHarg and his “Design with Nature” movement (Foss, 2005). The most notable project is The Woodlands, a residential community located in Texas, which is one of the case studies for this practicum.

The benefits of this type of system include a lower installation cost, wildlife value, and it deals with issues that are important to today’s environment; such as water quality, erosion, and declining aquifers.

*“Low Impact Development (LID) is a stormwater management strategy concerned with maintaining or restoring the natural hydrologic functions of a site to achieve natural resource protection*

*objectives and fulfill environmental regulatory requirements. LID employs a variety of natural and built features that reduce the rate of runoff, filter out its pollutants, and facilitate the infiltration of water into the ground. By reducing water pollution and increasing groundwater recharge, LID helps to improve the quality of receiving surface waters and stabilize the flow rates of nearby streams” (DOD, 2004).*

Low Impact Development is an integrative process that includes planning, design and management techniques. There are seven essential planning guidelines for LID sites:

1. Conserve natural areas, keeping as much natural vegetation and soils as possible to absorb and filter runoff;
2. Utilize many small scale stormwater management devices – in order to deal with stormwater at its source as much as possible;
3. Disconnect impervious areas, thereby directing runoff off impervious areas towards pervious surfaces where vegetation and soils have a chance to absorb some of the water;

4. Reduce the amount of impervious surfaces within the development by such methods as narrowing street widths and creating shorter street lengths;
5. Prevent the amount of pollutants that are used within the development, such as herbicides and pesticides, as well as promoting alternative transportation means other than vehicular use;
6. Maintain stormwater infrastructure so it functions to the best of its ability;
7. Finally, educate the community about the techniques that are used in their development, for example, that it is important not to mow the swales or the edge of wetlands, that this vegetation has a role in the absorption and purification of stormwater (DOD, 2004; MSSC, 2005).

The techniques used within this type of stormwater management system are Integrative Management Practices (IMPs). Among the IMPs, the techniques that are feasible for this project site include: bioretention; filter strips; vegetated swales; permeable pavement, including permeable pavers and permeable surfaces such as gravel; green roofs; rain barrels & cisterns; soil amendments; and vegetated buffers/ conserved natural areas (DOD, 2004).

Before discussing the different methods of stormwater management techniques, the location in which these methods will be implemented must be analyzed. The types of soil present, the amount and frequency of rainfall, and the climate, all influence which technique is feasible for the project site.

The soils within the City of Winnipeg are primarily clay or silty-clay soils. These soils belong to the Hydrologic Soil Group (HSG) "D", which has the lowest rate of infiltration at less than 0.1inches/hour (MSSC, 2005). The yearly average precipitation is 20.76" (519mm), with the majority of precipitation falling as small storm events (Environment Canada). The region's climate has extreme temperature fluctuations from very hot to very cold, with frozen ground for many months of the year and can have large amounts of snow fall in the winter. Because this city is located within a cold climate, additional requirements must be undertaken in the design of the following stormwater management techniques in order to accommodate additional snow storage and the possibility of large amounts of snow melt occurring at one time.

There are two basic types of stormwater detention systems: wet detention and dry detention. Wet detention systems are storage or conveyance systems that always contain a wet basin. They store stormwater runoff for a predetermined length of time. This excess water has a slow, controlled discharge into receiving water bodies. Wet detention systems include such practices as wet detention ponds and stormwater wetlands. Dry detention systems, on the other hand, are storage or conveyance systems that hold water only for a very short period of time, generally less than seventy two hours, in order to ensure that mosquitoes cannot breed within the standing water. These types of systems include vegetated swales, filter strips, and bioretention facilities, permeable surfaces, and green roofs.

### WET DETENTION SYSTEMS

In terms of water quantity, detention systems are capable of managing large storm events, retaining water on site until the storm subsides and water is later allowed to move into the receiving water body. In terms of water quality, these systems are primarily designed to settle out sediment and pollutants before the water moves on towards its next destination.

### Wet Detention Ponds

Wet detention ponds are storage areas in which a permanent pool of water is maintained. The primary method of treatment is the settlement of pollutants within the water body. The secondary treatment method is the act of bioremediation by the plants found along the edge of the pond (Metro, 2002). The detention ponds within Winnipeg only allow the former treatment method to occur, ignoring the other water quality benefits available by the latter. Cold climate considerations to stormwater ponds include allowing more area for extended detention, in which runoff can sit on top of a frozen layer of ice but still remain within the containment of the pond (MSSC, 2005).

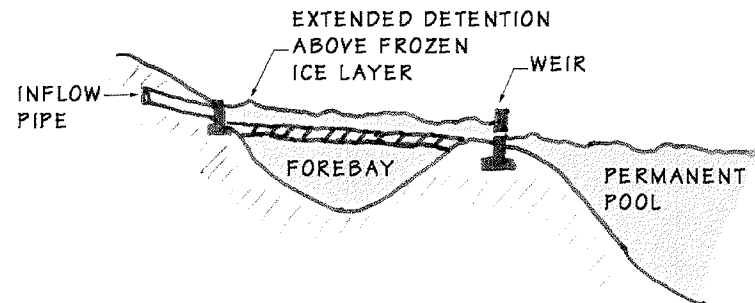


Figure 2: Extended detention above frozen stormwater pond layer

### Stormwater Wetlands

There are three primary types of stormwater wetlands: the shallow marsh, the pond-wetland system, and the

extended detention (ED) wetland. The shallow marsh is the wetland type that covers the most land area because this technique utilizes primarily shallow water throughout the wetland. This type of system requires a stringent implementation strategy and expert knowledge regarding plant material because when the system is first taking hold water levels must be carefully regulated to ensure the proper plants will thrive in this setting. Once this system has become established, it is highly valuable in terms of wildlife habitat and pollution control (Campbell & Ogden, 1999).

The pond-wetland system is a combination of the wet detention pond and the shallow wetland into one system, comprised of two cells. In so doing, it enables the same amount of water quantity to be stored within it while taking up less land area. The purpose of the pond is to reduce runoff velocity, settle out sediments, and remove pollutants (Campbell & Ogden, 1999). This system is functional in cold climates with added extended detention storage.

The extended detention (ED) wetland system combines the shallow marsh with a temporary upstream storage area, thus consuming less land area. Along the edges of

**Table 1: Wet Detention Pond Design Guidelines**

Drainage Area	25 acre min
Surface Area	Permanent pool volume: 1800 cu.ft/acre draining to pond, max. 100:1 drainage area to surface area Sediment Forebay: 10% of pond area, upstream of pond
Soils	"A" & "B" soils may require a liner
Depth to Bedrock And Water Table	if the site has shallow soils and bedrock, a wetland instead of a pond should be used
Shape	Irregularly shaped, min. 1.5:1 length to width ratio
Underdrain	Min. 8" diameter underdrain, in 1' deep gravel bed
Slope towards area	0.5 to 1% min., 25% max.
Side Slopes	1:3 (v:h) max.
Permanent Pool Depths	Min. 3', max. 8'
Shallow Zone	Recommended that approx. 15% of permanent pool surface area be shallow zone of 18" in depth or less, extending up to 10' inward from shoreline
Elevation Difference from Inflow to Outflow	6-10' recommended
Access Bench	10' out from permanent pool edge to toe of pond side, max. cross-slope of 0.06:1 (v:h), when pond side slopes are 1:4 or lower, do not need access bench
Maintenance Access	Min. 8' width, max. 15% slope of forebay, access bench, riser and outlet
Important Points	- Emergency Spillway Required

(source: MSSC, 2005)

the ED wetland systems are plantings that generally remain dry, but are inundated during larger storm events (Campbell & Ogden, 1999). Stormwater wetlands are the preferred form of detention for the project site because they also provide additional water quality and habitat

benefits, since they filter stormwater, reduce runoff rate, and provide wildlife benefits.

**Table 2: Stormwater Wetlands Design Guidelines**

	SHALLOW WETLAND	POND/ WETLAND	ED WETLAND
Drainage Area	25 acres		10 acres
Surface Area	0.2 acre of wetland/ acre of land	0.1 acre of wetland/ acre of land	
Extended Detention	No	Optional	Yes
Soils	"A" & "B" soils may require a liner		
Depth to Bedrock And Water Table	0'		
Shape	Irregularly shaped, min. 2:1 length to width ratio (should be maintained during low flow conditions)		Min. 1:1 length to width ratio
Pool/Marsh/Extended Detention percentages	25%/ 75%/ 10%	70%/ 30%/ 0%	20%/30%/50%
Surface Area: Deepwater/ Low Marsh/ High Marsh/ Semi-Wet	20%/ 35%/ 40%/ 5%	45%/ 25%/ 25%/ 5%	20% deep, 35% low, 45% high water
Forebay	Required		
Micropool	Required		
Side Slopes	Perimeter of deep pool areas (4' or deeper) require 10' access bench out from permanent pool edge to toe of pond side, max. cross-slope of 0.06:1 (v:h),		
Permanent Pool Depths	Deepwater zone: 1.5'-6' Low marsh zone: 6"-18"		
Elevation Difference from Inflow to Outflow	2' min		
Buffer	25'-50' buffer outward from max. water surface		
Maintenance	Clean out frequency: 2-5 years	Clean out frequency: 10 years	Clean out frequency: 2-5 years
Wildlife Potential	High	High	Moderate

(source: MSSC, 2005; Schueler, 1992)

**DRY DETENTION SYSTEMS**

As mentioned, dry detention systems includes any method that stores stormwater for a predetermined amount of time, but is more often dry than wet. Included in these types of systems are bioretention, filter strips, swales, permeable pavement, and green roofs.

**Bioretention (Rain garden)**

Bioretention systems have the ability to cleanse stormwater and encourage the process of infiltration. They are basically concave basins planted with vegetation that is capable of surviving through periods of drought and periods of inundation (CHI, 2000).

**Filter Strips**

Filter strips are essentially grassed areas that have a very shallow slope, accommodating flow depths of up to 0.5” (Metro, 2002). This type of LID strategy has been employed within the site design by encouraging runoff over grassed areas before the water reaches any type of conveyance system or storage area.

**Table 3: Bioretention Design Guidelines**

Drainage Area	5-10% of drainage area
Surface Area	Min. 200 sq.ft. area (approx. 10'x20')
Soils	“D” soils need underdrains
Depth to Bedrock And Water Table	3’ min.
Setback	Min. 10’ setback, located down grade from home’s foundation
Underdrain	Min. 8” diameter underdrain, in 1’ deep gravel bed
Slope towards area	Max 1%
Side Slopes	Max 3:1 (h:v)
Max. Ponding Depths	6’
Max. Pooling Depths	18”
Elevation Difference from Inflow to Outflow	4-6’
Depth of Prepared Soil	30” (but if large trees are planted, 48”-52” is recommended)
Bark Mulch Depth	3” max
Vegetation	Wildflowers, grasses, shrubs and trees. No woody vegetation at inflow and no trees on top of underdrains
Important Points	- Recommended to have a minimum 10’ grass filter strip (with pea gravel diaphragm) surrounding it, where water flows into device by the method of sheet flow - maximum 48 hour drawdown
Possible Uses	Parking lot islands, road medians/ traffic islands

(source: MSSC, 2005)

### **Swales**

Swales are wide, shallow channels that are used for water conveyance. They are designed to accommodate flow depths of up to 3". Grassy vegetation is used to remove sediment that attaches itself to runoff. These areas are designed with a minimum 1% and a maximum 6% slope (Metro, 2002). Within the City of Winnipeg, since the slope of the land is so minimal, the minimum acceptable swale slope is 0.5%. The maintenance required for this type of technique includes: mowing the vegetation approximately twice a growing season; filling in bald spots; and clearing filter strips and swales of fallen leaves and garbage (Metro, 2002). Cold climate considerations include: planting salt tolerant vegetation within swales if they are incorporated along roadways; and utilizing swales as a snow storage system in winter months.

### **Permeable Pavement**

Permeable pavement can include permeable asphalt, permeable concrete, permeable pavers, turf block or the utilization of permeable surfaces such as gravel or bark mulch. This type of design requires a special underlying

reservoir base coarse with a minimum 40% void space, through which water can infiltrate (Metro, 2002).

Permeable surfaces such as permeable asphalt and concrete, designed to allow water to percolate into the base coarse and thus soil below it, are not feasible in Winnipeg. In low-traffic areas, such as parking areas, rear lanes or pathways, permeable surfaces such as gravel and woodchips (for paths) are feasible and encouraged. These surfaces are not rigid and thus do not have the same expansion and contraction effects as does permeable asphalt or concrete surfaces.

### **Green Roofs**

There are two types of green roof systems: extensive and intensive. Intensive green roofs are commonly referred to as roof gardens. These are designed for public use as well as vegetative planting. They are more expensive and require more structural support than the extensive green roof system which is designed with a thinner growing medium that supports vegetation that is able to grow in harsh conditions. This type of system is beneficial for its insulating capabilities and stormwater absorption qualities (GVSD, 2005).

The benefits of green roofs include: providing stormwater storage; delaying runoff; reduces the heat island effect; filters air pollution; reduces air conditioning requirements in hot weather and reduces heat loss in cold weather; increases length of roof life; acts as sound insulation; and increases biodiversity in urban areas (GVSD, 2005).

*“In North America, the benefits of green roof technologies are poorly understood and the market remains immature, despite the efforts of several industry leaders. In Europe however, these technologies have become very well established. This has been the direct result of government legislative and financial support, at both the state and municipal level” (Green Roofs for Healthy Cities, 2005).*

Other methods of stormwater quantity reduction and quality improvement IMPs include: rain barrels & cisterns; soil amendments; and vegetated buffers/ conserved natural areas.

### **Rain Barrels & Cisterns**

Rain barrels and cisterns are devices that catch stormwater and store it for future re-use. Rain barrels are

typically located along the sides of buildings, capturing roof runoff. The water from these barrels is often used for watering gardens and lawns. Cisterns are larger systems that can be located underground, such as under a garage, and store a much larger volume of water. Often water from this type of system is used for grey water uses, such as flushing toilets and washing clothes. In order to size this type of system, the following calculation: 1” of rainfall on a 1,000 sq.ft. roof will create approximately 600 gallons of runoff (MSSC, 2005).

### **Soil Amendments**

Soil amendments include utilizing an engineered soil layer, with a high organic content, that is more absorbent than is soil found on site.

*“Runoff from landscaped areas can be virtually eliminated by providing a 300 mm layer of landscaped absorbent soil, even under very wet conditions where the hydraulic conductivity of the underlying soil is low” (UBC, 2002).*

For all bioretention areas within the project site soil amendments will be used to ensure maximum water absorption.

### **Vegetated Buffers/ Conserved Natural Areas**

Trees are important to the health of the city. They help with air pollution by filtering dust. They also help regulate urban temperatures by providing shade to buildings and hard surfaces under the heat of the summer sun, but still allowing sun through in the winter when the leaves have fallen off. They slow down the velocity of wind, creating a much more comfortable micro-climate. They also regulate humidity through the process of transpiration, and filter stormwater (Hough, 1989).

When large amounts of trees, shrubs and herbs are found working together within a forest, they create the most absorbent landscape type. With their deep roots and complex vegetative structure, virtually no water runs off forested areas (UBC, 2002).

*“... [forests] stabilize slopes, minimize erosion, reduce sediment inputs to streams and maintain the quality and temperature of the water” (Hough, 1989).*

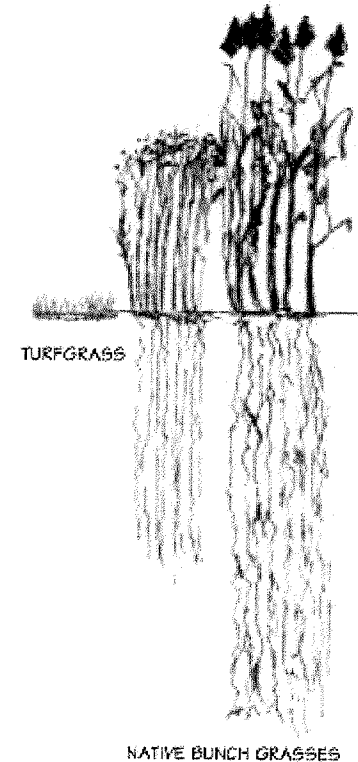
The type of vegetation that covers the soil affects the permeability of the soil. The tall grass prairie, that historically covered much of this region, has been replaced

by turf grass. Turf grass does not have the same deep root structure of the prairie grasses, and thus do not have the same water absorption capabilities. (Graham, 1984, 47).

The maximum amount of existing forest will be preserved within the project site. All other open space areas will be planted with native prairie grasses in order to maximize water absorption within the site. Within the open spaces there will be certain areas designated as “mow zones”, where playgrounds and playing fields will be located.

### **SUMMARY**

One of the goals of this practicum is to utilize the unique characteristics of the site in determining the ideal



**Figure 3: Comparison of Different Grass Roots** (source: Adapted from CHI, 2000)

neighborhood layout. In order to do so, Best Management Practices (BMPs) and Low Impact Development (LID) methods of dealing with the stormwater runoff on the site have been researched. BMPs and LID methods are not only effective means of dealing with the lack of drainage infrastructure on this site, but they also work together to create a more integrative, sustainable community. The type of infrastructure utilized in this project can be defined as Green Infrastructure, combining Best Management Practices and Low Impact Development Techniques into one integrative system:

*“Green urban infrastructure is the preserved ecological structure within an urban area. It is an interconnected system of parks, greenways, trails, surface stormwater conveyances, and natural areas that, together, can provide the fundamental ecological structure within which urbanization may occur” (CHI, 2000).*

In essence, green infrastructure focuses on the creation of multi-functional, connective open spaces: one of the goals of this project. This infrastructure combines ecological, recreational and aesthetic benefits into one system. Ecological benefits include: improvements in air quality,

through filtration of dust and pollutants by vegetation; modifications in microclimate, by vegetation; stormwater management, by absorbing and filtering excess stormwater in natural areas; and biodiversity, by promoting a diverse palette of native plantings within open space design. The recreational benefits include multi-purpose paths, and passive and active recreation areas. Finally, aesthetic benefits are derived from bringing nature and wildlife back into the city (Watson et al, 2003).

## **CHAPTER SUMMARY**

This section brought to light the interaction between rainwater and the land. The ecology and engineering of stormwater as well as the effects of current land development practices on the hydrology of stormwater in urban conditions were also discussed. Stormwater management within urban areas can be more integrative and holistic than the current City of Winnipeg practices. This was evident in the vast number of alternative methods available for controlling stormwater found within Best Management Practices and Low Impact Development Techniques. As mentioned within the LID section, controlling runoff involves more than simply end of pipe

solutions. It is an integrative process that includes planning, design and management techniques. It is a combination of the research on stormwater and these LID planning guidelines that led to the first set of Design Principles for the design of the project site:

- **Create a Multi-Functional Landscape**

- Parks and open spaces need not only encompass mowed playing fields. There is value in combining stormwater techniques with open spaces in the design of urban environments. Wet Detention Ponds need not only have one function, to detain runoff. They can also serve as wildlife habitat areas, cleanse polluted runoff and act as recreation areas for more people than simply those who live along its shores.

- **Conserve Natural Areas**

- Existing forests and grasslands are important to the health of our cities. They filter pollutants, are habitat for many wildlife species, and they absorb large quantities of runoff.

- **Control Stormwater at the Source**

- An important aspect to dealing with non-point pollution is the issue of controlling runoff at its source. This type of pollution is found primarily within small storm events. Low Impact Design Techniques involve a series of smaller scale practices that instead are designed to absorb runoff at its source, storing water in many smaller areas, thus enabling it to be filtered and absorbed into the soil where it falls, like it would historically have done.

- **Daylight Stormwater Runoff**

- This is a means of controlling stormwater at the source. Instead of moving runoff underground, it is directed overland allowing natural filtration and absorption by vegetation and soils. In so doing, the presence and movement of water is made visible within the site.

- **Reduce Impervious Cover**

- As discovered through the literature review, increases in impervious cover are a major cause of decreased water quality from urban areas. These surfaces increase the quantity of runoff and decrease the quality of runoff by replacing the site's pervious natural areas which previously would absorb and filter runoff and pollutants with impervious surfaces. Reduce roof surfaces, street size, parking spaces, setbacks, lot sizes, driveways, and sidewalks. Since impervious surfaces are necessary in a residential development, what is required should be disconnected from the drainage system. Water running off roof tops and roadways should drain onto pervious surfaces first so it has the ability to be absorbed and filtered by plant material and soil before it reaches the drainage system.

- **Create Connective Networks: Open Space/ Hydrology**

- These connective networks are necessary to daylight stormwater runoff and also work towards creating a multi-functional landscape. Connective open space networks allow for a functional above-ground vegetated swale conveyance system.

## iv.

## The Residential Neighborhood

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The goal of this practicum is to design an integrative residential neighborhood by first and foremost amalgamating stormwater and open spaces. In order to determine the best method to do so, an examination of what is required within a residential neighborhood had to be undertaken. This chapter will focus on the way residential neighborhoods are designed, how these designs influence human's connection to nature, and the relationship of rain water to the residential landscape. The first part of this section will define the residential neighborhood: the security, familiarity and nurture of home and how this relates to one's connection and understanding of nature. Next there will be a discussion about the neighborhood layout and conventional as well as alternative neighborhood patterns that can be utilized to plan the project site. Finally, this chapter will conclude with a summary of key points derived from this research and the principles that have thus been established in order to guide the design of the project site.

Webster's online dictionary defines a neighborhood as "a geographically localized community located within a larger

city or suburb." It further defines a community as "a set of people with some shared element. Also a community is a group of people or things that live in the same area. The substance of shared element varies widely, from a situation to interest to lives and values." A neighborhood is composed of much more than roads and houses; it encompasses the places that people call "home".

A house is what provides us with shelter; a home is something to which we have an emotional attachment. This attachment does not confine itself to the interior of the house, nor the yard, but to the entire neighborhood where the majority of one's time growing up and learning about the world around us is spent. In the words of Yi-Fu Tuan, "Home is a place that offers security, familiarity and nurture" (Harrison et al, 2004, 164).

Tuan defines security as a clearly bound space, which offers comfort in the fact that one finds reassurance in knowing that they are in or out of the particular space. One can thus brace oneself when departing the space into unfamiliar territory. Familiarity is what gives the space a

sense of security. "Home is the familiar place where difficult and stressful choices no longer have to be made since, thanks to prior experience, one knows just where things are and what to do" (Harrison et al, 2004, 164). Finally, Tuan defines nurture as a means of recovery within the familiarity and security of home.

Before transportation and communication over large distances became so accessible and commonplace, people found security in their own community. The security came from their experience in that place, their parents' experience and that of their grandparents. From that came an understanding of the people of the place, where to go to find what was necessary to survive, and where and what to do to avoid getting hurt. As the world became more open and accessible, people were no longer limited to their home place. They were able to explore the world, and their home place grew much larger to encompass not only a village, a city, a province, or a country, but the entire globe. At one time people derived security in knowing, or at least feeling like they knew and understood their immediate surrounding and the people in it, now this security has been shattered with life around them changing so quickly that no one has a chance to

adjust. The understanding has been lost and the security along with it.

We are in a world where environmental concerns are becoming increasingly prevalent. Water quality, decreasing oil reserves, and climate change are all issues that are gaining more frequent attention.

For many, the entire view of nature has changed. Nature was once regarded as something that we had to control, and in fact had control over. Now we cannot help but realize that nature is what controls us. We are a part of nature.

*"In the course of the growing ecological understanding that did not start until the late sixties, man came to perceive himself as an integral part of a set of connected, natural and cultural ecosystems, and thus also part of the nature surrounding him" (Strelow, 2004, 11).*

We can manipulate nature, but we can never control it. We can attempt to understand its systems, but we can never understand every minute detail. The more we learn, the more questions we have. What is so intriguing about

nature is its complexity. We are naturally curious creatures and will never give up the pursuit to understand the world around us. The solution to this is not to hide the natural systems underground but to work within their bounds. To utilize what we understand about the natural world and work with it to create the neighborhoods in which we live.

The aim of this project is to utilize our understanding of some of nature's systems, namely that of the hydrological cycle, and to create a more integrative solution to stormwater infrastructure. In so doing, our "homes" acknowledge the natural systems and the natural environment in which we are a part of instead of attempting to control the urban environment by quickly ridding these elements from our neighborhoods. The security is found within these new neighborhood types through our feeling of belonging within nature, rather than our fear and desire to control it. Instead of feeling a lack of control regarding the state of the broader environment, we can feel secure in knowing that our neighborhoods are working within nature's ecological systems. We begin to have a greater understanding of the natural world in which we are apart of

because its systems are now visible and not hidden underground.

Our neighborhoods can be designed with people in mind while still working within the earth's natural systems. These neighborhoods can become places in which security is derived from walking through and experiencing them on the personal level rather than viewing them simply through the window of the car. Our neighborhoods can be designed to encourage the interaction with residents and their neighbors as well as the natural systems of the surrounding environment.

## ***THE NEIGHBORHOOD LAYOUT***

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Our neighborhoods should be designed with people in mind while still working within the earth's natural systems. In researching different neighborhood layouts for this project, it was important to keep this issue as well as the design principles derived in the chapter on stormwater at the forefront. The aforementioned principles include: create a multi-functional landscape, conserve natural areas, control stormwater at the source, daylight stormwater runoff, reduce impervious cover, and create connective open space and hydrologic networks. In order to design a neighborhood with people in mind, a seventh principle was added to this list: to create a pedestrian oriented community. It is the person, not the car that calls the neighborhood "home".

These principles have implications on the layout of the neighborhood, including such issues as the design and layout of the street network, the density of the neighborhood, and the design and location of open space. The building density is directly connected to the amount of open space that is available for the neighborhood. The less building density, the less open space is available for

such uses as open drainage and the conservation of natural areas. The density also has implications on the level of pedestrian connectivity of the site and the availability of alternative transportation methods, such as transit.

The primary planning issues to consider in the layout of a residential neighborhood include: density, dwelling types, infrastructure, open spaces, and land uses. The design of a neighborhood can be spatially broken down into a series of networks, nodes and edges. While the planning issues are important in determining the essential ingredients of the neighborhood, the spatial issues are what give form to the community. Networks include the physical elements such as streets, green spaces and hydrology. Nodes include gathering places, areas that give the community a sense of place. These include commercial areas, schools, community clubs, focal points, and park spaces. The edges create containment to the space; they are what create the clearly bound space, what Tuan defines as "security" within the home place.

## ***Conventional Residential Subdivision Development***

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The history of North American and European suburbs began with the advancement of transportation technologies. As soon as people were able to physically escape from over-populated, unsanitary cities in search of rural, natural settings, they did. With the advent of the streetcar came one of the first suburban communities, the streetcar suburb. The nature of these suburbs is similar in concept to today's Transit Oriented Development type. The suburbs were laid out along streetcar lines, similar to the idea of rapid transit lines, and the areas around the stops became commercial and social activity centers. The suburb relied on walking as the primary method of transportation within it and therefore the layout was completely pedestrian oriented. From that point on, people continued to move out of the city as transportation options became more readily accessible and cities became unsanitary and crowded. Eventually the majority of the population owned at least one car per family and movement within and around the city became limitless. The car replaced walking as the primary means of movement within the city and the layout of the city evolved from pedestrian oriented to vehicular oriented patterns.

Within car oriented suburb neighborhood traffic noises, environmental concerns and issues of pedestrian safety are of primary concern.

*“Rather than being guided, as it should be, by natural systems or human needs, the quality and placement of growth in our regions is largely dependent on the car. The car is now the defining technology of our built environment. It sets the form of our cities and town, dictating the scale of streets, the relationship between buildings, the need for vast parking areas, and the speed at which we experience our environment” (Calthorpe, 1993, 27).*

Currently there is limited competition for the development of land within the City of Winnipeg, with a few major companies controlling most areas within city limits. With few competing companies, there are limited alternative development patterns available within the residential subdivision market and developers are not forced to provide different options. The conventional subdivision pattern is sufficient and guaranteed to sell homes. What

determines the current development pattern is primarily the market's preference for curvilinear streets and cul-de-sacs, as well as city by-laws and zoning ordinances that prescribe minimum lot and street sizes and the allowable uses within each sector. Within this system it is much more cost effective and much less time consuming for a developer to follow the conventional pattern than to attempt an alternative form. Any development that deviates from the norm and attempts to alter current zoning by-laws will have a much more labor intensive process, requiring by-law amendments, more public consultation (and possibly public outcry based on misunderstandings) and simply further proof that this alternative is in fact viable, especially if it has not previously been tried in this municipality.

*“Conventional suburban development practices are embedded in zoning bylaws, infrastructure standards, building codes, and lending practices” (Gordon & Vipon, 2005).*

The conventional method for designing a residential subdivision includes six primary steps: an assessment of municipal zoning ordinances and by-laws that affect the property of land, the site inspection, the yield study, market

analysis, a traffic study, and an environmental impact study (Dewberry, 1998). Within the local government and planning regulation framework, the developer must first determine if the proposed use is acceptable within the municipal development plan, which in the case of the City of Winnipeg is currently Plan Winnipeg 2020. If this type of land is acceptable within Plan Winnipeg, the next issue to consider is if this land area is covered by a Secondary Plan. The Secondary Plan is a composition of detailed land concepts for a defined area (City of Winnipeg, 2005). Such a plan generally exists within areas that either have special development constraints or in which the city would like a certain type of land use mix, ensuring a more efficient development process. The land which must be subdivided for the creation of a residential area may already belong under the residential zoning category or may be currently zoned for a higher or lower intensity use, such as commercial or agricultural. Usually the land is already zoned residential or is of a lower intensity use, such as agricultural. If the zoning differs from the use intended for the development, a land re-zoning must occur. Under residential zoning there are a number of different densities, lot sizes and land use mixes that are acceptable. Each of these issues impact the length of time it will take to

develop the land as well as additional costs required in the development of the site. The yield study is what determines the maximum number of units possible within the given land base. In order to determine this, all land that cannot be built on is first subtracted from the land base and then twenty percent of the remaining land is subtracted to account for future streets, stormwater facilities, and open space requirements. The remaining land is divided by minimum acceptable lot sizes and the result of this is the maximum number of lots. Market analysis for the site includes such issues as determining the demographic and economic trends in the area, commuting trends, consumer preferences, and the community's housing needs (Dewberry, 1998). The traffic study determines the capacity of existing roads to absorb excess traffic, includes an assessment of how much traffic is expected to be generated through development of the site, and finally determines if any additional roads or pavement widening will be required to support these additional traffic volumes (Dewberry, 1998). The environmental impact study includes the assessment of such issues as soil contamination and the impact of development on natural features, such as conservation areas, etc. The environmental impact study can be quite

extensive, but typically it is simply glazed over with only essential requirements being assessed.

Within the City of Winnipeg there are certain Development Agreement Parameters that must be met in order to develop a piece of land. Included in these parameters is a certain land dedication component, generally a minimum of 8% of the net developable area dedicated to the city in terms of public park reserves, with a 2% cash dedication to the city for such issues as the maintenance and development of these sites. Additionally there is also a requirement of land to be developed as stormwater storage with an area set aside for access and maintenance of these areas (City of Winnipeg, 2005).

Conventional municipal ordinances are prescriptive in nature. They provide rigid sets of data that must be followed in order to gain approval. Specific land uses, lot sizes, and road widths are permitted. There is no deviation from the norm allowed, except in such a case where one would attempt a by-law amendment, in which case much more time and expense is necessary.

*“The rigid framework of current street standards has resulted in uniform, unresponsive suburban environments” (Ben-Joseph, 1995).*

The process of suburbanization began before WWII, but it accelerated after WWII, with veterans returning from war in need of a large number of new homes. Also, what enabled this expansion were the proliferation of federal highways and the availability of housing subsidies, both which made suburban housing affordable and attainable by car (Schmitz, 2003). The demographics at that time included a large number of traditional families. The current urban and suburban population is comprised of a much more diverse mix, including a large percentage of seniors, many single people, married couples choosing not to have children, single parent families, mixed families bringing together 2 separate families into one household, and many recent immigrants. As well as changing family compositions, lifestyles have also changed. Two parent earners, and the reliance on daycare, is quite different than in the 1950s where only one parent would work and the other would stay home with the children.

*“Many people have more money but less free time than ever; consequently, they value time over*

*money. Some people have grown tired of the maintenance that comes with homeownership; others never want to settle into that routine to begin with...increasing numbers of people work at home: between 1997 and 2001, the number of people who worked at home at least part of the time increased from 22.4 million to 25.0 million. More people are concerned about environmental and health-related issues” (Schmitz, 2003, 4).*

The changing demographics have an effect on the types of housing and neighborhoods that are appropriate in today’s society.

*“According to a recent study that explores what baby boomers want in their communities...’As the percentage of childless households increases, the market for smaller lots – if not smaller homes – is expected to increase. The declining presence of children suggests a growing market for denser, more walk able neighborhoods that adults find interesting” (Schmitz, 2003, 9).*

Even with the changes in family composition and housing needs, the suburbs are still being built to the same standards as they were in the 1950s (Schmitz, 2003).

*“In many regions, the existing stock of traditional suburban housing will meet the demand for years to come, but there is a shortage of attached housing (both for rent and for sale), of affordable units, and of other kinds of smaller housing types” (Schmitz, 2003, 7).*

The design of the project site will include a variety of housing types in order to accommodate the wide diversity of family composition in contemporary society. The site

will also aim to provide appropriate housing for a person’s entire lifecycle; from young adult, to family with children, to retirement age. Instead of designing a community based on conventional methods, conforming to municipal zoning ordinances and by-laws, as well as focusing on maximizing the allowable amount of lots per land area, the design for the project site will base its neighborhood design on the set of Design Principles that have been derived from the literature review on stormwater and the residential neighborhood. Utilizing the Design Principles to guide the design of the site will ensure that the intent of reconnecting people with the natural environment through the integration of stormwater and open spaces in the design of a residential neighborhood is met.

## ***Alternative Development Types***

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Alternative development types, such as Traditional Neighborhood Design and Cluster Development, were researched and analyzed in order to create a more integrative residential neighborhood design, focusing on creating a pedestrian oriented community while minimizing impervious surfaces, conserving natural areas, and enabling the ability for the conveyance and storage of stormwater within the site's open spaces.

Instead of designing a development pattern focusing primarily on the movement of traffic and the minimum acceptable lot size and spacing for the area, issues such as preservation of existing forested areas and wildlife corridors must also be integrated within the site.

*"The special places that give our rural and semi-rural communities their distinctive character need not all be cleared, graded, and paved over just because they contain flat, dry, buildable land, although that has been the fate of countless*

*similar natural areas in virtually all suburbs built up to this time" (Arendt, 1996, xviii).*

A 2001 National Association of Home Builders (NAHB) survey found that amenities that influenced homeowners' decision to move to a new community include "parks (62%) and walking trails (58%)... about one-third of those surveyed said that they would be seriously influenced by the availability of public transportation... 50 percent said that they wanted an environment-friendly home, and 14 percent were willing to pay more for such a home... Sixty-two percent rated 'natural undeveloped lands' as important" (Schmitz, 2003, 6).

The two alternative types of neighborhood layouts that were researched for the purpose of this practicum each have different community goals and thus create different neighborhood characters. The intent of Traditional Neighborhood Design (TND) is to create a more walkable, mixed-use neighborhood producing a village type character. The objective of Cluster Development, on the other hand, is to create more compact lot development in

order to conserve open space. This open space can be utilized as agricultural land, forests, wetlands, or shared common areas. This type of development generally produces a more rural character. The essence of both of these development types is important to the design of the project site. Within Cluster Development, the conservation of open spaces is important in the formation of a more integrative stormwater system. Within Traditional Neighborhood Design, the focus on pedestrian connectivity is important in the development of a neighborhood designed with people in mind. Both of these issues are integral to the Design Principles that have been derived for this project. A final layout type, that of the Fused Grid, is the result of the combination of these two approaches.

**TRADITIONAL NEIGHBORHOOD DESIGN (TND)**  
[NEW URBANISM/ TRANSIT ORIENTED DESIGN (TOD)]

The primary intention of Traditional Neighborhood Design (TND), New Urbanism, and the Transit Oriented Pattern (TOD) movements, is to create a pedestrian oriented community.

*“The New Urbanism, also called traditional neighborhood development, livable communities,*

*transit-oriented development and smart growth, is a method of building human-scale neighborhoods in place of single-use subdivisions, shopping centers, and office parks” (Steuteville, 2001).*

The New Urbanist movement began to expand in North America in the 1970s and 1980s (Ellis, 2002). Since then the Congress for New Urbanism (CNU) created a charter of principles and a New Urbanist ‘Lexicon’, ‘Transect’, and ‘SmartCode’ were created by Duany Plater-Zyberk & Company (Ellis, 2002). Each of these set of guidelines attempts to clearly define how New Urbanist principles can be implemented within the land development process. The SmartCode can even become adopted as a municipal ordinance. It defines street widths, lot layouts and neighborhood planning guidelines all within the New Urbanist Transect (which describes development on a density gradient from the city centre, with the highest density, to the rural environment, with the least density). The Charter of the New Urbanism combines many of the principles of Traditional Neighborhood Development and Transit Oriented Development into one (Gordon & Vipon, 2005).

Key elements to the New Urbanist and Traditional Neighborhood Design Philosophy include:

- *Pedestrian Oriented & Encourage Compact Form;*
  - Size/ layout based on the Pedestrian Shed [5 minute walk – conventionally 1,320 feet (400m), but can be extended to 2,640 feet (800m)].
- *Integrate Uses;*
  - Encourage mixed uses and variety of housing types
  - Neighborhood shops and institutions and bus stop located in the center
- *Highly Connective Road Pattern;*
- *Connectivity of Active Transportation Network;*
- *Range of Public Spaces;* and
  - town square as focal point
- *Clearly Defined Urban Boundaries*  
(Sustainable Community Research Group, 2000; Watson et al, 2003).

*“In every context the quality of new development should follow town-like principles: housing for a diverse population, a full mix of uses, walkable streets, positive public space, integrated civic and commercial centers,*

*transit orientation, and accessible open space” (Calthorpe, 1993, 34).*

## **CLUSTER DEVELOPMENT**

[CONSERVATION SUBDIVISIONS/ OPEN SPACE SUBDIVISIONS]

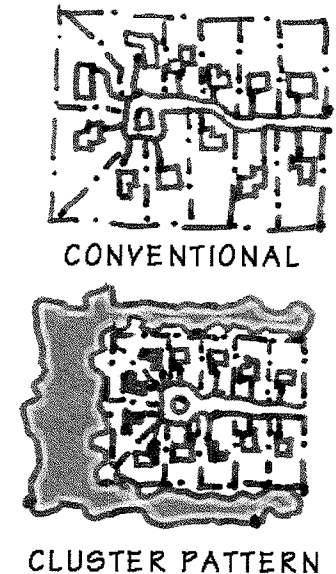
This alternative development type is most often used to replace conventional large lot subdivisions that would otherwise swallow up vast amounts of land and destroy large areas of natural habitat. The open space that these subdivisions create can both preserve and protect a particular land use, (such as the preservation of agricultural land or protection of wildlife habitat), or become private spaces used solely by residents of the community, (such as private trails or passive recreation spaces). The designer of such a subdivision would first determine the amount of units allowable through a yield plan, which is simply the maximum number of units that would fit within the parcel utilizing the existing land zoning. Instead of filling that land with roads and lots, the designer would set aside a certain percentage of protected land (open space), and construct smaller lots and roads within the rest of the development.

*“The term “Conservation Subdivision Design” (CSD), as coined by Randall Arendt, describes a relatively new concept of cluster-type development that enables land to be developed while simultaneously preserving community character, reducing environmental impacts, protecting the rights of property owners, and enabling a developer to benefit from a high-quality project. CSD accomplishes these goals through a creative design process that identifies primary and secondary conservation areas. Wetlands, floodplains, and steep slopes, in addition to a large portion of the flat, dry, and otherwise buildable land are set aside within those conservation areas from clearing, grading, and construction. Instead, lot sizes are reduced and the allowed development is arranged to “fit” onto the unconstrained land” (MAPC, 2000).*

In his book Conservation Design for Subdivisions, Randall Arendt describes four primary benefits to designing subdivision sites for both conservation and development. The first states that the end result of conventional site design includes only house lots and streets. When an

entire area is covered solely in house lots and streets, the area becomes impoverished in natural areas and local identity. Streams are covered over, forests are cut down, impervious areas increase dramatically, and every development begins to appear the same. The second benefit Arendt mentions is that alternative methods are not difficult to master and they create more attractive environments that residents appreciate. He defines the third benefit as a means of smoothing the local review and approval process and responding to

environmental concerns before they become an issue, through land protection. Polluted water bodies are becoming an increasing concern in many regions, as is the threat of a decreasing supply and availability of fresh drinking water. Eventually, the cleansing of polluted stormwater will become an issue that will be required by law, preserving wildlife habitat will become essential and



**Figure 4: Difference between Conventional and Cluster Pattern**

this will already be inclusive in the conservation subdivision. The final benefit Arendt mentions is that “conservation subdivisions are simply better places to live” (Arendt, 1996). They offer a larger variety of spaces for play, recreation, pedestrian access and social gatherings. With more activities possible outside of one’s home, more places for recreation, exploration, and education, it is believed that people within the community will create stronger community ties. With more chance encounters, it is more likely that a community will have a stronger neighborhood bond (Arendt, 1996). “...increased neighboring has been found to result from feelings of safety, from greater utilization of public spaces and from greater use of local facilities for shopping” (Talen, 1999).

### FUSED GRID

The fused grid is a street layout concept initially developed by the Canada Mortgage and Housing Corporation (CMHC). This layout combines the conventional loop and cul-de-sac street pattern with the historic grid pattern (Liebner, 2003), see Figure 5. This hybrid street system is a good method of creating a connective framework while still allowing for more private, many times favored, cul-de-sac and loop roads, and reducing the amount of

imperviousness that the street system creates within the neighborhood.

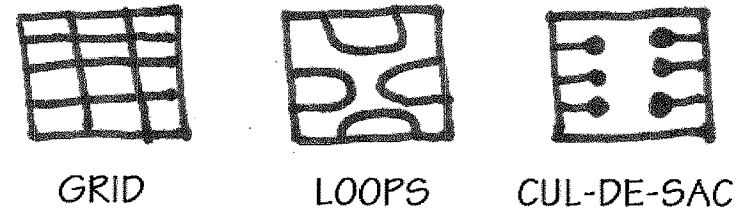
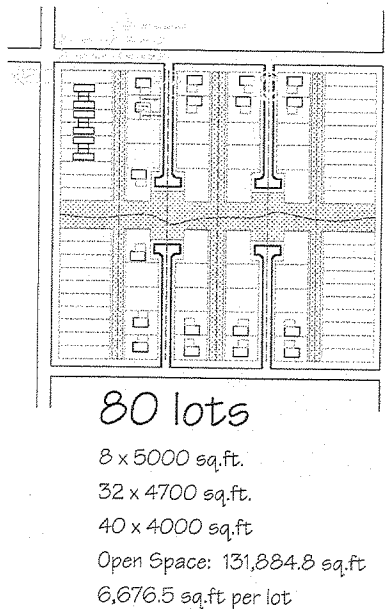
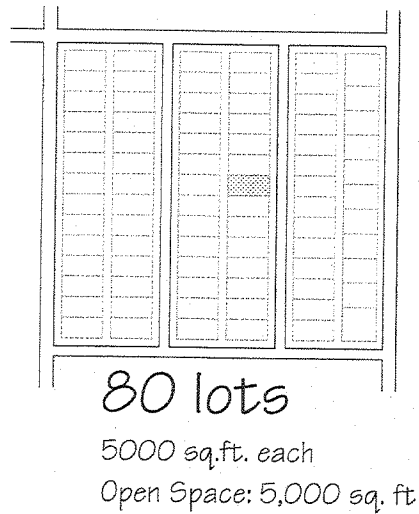


Figure 5: Various Street Patterns

### SITE PATTERN

In combining key points from all of the Alternative Development patterns, a new street and lot layout was developed. This was accomplished through an analysis of the three primary street layouts that can be seen in Figure 5, and utilizing the concepts of creating more compact lots and the use of narrower street widths to maximize open spaces (principles derived from Cluster Development) as well as to create a connective vehicular and pedestrian framework (principles derived from Traditional Neighborhood Design). The intent was to create a pattern that would allow for the same number of lots as a conventional subdivision, while conserving a larger amount of open space.



**Figure 6: Comparison between the standard grid pattern and the new Site Pattern**

This analysis determined that a grid pattern that would normally create 80 uniform lots could be transformed into a fused grid pattern creating the same number of lots, of varying sizes, while conserving a larger amount of open space. The new pattern created eight 5,000sq.ft. lots; thirty-two 4,700 sq.ft. lots; and forty 4,000sq.ft. lots, while conserving 131,884.8sq.ft. of open space.

## CHAPTER SUMMARY

The intent of this chapter was to research the important issues of a number of different development patterns and determine the best way of designing a pedestrian oriented development that would facilitate the stormwater minimization principles established in the previous section. This research has concluded that the conventional development pattern has developed through the rigid municipal structure of by-laws and zoning ordinances as well as subjective consumer preference. Since there are no other new development patterns being constructed within the City of Winnipeg to give consumers a different neighborhood option, market preferences are not satisfactory methods of evaluating the success of the conventional pattern. City by-laws and zoning ordinances are designed to protect the urban citizen, to ensure the built environment is safe, and to protect the quality of life within the municipal environment. It is these same standards that create homogenous neighborhoods that lack diversity and disregard environmental consequences. They are designed for the cars that people drive and not the people themselves. Since it is these very by-laws that create the neighborhoods that this project does not want to replicate, they are ignored and instead alternative

development patterns were sought out in an attempt to create a better community.

By researching neighborhood patterns such as Traditional Neighborhood Design, Cluster Development, and the Fused Grid, a few more principles were adopted to finalize the list of Design Principles that will be utilized in the design of the project site.

Additional Principles determined in this chapter:

- **Create Connective Networks: Transportation**
  - This includes a connective vehicular as well as active transportation network.
  
- **Emphasize the Pedestrian**
  - Base the layout on the Pedestrian Shed (average 5 and 10 minute walking distances)
  - The neighborhood is the home of people and therefore should be designed as such.
  
- **Emphasize Community**
  - A neighbourhood is home to a community of people. It is more advantageous to the

people of that community to feel apart of the community rather than separate from it.

This creates a sense of comfort, belonging and security within one's home place.

- The sense of community can be encouraged through the creation of shared open spaces and public gathering places, such as village squares or commercial hubs.

Additional information that can be added to Principles derived from the previous chapter:

- **Create a Multi-Functional Landscape**
  - A multi-functional landscape includes open space use as well as multi-use zones, and a variety of housing types within the residential neighbourhood. In order to create a heterogeneous neighbourhood that creates housing for number of different family compositions, a variety of housing types must be encouraged. Multi-use zones enable the ability to mix uses such as commercial and residential into one block or one building.

- **Create Connective Networks: Open Space/ Hydrology**

- These connective networks can become the heart of the community, where the shared open spaces and the connective active transportation network are found.

Because the aim is for this connective open space system to be the heart of the community a final Design Principle is added:

**Locate Open Spaces as Close as Possible to all Residents**

- By locating the open space network as close as possible to all residents it best serves its drainage function as well as connecting all residents with the active transportation network.

**Table 4: Minimum street width comparisons**

Pavement Width (feet)	Source
<b>24.6' (one lane parking)</b>	<b>City of Winnipeg</b>
20'	National Fire Protection Administration
18' (minimum)	Massachusetts State Fire Marshall
22'	American Association of State Highway and Transportation Officials
24' (on-street parking) 16' (no on-street parking)	Baltimore County, Maryland
20'	Prince George's County, Maryland
18' (one lane of parking) 26' (parking both sides)	Portland, Oregon
22' (one side, 350 ADT) 26' (one side, 500 - 1000 ADT)	Boulder, Colorado
21' (parking on one side)	Delaware
20' (parking on one side)	Portland, Oregon
12' (alley)	Bucks County, Pennsylvania
12' (alley) 20' (parking on one side)	City of Kirland, Washington
20' (6m) (no parking) 26' (7.8m) (parking on one side)	Time-Saver Standards for Landscape Architecture (1998) (p.342-24)

Source: adapted from Stormwater Manager's Resource Center (SMRC)

**Table 5: Collector Street Design Standard Comparisons**

	<i>Winnipeg</i>	<i>Time Saver Standards</i>	<i>Smart Code</i>	<i>Site</i>
ROW width	22m (72')	21.3m (70')		21.3m (70')
Pavement width	10m (32.8')	11 -12.2m (36-40')		9.6m (31.5'): 2 one way streets, each with one lane of parking (2.1m) and one travel lane (2.7m)
Travel lane width		3.6m (12') (50km/hr)	3.4m (11') (25-35mph)	
Parking lane width		3m (10') (50km/hr)	2.4m (8') (25-35mph)	
One way road w/ parking on one side			2.1m (7') parking 2.7m (9') travel = 4.8m (16') (20-30mph)	
Two way road w/ parking on one side			2.4m (8') parking 3m (10') travel x 2 = 8.5m (28') (25-30mph)	
Parking access			3.6m (12')	

(source: Watson et al. 2003; Duany et al; City of Winnipeg, 1991)

**Table 6: Local Street Design Standard Comparisons**

	<i>Winnipeg</i>	<i>Time Saver Standards</i>	<i>Smart Code (T4)</i>	<i>Site</i>
ROW width	18.3m (60')	18.3m (60')		15.2m (50') max
Pavement width	7.5m (24.6')	6.7-11m (22-36')		6.7m (22') max
Travel lane width		3m (10') (30 km/hr)	3m (10') (25-35mph)	
Parking lane width		2.4m (8') (30 km/hr)	2.1m (7') (20-25mph)	
Parking access			3.7m (12')	

(source: Watson et al. 2003; Duany et al; City of Winnipeg, 1991)

## V.

## CASE STUDIES

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The following section will discuss five different Case Studies and how these have influenced the design decisions for the project site. All of the projects that have been studied are alternative forms of a residential development. These developments all deviate in form from the conventional development pattern and the majority of them deal with stormwater infrastructure in an unconventional but successful manner.

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### ***Radburn, Fair Lawn, New Jersey***

*Designer:* Clarence Stein & Henry Wright

*Builder:* City Housing Corporation

*Project date:* 1929

*Site Size:* 149 acres (incl. 23 acre park network)

*Location:* Fair Lawn, New Jersey, 12 miles from New York City

*Population:* approx. 3,100 people

(The Radburn Association)

Radburn is a Planned Community – “The Town for the Motor Age” - famous for its deviation from the traditional pattern and its creation of a new layout type, that of the superblock. Since the inception of Radburn, the curvilinear street pattern and the use of cul-de-sacs have become widespread. This development is also famous for designing for the pedestrian, rather than the car, which was common at the time it was built. The housing lots organize themselves around a common open space network that is completely pedestrian in nature.

Throughout the entire open space network there are no locations in which a pathway crosses the road. The housing lots also differ from the norm, since they face onto public greenspace instead of a front street.

#### **Project Goals:**

*“The intent was to build a community which made provisions for the complexities of modern life, while still providing the amenities of open space,*

*community service and economic viability” (The Radburn Association).*

The project intended to become a self-sufficient community, accommodating 25,000 people, but because of the Great Depression, the City Housing Corporation was forced into bankruptcy.

### **Design Principles:**

Henry Wright devised a set of six principles known as the “6 planks for a housing platform”. These principles include:

1. Plan comprehensively. Do not follow the conventional pattern, plan according to the specific site.
2. Ensure there are plenty of community sites.
3. Ensure the locations of industrial uses and factories do not require excessive transportation requirements.
4. The presence and use of vehicles must be planned for while minimizing noise, danger and confusion.
5. Keep in mind the relationship between private and public land
6. Ensure that the cost of homes and services are fair (The Radburn Association).

### **Unique Features**

- Separation of pedestrian and vehicular traffic in order to create a safer community and with the understanding that the vehicular environment is necessary but should not guide the layout of the site.
- The creation of a Road System Hierarchy.
- The layout of the community was similar to that of the cluster development in the sense that the public park space was enabled through a revision of the neighborhood layout. The space for the public park was provided through savings from less land required for roads and utilities. The superblock road pattern enabled the requirement of less road surface while still allowing the same number of lots. (The Radburn Association; NSW Department of Housing)

### **Circulation System**

- Separation of pedestrian and vehicular traffic in order to create a safer community
- The creation of a Road System Hierarchy, influenced from Olmstead’s Central Park. Roads were designed as high intensity networks, such as

highways, to lower intensity uses, such as cul-de-sacs.

- Creation of the superblock. This superblock was 365m to 548m (1,200' to 1,800') long, in comparison to the 61m to 183m (200' to 600') urban block that was standard at the time (Girling, 1993).
- Cul-de-sac layout: 100 to 130 meter (328' to 426') length with 10 meter (32') right of way (conventional at the time was a 16-20m ROW). 6m (19.6') paved driving lane with 2m (6.5') utility strip on each side. 5m building setbacks  
(The Radburn Association; NSW Department of Housing; Girling et al, 1994).

### **Lot Sizes and Layouts**

- 469 single family homes, 48 townhouses, 30 duplexes, and a 93 unit apartment complex (The Radburn Association)
- Average lot size of 4,500 square feet (Girling et al, 1994).

### **Open Spaces**

- The superblock, use of cul-de-sacs, and internal park system allows every residence to have access to open spaces. "No Radburn home was more than 400 feet from parkland or roadway" (Girling et al, 1994)
- Open space amenities include: interior parkland, 2 tot lots, 3 hardball fields, 2 softball fields, 2 playgrounds, an archery plaza, 4 tennis courts, and 2 outdoor basketball courts (The Radburn Association).

### **Community**

- The park network and recreational programs within the community are managed internally through the Radburn Association. Therefore, the community has more control over their amenities and open space system.
- Community amenities include: 2 swimming pools, 1 tot pool, and a community centre which has administrative offices, library gymnasium, clubroom and maintenance shops (The Radburn Association).

### **Green Infrastructure**

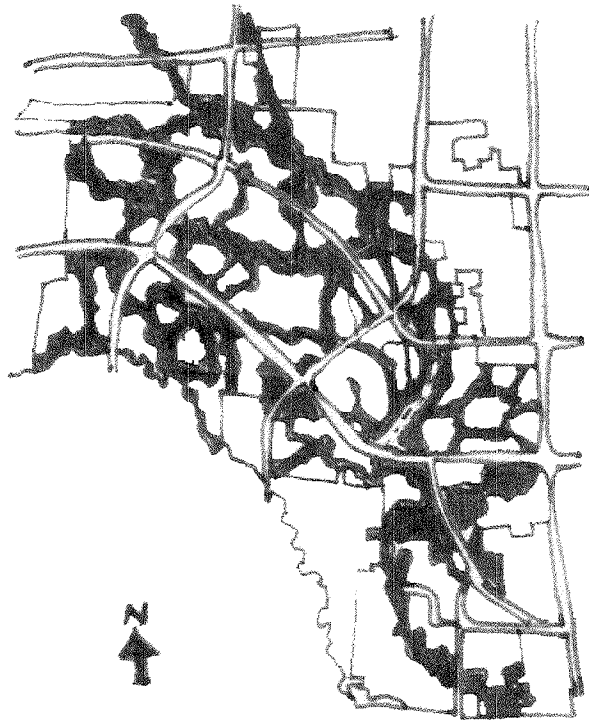
- This project did not incorporate green drainage infrastructure but it did create a connective open space network.

### **Challenges and Lessons**

- The entire plan was not able to be built because of the Great Depression.
- The residential lots were designed to be smaller than average because of the large amount of open space available to each resident. The problem that occurred is homes were built small because of the size of the lots, limiting the current residents from expanding their homes as average housing sizes grow larger than they were in the past.
- There is less privacy within the individual lots because the homes are placed close together and front onto open space, while the back yard faces the cul-de-sac street.

- In general, the lots were designed for only one car per family, yet it is quite common for families to have two or more cars. This causes crowding and congestion on the small cul-de-sac streets.
- There is confusion between the “front” and “rear” yards of the houses. The lots were designed with the housing fronting onto the public greenspace but it is the rear yards that the majority of the people use since they generally arrive to their homes by car. Often the “front” door is never used.
- “In his 1957 writings about Radburn, Clarence Stein confirmed that the complete separation of the street from recreation did not work. Children persisted in playing on the street side of the houses, frequently with the encouragement of parents” (Girling et al, 1994).  
(Wikipedia; Girling et al, 1994)

## ***The Woodlands, Texas***



**Figure 7: Plan of The Woodlands**

The Woodlands is a Master Planned Community that can be described as a form of Cluster Development.

Residential areas were clustered in order to preserve existing forest areas and to create a natural system of

*Owner/Developer:* George Mitchell  
*Project began:* 1964-purchased land  
1971-team of an architect/planner, environmental planners, engineering consultants, and marketing consultants was put together

*Date Completed:* 1974

*Project Size:* 25,000 acres

*Location:* 27 miles north of Houston, Texas

*Population:* 55,649 (yr 2000)

*Architect & Planner:* William Pereira

*Environmental Planners:* Wallace McHarg Roberts & Todd

*Engineering:* Richard P. Browne Associates

*Marketing Consultants:* Glandstone Associates

*Average Min. & Max Temperature:* 14.2°C (57.6°F) to 26°C (78.8°F)

stormwater management. At the time it was built it was viewed as a model of ecological planning.

In an attempt to receive financing from a new federal program, the developer was encouraged to improve his technical staff. He was referred to read Ian McHarg's 1969

book Design with Nature and was extremely inspired by it. The developer then hired McHarg's team, Wallace McHarg Roberts & Todd (WMRT), to devise the master plan for The Woodlands site in conjunction with architect and planner William Pereira (Forsyth, 2005).

The Community was developed in stages, composed of 7 villages of approximately 2,000 acres each. The first village built was Grogan's Mill. This village is the closest in character to the original concept for the Woodlands site. The newer neighborhoods have deviated from the original plan and when walking through the site these areas can be barely distinguished from surrounding conventional communities.

### **Project Goals**

*"The Woodlands is designed primarily to protect relatively invisible water systems, allowing aquifer recharge and limiting runoff. It combines an emphasis on hydrology with an aesthetic that uses the original woods to mask development" (Forsyth, 2005).*

### **Design Principles**

- Utilized WMRT's "Ecological Inventory" to lay out the site.
- Mimic the site's natural hydrologic cycle
- Protect existing forest areas

### **Unique Features**

- The method in which the site was designed, utilizing a broad team of architect/planners, environmental planners, engineering consultants, and marketing consultants
- There was an extensive ecological analysis of the site undertaken by WMRT.
- The framework for the plan came first of all from analyzing and working with the landscape and secondly from circulation routes and commercial centers.
- The site had no master land use plan; instead the intention was to work within the guiding framework of the ecological plan, while retaining land use flexibility (Girling et al, 1994).
- The unique natural system of stormwater management including a surface drainage system and the preservation of riparian areas.

### **Circulation System**

- The road system was of the curving loops and cul-de-sac pattern (Girling et al, 1994)
- The circulation system was divided into a network of east-west and north-south arterial roads, at approximately 2 mile spacing.
- The main arterials followed the ridges of the site with smaller roads located between drainage channels.
- The road corridors were designated as greenbelts with the primary walking and bike paths located within these greenbelts. *“The pathways are extensive but, by following roadways, do not always provide direct, grade-separated linkages from homes to schools or shopping centers. Paralleling drivers, bikers and pedestrians must go from cul-de-sac to collector to arterial and back, crossing several high-speed roads along the way, to reach most destinations. The circuitous routes and risks to safety discourage all but the most determined bikers and pedestrians” (Girling et al, 1994, 164).*

### **Open Space**

- Approximately 25% of the community was retained as open space
- Open space amenities include: 3 outdoor pools, tennis courts, basketball courts, baseball fields, picnic areas and playgrounds, and miniparks.
- High-intensity recreation areas are designed to complement, but not infringe upon the natural open spaces; therefore community open spaces and roads are not directly connected to the forest areas. This is beneficial from an ecological standpoint but not in terms of environmental education (Girling et al, 1994).

### **Community**

- A Major Town Center (a mall, surrounded by hotels, business parks, and cultural and recreational facilities) is located within the community.
- University, business, industry, and research campuses are all located within the site (Girling et al, 1994).
- The parks and open space facilities within the community are all managed by the Woodlands Community Association (WCA).

## **Green Infrastructure**

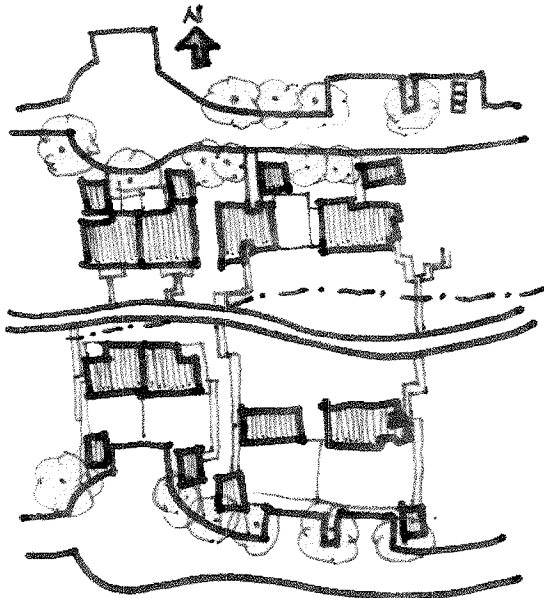
Included within the intent behind the stormwater infrastructure for the site are: maximizing recharge areas, protecting permeable soils from development, maintain the water table level, reduce runoff volumes, reduce erosion and siltation, increase stream base flows, and protect natural vegetation and wildlife habitats (McHarg & Sutton, 1975).

- Natural floodplains were preserved as park spaces.
- Long before the term Low impact development was coined, the drainage design for the Woodlands attempted to create areas to encourage the rain from small storm events to soak into the soil.

## **Challenges and Lessons**

- The commitment to McHarg's Ecological Plan was abandoned in the 1980s. The natural drainage system is no longer used instead the newer communities are drained using the conventional curb and gutter system (Girling et al, 1994). A community can be a model ecological development, well known for its successful natural drainage system, but economic pressure and uninformed citizens can be the cause of the breakdown of the core principles of the site.

## Village Homes, Davis, California



**Figure 8: Neighborhood Cluster Plan**

Village Homes is a Planned Residential Community designed as a form of Cluster Development. The site clusters residential units in order to conserve open space. This is a mixed-use residential community that is composed of an open space network, common agricultural land and commercial office space and a community center. The design for this site was inspired by Ebenezer Howard's Garden City. The intent of the development was

*Developer & Designer:* Michael and Judy Corbett  
*Date Designed:* 1973-1975  
*Construction began:* 1975  
*Date Completed:* 1981  
*Project Size:* 60 acres  
*Location:* Davis, California  
*Population:* 650  
*Number of Units:* 242  
*Average Density:* 7 units/net acre (4 du, 7 du not counting common landscape, 6,933 people per square mile)  
*Lot Sizes:* 4,000 square feet  
*Home Sizes:* from 600 sq.ft to 2,800 sq.ft & a nine-bedroom co-op  
*Employment:* Home Owner's Association, commercial office work & agriculture  
*Average Walking Distance to Village Center:* 4.3 minutes  
*Average Min. & Max Temperature:* 39° - 95° (4°C - 35°C)

to create a more sustainable community in response to environmental issues that had arisen in the 1970s. The community was intended to be holistic, incorporating living quarters, a strong sense of community and agricultural lands in order to produce food for the people within the community as well as an additional income base for the neighborhood.

### **Project Goals:**

1. Reduce energy consumption through the creation of an ecologically sound lifestyle; and
2. Establish a sense of neighborhood community (Corbett & Corbett, 2004).

### **Design Principles**

1. *Connected/ Related: "Every living thing survives by numerous and subtle relationships with all living things and with the inanimate environment."* (Corbett, 2000, 53).
  - Humans, like every other life form, are part of the same ecosystem and need clean water, clean air, and a survivable climate
2. *Diversity - "Ecosystems and part of ecosystems composed of a wide variety of species tend to adapt better to environmental changes or human tampering than do those composed of fewer species"* (Corbett, 2000, 54).
  - A community can be more stable and adaptive to change with a greater diversity of energy sources, economy, and food sources.

3. *Renewable Energy - "Part of the ecosystem is a complex system of energy transfers that depends, ultimately, on energy input"* (Corbett, 2000, 55).
4. *Renewable Resources - "In the long run, every one of humanity's physical needs must be satisfied either without the use of nonrenewable resources or through recovery and reuse of those resources"* (Corbett, 2000, 55).
5. *Human Physical & Psychological Needs - "Although humans seem to be the most adaptable of living things, we still have certain inherent physical and psychological needs that must be met by the ecosystem, the human-made physical environment, and the social environment."* (Corbett, 2000, p.56)
6. *Human Genetic Makeup - "Humans are for the most part genetically adapted to the environment that existed from about 200 to 20,000 years ago. This adaptation involves not just our physical makeup but also our modes of perception and behavior and relates to the social environment as well as the physical environment"* (Corbett, 2000, 56).
7. *Human Interrelationship With Its Environment - "The relationship between people and the*

*environment goes both ways: humanity both shapes and is shaped by its environment” (Corbett, 2000, 58).*

8. *Effects Of Human Stress - “Humans can adapt to a wide range of environmental conditions, but the result of adaptation to inhospitable conditions is temporary or chronic stress” (Corbett, 2000, 59).*

### **Unique Features**

- Natural drainage system
- The design’s focus on renewable energy sources:
  - solar water and space heating, natural cooling systems
  - Houses are oriented north-south along the streets to maximize solar exposure
- Pedestrian friendly design with bike paths and narrow streets:
  - Network of pathways and common areas
- Edible landscaping and organic agriculture
  - Orchards and community gardens
- Homeowners Association:
  - Owns household commons, greenbelt commons, agricultural land (orchards and vineyards), and the community center

### **Land Uses**

#### Residential:

- 244 housing units (222 single family units, 22 apartments)
- 800 residents

#### Commercial:

- Commercial office space: 4,000 square feet with 15 small businesses, including consulting and professional firms

#### Agricultural

- 12,000 square feet – small scale agricultural production: row crops, vineyards, and orchards.

#### Public and Natural Areas

- 12 acres of greenbelts and open space
- 12 acres of common agricultural land
- 2 village greens
- Swimming pool
- Community center building
- Restaurant, dance studio, and day care center (Francis, 2003, 19).

### **Circulation System**

The circulation system is composed of a series of cul-de-sac street encircled by a minor arterial street. The narrow,

tree-lined streets run primarily east-west to maximize southern exposure for residences, and to encourage passive solar energy design.

Streets are a series of cul-de-sacs that feed out to an adjacent minor arterial street.

- The circulation system is composed of a system of roads and a pedestrian network.
- The pedestrian network along with the layout of the site ensures that all residents can walk to meet their daily needs in less than ten minutes.

### **Lot Sizes and Layouts**

- 4,000 square feet lots, smaller than the average conventional lot.
- Houses front onto open space system as well as rear cul-de-sac.
- The lot area that faces the street is private, composed of carports or garages, small fenced yard and landscaped courtyards.
- The lot area that faces the open space system is semi-public space, jointly owned by smaller groups of 8 families that back onto the space. The private space within the homeowner's lot consists of a

narrow space between the house and this greenspace commons.

- The design and landscaping of the common areas was the responsibility of the group of home owners located adjacent to it, therefore each has a very different character
  - Some are vegetable gardens
  - Some are large perennial gardens
  - Some have large play areas (Girling et al, 1994).
- The community is composed of a mix of housing types – 220 individual homes and 20 apartments: Home Sizes: from 600 square feet common-wall homes to 2,800 square feet detached single family homes & 20 units of rental apartments.

### **Open Spaces**

The community is composed of three types of open space:

1. Private property;
2. Association-owned common lands; and
3. common land owned by smaller groups of eight families (Girling et al, 1994).

## Community

*“The emphasis in both design and management is on creating usable spaces that foster a strong sense of community ownership as compared to public spaces of formal parks, gridded streets, and front porches” (Francis, 2003, 36).*

- A Homeowners Association manages agricultural lands, owns major building complexes and apartment buildings, and maintains community open spaces and recreation facilities. This gives the community a sense of control over their own space.

*“To establish this sense of community, people must know their neighbors, and they will get to know them only if they have reasons to get together. In Village Homes, we have made it easier by setting up common areas of greenbelts which are controlled by eight families, who were in most cases involved from design through to construction. After completion, most of the maintenance is also done by the cluster members. This has not always been easy for those of us unused to sharing responsibility, but it has been very effective in establishing community” (Corbett & Corbett, 2004).*

## Green Infrastructure

The neighborhood’s environmental ideals include:

- To conserve and clean water,
  - Stormwater is directed through a natural drainage system of creeks and ponds
  - Streets are located along ridge lines, with water from roofs and roads draining across lawns into the natural drainage system
- Use passive and active solar energy,
- Produce more food than its residents could consume,
- Include the residents in managing their community’s resources (Girling et al, 1994).

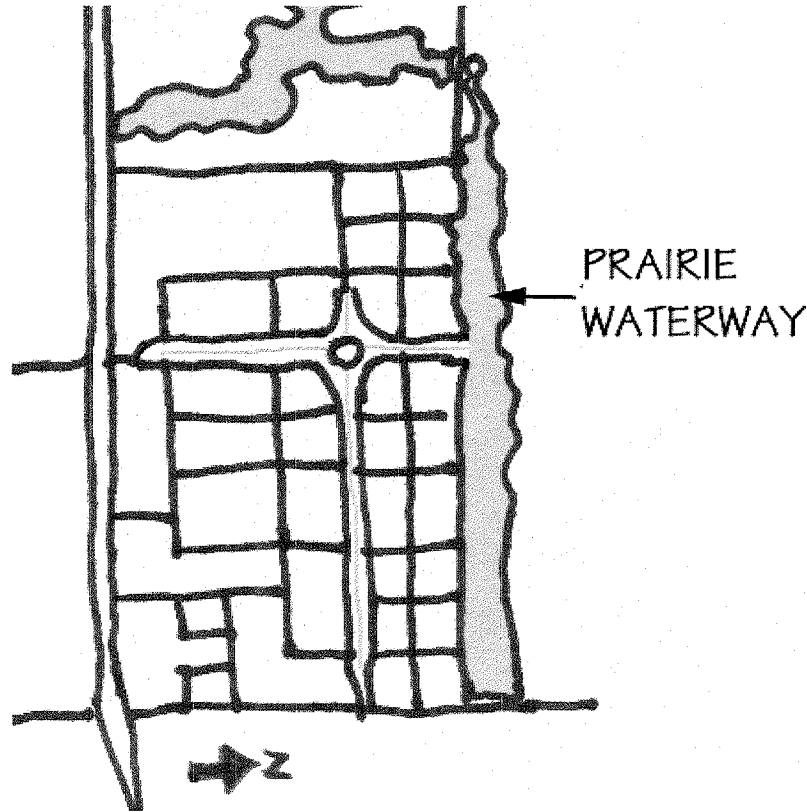
## Challenges and Lessons

*“Mike Corbett suggests that the development could be three times denser while providing the same amount of green space. Judy Corbett suggests that the community may be too big with some 800 residents” (Francis, 2003, 66).*

Some challenges to this neighborhood that have been mentioned by Michael include the lack of people within the community during the day and a blurred boundary between

public and private space (Francis, 2003). Another issue with the community is the agricultural areas that were meant to provide funds for the residents of the community actually cost more to maintain than the profits they earn.

## ***Park Place, Farmington, Minnesota***



*Developer: Sienna Corporation  
Layout Concept: Derek Thompson, RLA  
Engineering: J.R. Hill Inc.  
Prairie Waterway Concept: DCAUL  
Prairie Waterway Design: Balmori and Associates  
with Paul Barten (hydrologist)  
Date Designed: 1993  
Date Completed:  
Project Size: 200 acres  
Location: Approx. 20 miles south of Minneapolis-St. Paul  
Number of Units: 486*

**Figure 9: Plan of Park Place**

Park Place is a Planned Development located on a flat prairie site surrounded by farmland. The development was inspired by Traditional Neighborhood Design and utilizes Low Impact Development concepts. It is composed of a grid street system and smaller than conventional lots.

### **Project Goals**

- To connect the existing neighborhoods with this new development.
- The water management goals included the improvement of water quality and limited water quantity.
- To create a neighborhood rich in amenities (Design Centre for American Urban Landscape, 2002).

### **Design Principles**

This set of principles was developed by the Design Center, the planning study committee, and the developer:

- Use the existing grid pattern in adjacent city to shape development's layout;
- Protect and restore natural systems through the use of such methods as smaller street widths and native plantings;
- Foster social connections, through such means as pedestrian linkages connecting natural and civic spaces;
- Provide travel options, in terms of different road options such as parkways versus highways, as well as offering pedestrian and bicycle paths within the community;

- Diversify and increase the local economy. This was attained by designing stormwater ponds and drainage systems as recreation corridors as well as wildlife habitat (Design Centre for American Urban Landscape, 2002).

### **Unique Features**

- Construction of a 'Prairie Waterway' as a means of dealing with the quantity (flood control) and quality of stormwater drainage.
- Use of central road median channels to move stormwater runoff from back yards and streets into the Prairie Waterway.

### **Circulation System**

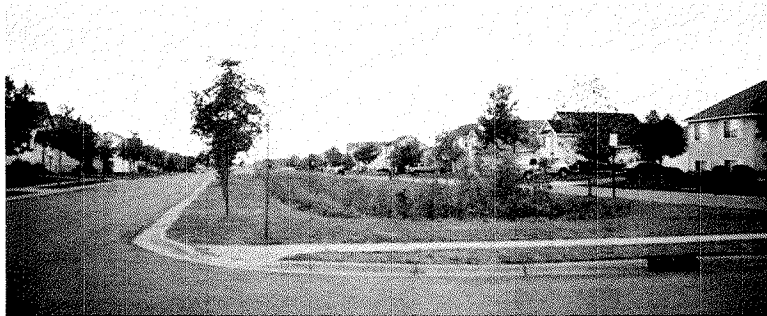
- The circulation for this site is composed of a pedestrian network and two primary roadway types.
- The pedestrian network includes sidewalks along both sides of each road, pathways through the central open space within each block layout, and a series of pathways within the Prairie Waterway.
- The vehicular network includes a major and minor street system. The major streets have a central drainage median where stormwater is directed

through a series of catch basins and underground pipes. This street is easily visible and allows for easy wayfinding within the site.

- The second, minor, street system includes local streets. Houses with front driveways are located along these streets.

### Lot Sizes and Layouts

- Roads are laid out in a grid network, similar to the pattern of the existing community (**Figure 9**).
- The lots edge each block, with a greenspace located within the center.



**Figure 10: Major street with central drainage median**



**Figure 11: Local street**

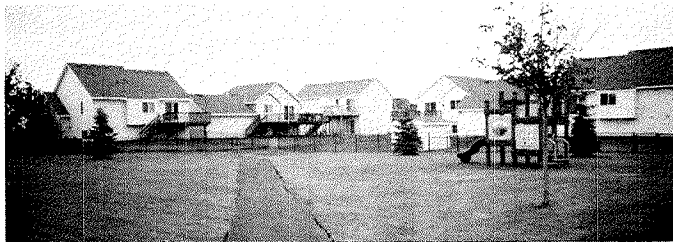
### Open Spaces

- Large Waterway Park with a system of trails and a picnic shelter,
- Playground and playing fields
- Each block has a central greenspace that is shared by the surrounding residents. Within the center of this space is an infiltration area where stormwater is able to infiltrate into the soil. These areas are composed of turf grass, some trees and some of them also include play structure.

*“Since houses are set fairly close to the street, the space behind the houses is fairly generous, such that the distance back-to-back is more than 200 feet”  
(Martin, 2002, 128).*



**Figure 12: Prairie Waterway**



**Figure 13: One block's central greenspace**

### **Community**

1. A sense of community is encouraged through the creation of the shared central greenspaces.

### **Green Infrastructure**

Instead of designing stormwater infrastructure that utilized the conventional pond and underground drainage system, a Prairie Waterway was designed. This waterway would collect runoff from the neighborhood and adjacent agricultural fields and transport it to the river located west of the site.

- The layout of the development was modified to reduce the stormwater runoff. In order to reduce impermeable surfaces, street widths were narrowed and driveways were shortened.
- Each block's central greenspace was designed with a depression within its center that would encourage infiltration of roof and lot runoff (France, 2002).

I briefly visited Park Place on Sunday, October 8, 2006. I happened to be in Minneapolis so decided to take a drive to see what the community is like in person. What struck me about it was how conventional the community appeared. I would not have known that this community was progressive in any way in terms of natural drainage if I had not previously read about it. The main roadways with the central median swales were quite impressive. I loved the look of them and they did bring a unique character to the place. But if I was not on one of those roads everywhere else looked like any other subdivision. This of course is great for getting people to move into the area, for it really does not take any getting used to, there are curbs and gutters and front driveways. The houses are on fairly large lots.

The central commons were certainly a different feature from conventional subdivisions. I walked through a number of these spaces. Many of them had small play structures for the grouping of homes to share, and some were simply large turf areas with a few scattered trees. Even though the day I was there was a cloudy, fall day, with a slight sprinkling of rain, there were still kids playing on the grass and the play structures in some of the common areas. What was interesting was the amount of fencing in most of the common areas, defining each home's private space. Most of the fencing was black chain link fencing so the look was not too intrusive and it still left the space feeling quite open. Some of the yards, though, had wooden fencing that completely separated their yard from the rest of the open space. Even with each yard

fenced off there was still a large amount of open space available for play or for group gatherings. I would assume that in areas without children or without play structures that space would be rarely used because the space is not at all private. Another thing about the central commons was that the homes clearly faced the front streets with large windows and doors on that side. The central commons side of the homes definitely had a back side of the house appearance with small openings for windows scattered around that wall. This most likely occurred because the homes were conventional suburban home designs placed into this setting, therefore they were not able to take advantage of a better flow from back door to open space plus again this could be another means of arriving at more privacy.

## ***East Clayton, BC***

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*Neighborhood Concept Plan: City of Surrey*  
*Design Charette: led by the James Taylor chair in Landscapes and Liveable Environments at UBC (Patrick Condon)*  
*Construction began: 2002*  
*Date Completed: not completed*  
*(expect 20yr build out)*  
*Project Size: 250-hectare (617 acres)*  
*Location: Surrey, British Columbia*  
*Population: future population of 13,000 residents*  
*Number of Units: 4,739 units of housing*  
*Average Density: overall density of almost 10 units per acre*  
*Lot Sizes: 2,700 to 6,000 sq.ft.*  
*Employment: Over 5,000 jobs*  
*Average Walking Distance to Village Center: 5 minutes*

East Clayton was chosen as one of the case studies for this practicum because the criteria for the project matched closely the planning and design principles that were developed for the practicum site. East Clayton was an interesting project to study, for it is a recent project, considering construction only began in 2002, and it is a Canadian site. The plan for East Clayton responds to contemporary issues with an emphasis on designing the community in a sustainable fashion and an attempt to walk lightly on the land. Water quality and quantity issues were of high importance for this project as they are for this practicum. There were very tight constraints placed upon

the development of East Clayton in terms of stormwater drainage and the amount of runoff that was able to move into downstream water bodies. An important component to the design of the concept plan, therefore, was the increase in the quantity of stormwater once the area was changed from agricultural to urban uses, and the decreases in stormwater quality. Even with an abundance of slow draining clay soils (as what is found within the practicum site), the intent of the drainage infrastructure was to absorb as much runoff as possible on site. This includes the encouragement of infiltration and evapotranspiration processes.

*“More than anything else, the East Clayton Neighborhood Concept Plan is a “green infrastructure” plan. East Clayton will be one of North America’s most significant examples of an integrated system of green streets and affordable sites. Parks, playgrounds, and natural areas are essential and integral components of this system”* (CEA, 1999).

### **Project Goals**

1. To preserve the natural environment, and
2. to promote natural drainage systems.

### **Design Principles**

The following sustainable design principles, utilized to guide the development of East Clayton’s Neighborhood Concept Plan, were developed through the design Charette process in conjunction with the research of the James Taylor chair of Landscape and Liveable Environments at the University of British Columbia:

1. *Conserve land and energy by designing compact walkable neighborhoods. This will encourage pedestrian activities where basic services (e.g.,*

*schools, parks, transit, shops, etc.) are within a five- to six-minute walk of their homes;*

2. *Provide different dwelling types (a mix of housing types, including a broad range of densities from single-family homes to apartment buildings) in the same neighborhood and even on the same street;*
3. *Communities are designed for people; therefore, all dwellings should present a friendly face to the street in order to promote social interaction;*
4. *Ensure that car storage and services are handled at the rear of dwellings;*
5. *Provide an interconnected street network, in a grid or modified grid pattern, to ensure a variety of itineraries and to disperse traffic congestion; and provide public transit to connect East Clayton with the surrounding region;*
6. *Provide narrow streets shaded by rows of trees in order to save costs to provide a greener, friendlier environment; and*
7. *Preserve the natural environment and promote natural drainage systems (in which stormwater is held on the surface and permitted to seep naturally into the ground) (City of Surrey, 2004).*

### **Unique Features**

- The integration of green infrastructure, including a focus on natural drainage;
- Environmental preservation goals;
- The creation of a walkable neighborhood;
- An interconnected street system;
- A mix of residential uses; and
- The inclusion of commercial areas within the neighborhood.

### **Land Uses**

The East Clayton Neighborhood Concept Plan included a clear list and description of acceptable land uses within the site. These land uses were utilized to guide the Master Plan of the practicum site.

- The residential uses ranged in density low density areas with a maximum of 4 units per acre (upa) to high residential areas, with a maximum of 45upa.
- Commercial uses included: mixed use areas, with residential units above main floor commercial uses; neighborhood commercial, enabling commercial centers to be located within a five minute walk of each resident; and specialty commercial areas,

geared towards residents of surrounding communities.

- The East Clayton NCP also included areas in which people of the community can work, such as Live/Work areas and a Techno/Business Park.
- Finally, a system of park spaces was developed. These include such areas as schools, a linear greenway, riparian parks, and neighborhood parks.

### **Circulation System**

The circulation system is composed of a modified grid street layout and a connective pedestrian and bicycle network.

- The street network is composed of a four-part hierarchy, ranging from arterial streets to back lanes (City of Surrey NCP, 2000).

### **Green Infrastructure**

Drainage infrastructure components include:

1. The creation of an urban forest. This is composed of a dense tree canopy including tree-lined streets and trees and shrubs planted in each lot and urban parks.

2. Within the individual lots, infiltration facilities were designed to store runoff from roofs and yards, and allow this runoff to percolate into the ground. In order for this to function.
3. Along the streets, shallow infiltration BMPs, such as infiltration trenches and vegetated swales were installed.
4. A system of recharge wells were installed, encouraging deep infiltration of stormwater;
5. Finally, a number of stormwater detention ponds were developed. These areas were designed to detain water for a predetermined amount of time and slowly release it into receiving water bodies (City of Surrey NCP, 2000)

### **Challenges and Lessons**

- Concerns by development industry – concern over marketability of natural drainage systems, mix of housing types, and rear lanes.
- Municipal staff concerns – concern alternative drainage system will not function properly and concerns over the unknown maintenance requirements for these systems (Condon, 2005).
- One of the lessons that learnt through the development of East Clayton is that “incremental changes are easier to sell than a quantum leap” (Condon, 2005).

## CASE STUDY COMPARISONS

	<b>Radburn</b>	<b>Woodlands</b>	<b>Village Homes</b>	<b>Park Place</b>	<b>East Clayton</b>
<b>Year</b>	1929	1964-1974	1975-1981	1993-1995	2002 to present
<b>Location</b>	Fair Lawn, New Jersey, US	Texas, US	Davis, California, US	20 miles south of Twin Cities, MN, US	Surrey, BC, Canada
<b>Average Temperature</b>		14.2°C (57.6°F) to 26°C (78.8°F)	39° - 95° (4°C - 35°C)		
<b>Developer</b>	City Housing Corporation	George Mitchell	Michael and Judy Corbett	Sienna Corporation	Neighborhood Concept Plan – City of Surrey
<b>Land Area</b>	149 acres	25,000 acres	70 acres	200 acres	250-hectare (617 acre)
<b>Overall Density</b>			7.7 units/net acre (overall 4 units per acre)		Almost 10 units per acre
<b># Residents</b>	Approx. 3,100	55,649 (yr 2000)	650		13,000 (proposed)
<b>Narrow Streets</b>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<b># units</b>	469 single family homes, 48 townhouses, 30 duplexes, and a 93 unit apartment complex			486 single family homes	
<b>Lot Sizes</b>	4,500 square feet average		4,000 square feet		2,700 to 6,000 sq.ft.
<b>Unit Sizes</b>			600 sqft – 2,800 sqft		
<b>Dwelling Types</b>	Single family homes, townhouses, duplexes and apartment complex		Single family homes and apartments	Primarily single family detached	Single family detached, duplexes, row houses, townhouses, 4-storey apartments
<b>Road Layout</b>	Superblock, Cul-de-sacs	Loops and cul-de-sacs	Cul-de-sacs Streets run east-west	Grid	Grid & Modified Grid
<b>Front Yard Setbacks</b>				Small	Single family & duplexes– 4-5m (13'-16.5') Row houses & townhouses – 3m (10') Main street residential – 0-2m (0-6.5')
<b>Garage Access</b>	Rear Lane, houses face greenspace		Front street, houses face greenspace	Front Street	Primarily Rear Lane (but some wide shallow lots with front street access)
<b>Tree Lined Streets</b>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

	<b>Radburn</b>	<b>Woodlands</b>	<b>Village Homes</b>	<b>Park Place</b>	<b>East Clayton</b>
<b>Character</b>	"garden city"	Rural character	Inspired by garden city, rural character	Traditional, small town	Village Centre Node
<b>Commercial Centre</b>				Development is adjacent to downtown Farmington	<input checked="" type="checkbox"/> 7.4 acres
<b>Open Space</b>	Interior common space in which homes front onto. Pedestrian pathway through open space that does not cross any roads.	Primarily along two creek floodplains and four golf courses	Agricultural lands, greenbelts	Linear Park & interior common spaces within blocks	Linear Parks – greenway to act as recreational corridor (40m wide) & Neighborhood Parks
<b>BMPs/ IMPs</b>		1. natural drainage system – swales 2. infiltration 3. storm detention ponds/wetlands	1. natural drainage system - swales	1. gravel-backfilled drywells in the center of each block  2. channels carrying runoff from front yards and streets	1. infiltration 2. storm detention ponds 3. vegetated swales 4. urban forest
<b>Traffic Calming Devices</b>	No traffic crosses connective pedestrian paths			- traffic circles	- traffic circles - street parking
<b>Special</b>			Houses oriented north-south to take advantage of passive solar  8 homes per cluster – facilitate neighborhood interaction	Interior common space for each block acting as temp water storage	

	<b>Radburn</b>	<b>Woodlands</b>	<b>Village Homes</b>	<b>Park Place</b>	<b>East Clayton</b>
<b>Design Principles</b>	<p>1. Plan comprehensively. Do not follow the conventional pattern, plan according to the specific site.</p> <p>2. Ensure there are plenty of community sites.</p> <p>3. Ensure the locations of industrial uses and factories do not require excessive transportation requirements.</p> <p>4. The presence and use of vehicles must be planned for while minimizing noise, danger and confusion.</p> <p>5. Keep in mind the relationship between private and public land</p> <p>6. Ensure that the cost of homes and services are fair.</p>	<p>WMRT's "Ecological Inventory"</p>	<p>1. Everything is connected/ related.</p> <p>2. A diverse ecosystem/ community is more adaptive to change.</p> <p>3. Utilize renewable energy sources.</p> <p>4. Utilize renewable resources</p> <p>5. Design for human physical and psychological needs.</p> <p>6. Consider pre-existing human genetic makeup.</p> <p>7. Human Interrelationship With Its Environment.</p> <p>8. Effects of human stress.</p>	<p>1. Entrance Homes and Neighborhoods (Utilize the existing grid pattern in adjacent city to shape development's layout).</p> <p>2. Protect and restore natural systems (smaller street widths and native plantings)</p> <p>3. Foster Social Connections (pedestrian linkages connecting natural and civic spaces)</p> <p>4. Provide Travel Options (parkway vs. highway, pedestrian and bicycle paths)</p> <p>5. Diversify and Increase the Local Economy (stormwater ponds and drainage systems designed as recreation corridors as well as wildlife habitat) (source: Design Centre for American Urban Landscape, 2002)</p>	<p>1. compact, walkable neighborhoods, with basic services located within a five to six minute walking distance from most homes</p> <p>2. range of dwelling types and densities to provide housing options in the same neighborhood and even on the same street</p> <p>3. Designing communities for people in order to promote social interaction</p> <p>4. Locating car storage and services at the rear of dwellings</p> <p>5. interconnected street network, in a grid or modified grid pattern, to ensure a variety of itineraries and to disperse traffic congestion</p> <p>6. of narrow, tree-shaded streets to save costs and provide a greener, friendlier environment</p> <p>7. Preservation of the natural environment and promotion of natural drainage systems</p>

Each of these case studies has informed the design for the practicum site. Radburn and the Woodlands are well-known precedents. The first is a model development, designed with people in mind through the interconnected pedestrian pathway system and central open space network, while the second exemplifies ecological planning and the process of designing with nature, with its emphasis on preserving natural areas and its natural drainage system.

Village Homes was the one community that was studied in which the designers really focused on the idea of community and creating a sense of community within the neighbourhood. Even though this development was constructed in the 1970s, this is still a relevant issue today. This design as well as that of Radburn influenced my perception of shared space, which I was always drawn to. What I learnt through Village Homes was that social and physical responsibilities are very effective methods of bringing people together. Village Homes demonstrated how a neighbourhood could utilize this concept to create a sense of place and a strong feeling of belonging within the

community. One issue that Michael and Judy Corbett discussed in their book Designing Sustainable Communities: Learning from Village Homes is the lack of control people feel in large urban settings. Creating a Home-Owner's association was a method of giving people a sense of control back in their lives.

Park Place was a community that I was able to visit first hand, and thus experience the outcome of the design in person. The community had many unique qualities but the one that stood out most was the vegetated drainage swale in the roadway median. This created a beautiful streetscape year round and also clearly defined the space, what streets were the major streets that could easily bring you into or out of the community.

East Clayton provided clearly outlined and easily replicable alternative development standards that have been studied and developed on an actual site case. What was unique about this site was that it was a government agency and university working together to develop an alternative community. It was not simply the vision of a developer or

designer that made this neighborhood happen, which was the case in all of the other case studies. It is exciting and promising to see that governments can take a pro-active role, instead of simply sitting back and enforcing existing by-laws and regulations. The way the East Clayton site

was divided into different land uses and densities was replicated within the plan for the project site. Instead of following the conventional homogeneous zoning by-law for the site, the land was instead divided into a variety of residential density areas as well as mixed use spaces.

From the research of the ecology and engineering of stormwater along with the residential neighborhood and alternative development types, a set of design principles were derived and used to design this site.

- **Create Connective Networks: Transportation/ Open Space/ Hydrology**
  - Overland drainage systems and multi-use trails should be connected in a connective open space network.
  - Create a connective road network
- **Create a Multi-Functional Landscape**
  - Combine stormwater drainage within the site's open spaces.
  - Ensure all drainage strategies are multi-functional, for example, detaining runoff, creating wildlife habitat, and functioning as recreational amenities.
  - Ensure a mix of housing types are found within the residential neighbourhood.
  - Encourage multi-use zones such as commercial and residential mixes with the same block or the same building.
- **Conserve Natural Areas**
  - Conserve existing forests and grasslands.
- **Control Stormwater at the Source**
  - Utilize as many small scale stormwater storage, conveyance, filtration, and infiltration practices as possible focusing on Low Impact Development and Best Management Practices.
- **Daylight Stormwater Runoff**
  - Convey runoff above ground, making its presence visible and allowing infiltration, filtration and evaporation processes to occur.

- **Reduce Impervious Cover**

- Reduce road widths
- Encourage the use of cul-de-sacs, or T-intersections, thus utilizing less pavement than the grid pattern
- Encourage the use of permeable pavements within low intensity use areas (such as rear lanes, driveways, and parking areas)
- Encourage narrow lots, thus creating shorter street lengths
- When front driveways are used, minimize front yard setbacks to reduce driveway lengths
- Buildings should be a minimum of two stories in height, therefore reducing roof surfaces
- Ensure that impervious surfaces are not directly connected to the drainage system.
  - Runoff from roofs and roads should flow through vegetated areas before entering the final drainage system.

- **Emphasize the Pedestrian**

- Base the site layout on the Pedestrian Shed (average 5 and 10 minute walking distances)
- Ensure daily needs are located within the pedestrian shed (such as small grocery stores, coffee shops, schools, parks and playgrounds, and daycares)

- **Emphasize Community**

- Create a system of shared open spaces as well as public gathering places

- **Locate Open Spaces as Close as Possible to all Residents**

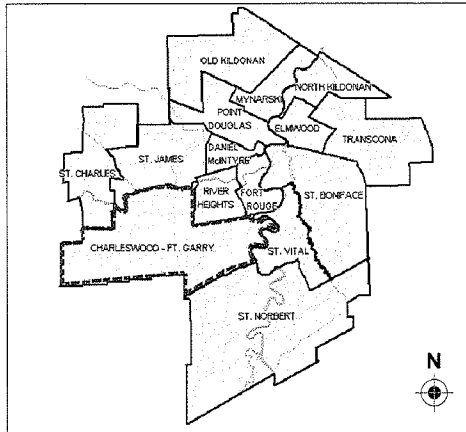
- Do not let economics overpower the pursuit for a sense of community within the neighbourhood. Ensure that open spaces have equal access and are not the sole property of individual land owners.

*\*Within the Concept Plan chapter, each section's corresponding Design Principles will be located at the bottom of the page.*

vii.

# INTRODUCTION TO THE PROJECT SITE

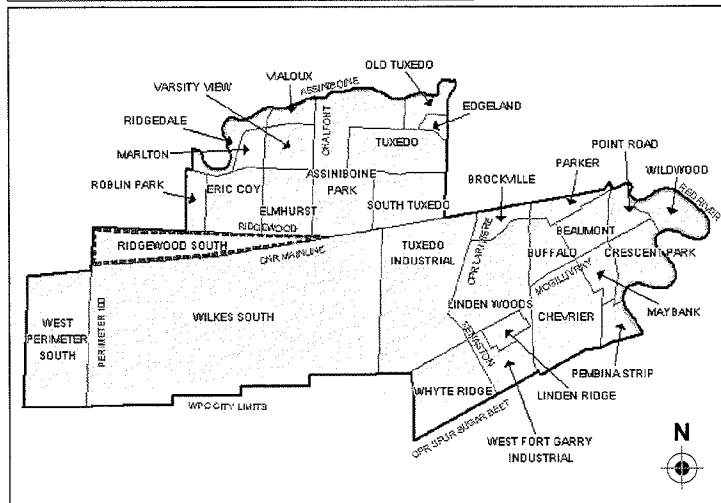
The 600 acre site is located in the south-western edge of the City of Winnipeg, in the ward of Charleswood. Its neighborhood name is Ridgewood South.



The unique qualities of the project site

were what drove this topic of study. This site has major constraints in terms of drainage and unique qualities such as the large amount of remnant forest patches and possibilities for open space connectivity.

This particular project derives from the interest in studying and applying alternative stormwater drainage techniques to residential subdivisions. This topic is timely, given the fact there is currently strong interest in developing this site into a residential neighborhood.



**Figure 14: Location Map**  
(adapted from [www.winnipeg.ca/services/yourcommunity.stm](http://www.winnipeg.ca/services/yourcommunity.stm))

The site is located at the city's edge, between primarily low-density residential uses to the north, agricultural uses to the west and south, and Winnipeg's largest urban forest, the Assiniboine Forest, to the east. Bounding the site on its northern edge is the Harte Trail, also considered part of the Trans Canada Trail. This trail follows an abandoned rail right of way and travels from the Assiniboine Forest

westward out past the city limits towards Beaudry Provincial Park. The western edge of the site is bounded by the Perimeter Highway, and the Assiniboine Forest is

located to the east. Along the southern edge of the site is the highly-used CNR mainline, and immediately south of these tracks is Wilkes Avenue. Wilkes Avenue is currently the only major east-west traffic corridor in the area and because of the concern of too much traffic crossing the existing railroad tracks, there are plans to develop a four-lane arterial to the north of the site between Wilkes Avenue and Harte Trail. This road would lessen traffic loads on Roblin Boulevard by connecting residents immediately North of the site with the Perimeter. There are also plans to extend Charleswood Parkway southward, creating a north-south traffic corridor and an alternative means of linking with northern areas of the city without over extending the existing residential streets in that area. None of the existing residential streets are currently designed to handle major through traffic.



**Figure 15: The Site**

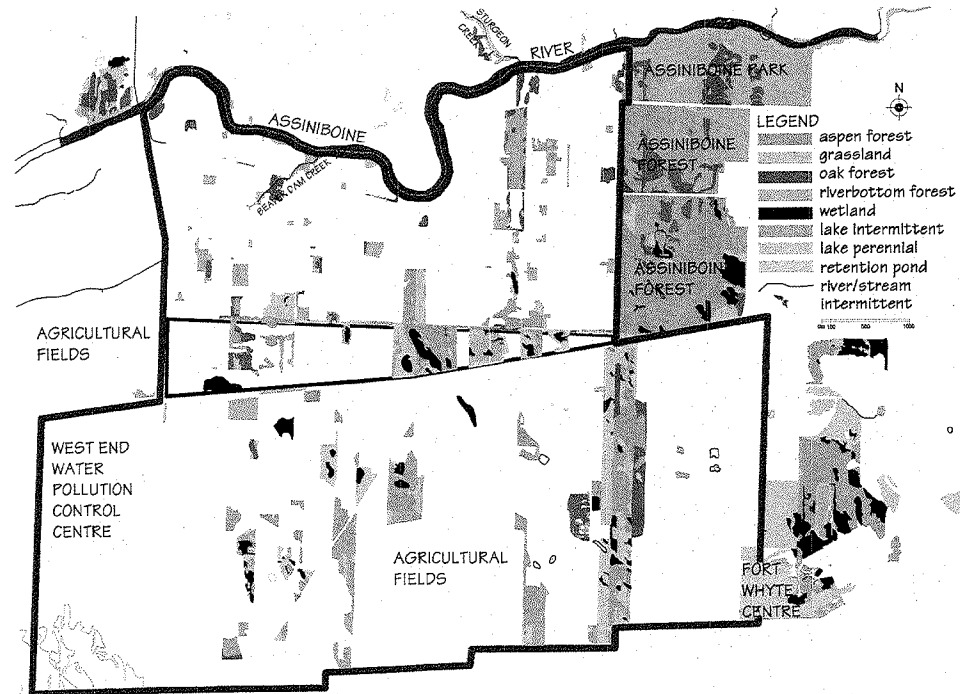
**VEGETATION AND WILDLIFE**

There are four habitat types found within the Ridgewood South area. These include aspen forest, oak forest, grassland, and wetlands (**Figure 16**). The most prevalent of these habitat types is the aspen forest which is the dominant forest type within the Assiniboine Forest and which is currently found in large remnant forest patches within the agricultural lands of Ridgewood South. There are a couple medium patches of oak forest habitat on the west side of the site (Naturalist Services).

The grassland habitat is composed of a mixture of perennial grasses, wildflowers and some low growing

shrubs.

The final habitat type found within this site is the wetland, a depression in the land that stores water (Naturalist Services). There are a couple large wetland areas found within the Ridgewood South site, with a



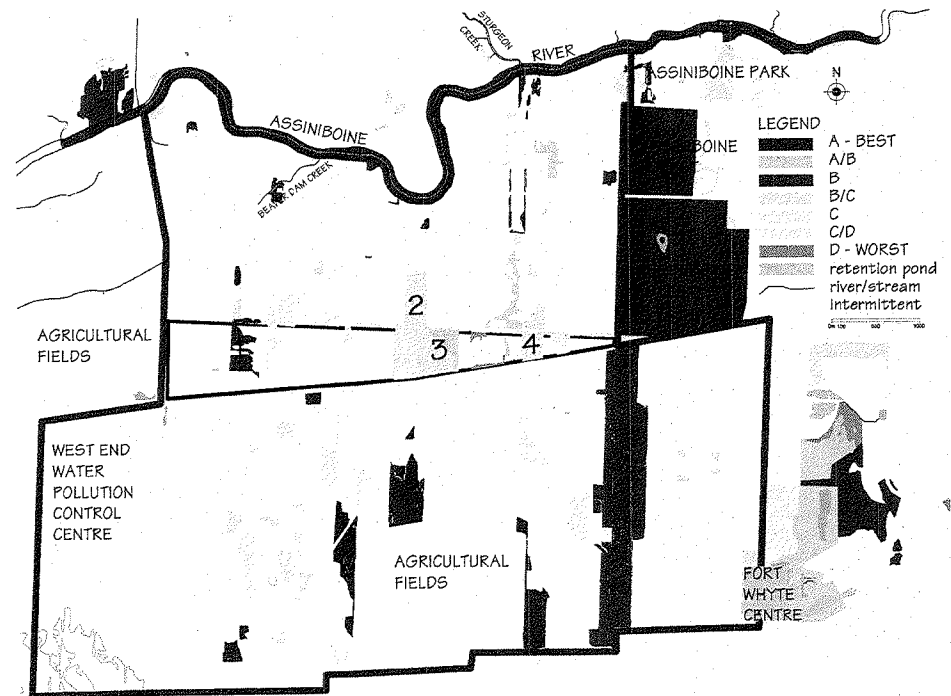
**Figure 16: Existing Habitat Areas**

few smaller wetlands mostly concentrated on the east side of the site.

The Winnipeg Naturalist Services completed an inventory and assessment of the natural areas found within the city of Winnipeg and graded these areas based on their level of natural heritage, or amount of species native to the Winnipeg region. These areas were graded between an A quality habitat (the best quality, with very little disturbance species present) to a D quality habitat (the worst quality, with a large number of disturbance species present). Within the Ridgewood South site there are habitats that range from second-best, A/B quality, to the worst, D quality habitat (**Figure 17**). The areas of special significance to this project are those that are of B/C quality and up, therefore the areas numbered in the image to the right are those that will be important to protect within the design of the site.

Habitat Area #1 is composed primarily of oak forest habitat with some smaller areas of prairie and aspen forest habitat. It has a high species richness and high density of trees and shrubs. (Naturalist

Services) Habitat Areas #2 & #3 is primarily composed of aspen forest, with a large wetland area on its west side and smaller areas of oak forest and prairie habitat. This site has high species diversity with few weeds. Habitat Area #4 is composed primarily of aspen forest and again has high species diversity and few weeds. The Habitat Area, #5, is the Assiniboine Forest which is the area that is in the best condition and is primarily composed of aspen forest with some oak forest, prairie and wetlands intermixed.



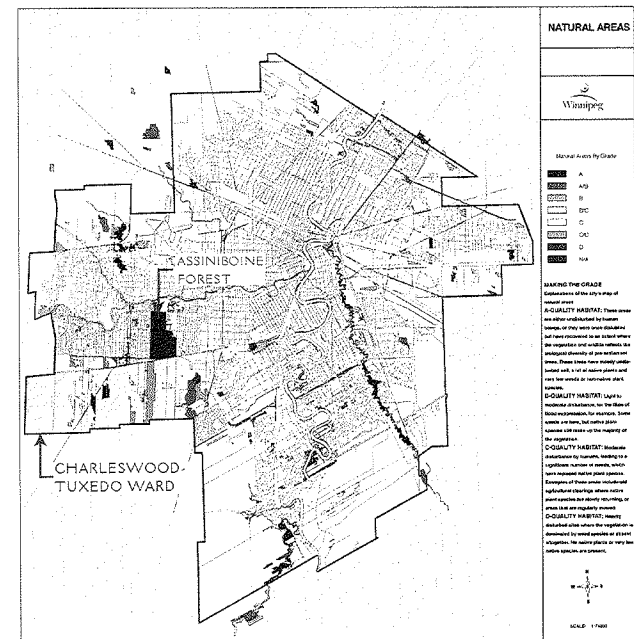
**Figure 17: Existing Habitat Area Grades**



**Figure 18: Existing Forest**

The Charleswood-Tuxedo ward has approximately 1,034 hectares of natural areas found within its limits, the largest remaining amount within the City of Winnipeg (Figure 19). The ward with the second largest amount of natural areas is St. Norbert with 379.1 hectares; therefore Charleswood-Tuxedo has more than double the amount of natural area than any other ward within Winnipeg (Kives, 2006). One reason for this is that the Assiniboine forest is located within this ward, which in itself encompasses approximately 287 hectares (Naturalist Services). This forest is an incredible piece of land within the city, one of

the largest urban natural parks within Canada (Naturalist Services). This forest acts as a regional park and attracts visitors from the entire city, not only from the ward in which it is located. Another reason for the substantial remaining natural areas is because of the history of development within the ward, especially within Charleswood.



**Figure 19: City of Winnipeg Natural Areas:**

Source: Adapted from Kives, 2006

Before the Second World War Charleswood was still a very rural municipality, with only scattered residential development along gravel roadways, serviced by drainage

ditches and without a municipal sanitary sewer system. The population in 1945 was 2,400 people but by 1955 the population had almost double to 4,100 people with the development of Veteran's Land Act Project 'Roblin Park' (Charleswood Detailed Area Plan, 1970). Subsequent to this was the development of Westdale (in the 1960s) and Riverwest Park. A sanitary sewer system was not installed for the existing Charleswood residential development until 1962.

In the Charleswood Detailed Area Plan completed in 1970 what is now called Ridgewood South was already at that time indicated as a residential reserve area suitable for low-density development. The 1970s plan assumed the site could manage a general density range of 4 to 17 units per acre, accommodating approximately 12,000 people at completion (Charleswood Detailed Area Plan, 1970).

Bill Clement, Councilor for Tuxedo-Charleswood, recently commented that "There's room for 4,500 new homes in Charleswood right now if only the money existed to replace rural-style drainage ditches with storm sewers..." (Kives, 2006). Yet one of the unique qualities of the many

neighborhoods in Charleswood is in fact their drainage ditches, their large lots and their more 'semi-rural nature'.

*"Most of the residential development in suburban municipalities in the post second World War years has been of the compact urban residential subdivision type. By contrast, residential expansion in Charleswood has been mainly of a more semi-rural nature, spread over a wide area, with houses situated on large lots. This type of residential area – urban homes with some urban services such as sanitary sewer and water, but located in a semi-rural environment – has been sought out by those who have located here in the past"* (Charleswood Detailed Area Plan 1970, 11).

Since the site is located at the periphery of the city, between agricultural land and the city's largest urban forest, with low-density residential to the north, and many remnant forest patches within the Charleswood ward, it currently serves as habitat for a large number of wildlife, most noticeably a large white tailed deer population. This low density area with large patches of forests, grasslands and marshes creates an open, rural feel to the existing community.

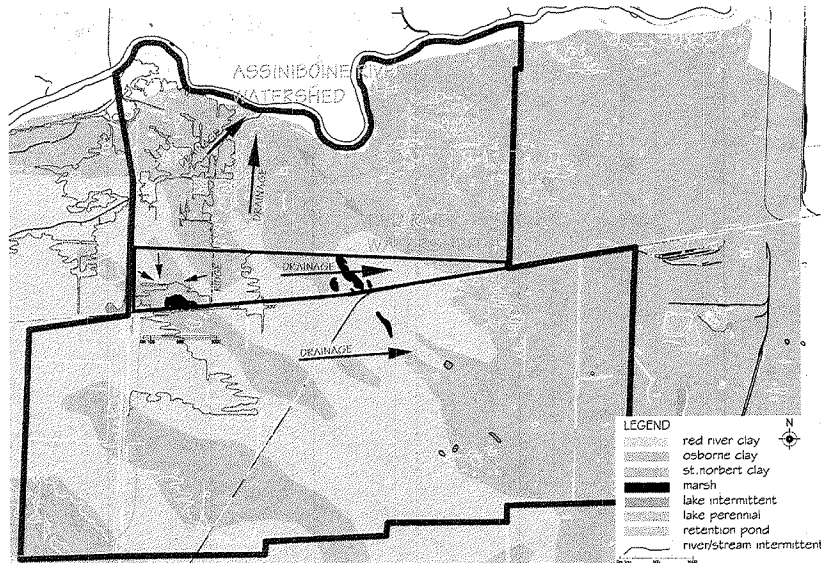
## **DRAINAGE**

The soils in the area have low infiltration rates, developed on fine textured sediments composed of Lacustrine Fine Clays. Within this Red River Association there are three different types of clay that cover the Ridgewood South area: Red River Clay (Rc), well to intermediately drained associates; Osborne Clay (Oc), poorly drained associates; and St. Norbert Clay (Nc), well-drained, wooded associates (Ehrlich et al, 1953).

The site is primarily located within the Red River Basin Watershed. With only the north-west corner of the site located within the Lower Assiniboine River Watershed of the Assiniboine River Basin. The entire size of the Red River watershed, including the Assiniboine River basin is 290 000 km<sup>2</sup>. The entire Red River Valley is relatively flat and therefore when too much water enters into the river corridor and this water rises higher than the banks of the river, large areas of surrounding land are at high risk of becoming flooded (Natural Resources Canada, 2005). This has implications for the design of the site since the slope of the land is extremely gentle, on average approximately a 0.11% slope.

## ***Drainage Observations:***

- Area covered in fine textured clay soil, which has very low infiltration rates. (class D soils)
- infiltration rate <0.1 inches/hr
- There are no areas within the site that contain soils with high permeability to take advantage of infiltration capabilities.
- Of the 3 soil types, the Red River Clay and St. Norbert Clay have the best water retention capacity – best for open space uses and plant areas.
- The site currently drains north and east. There are two large wetland areas that store excess water on site, one on the west side and one towards the east. These areas are natural low points and should be taken advantage of when draining the proposed development.
- Because the soils have low permeability rates Infiltration methods of dealing with runoff will not be applicable. The site will have to rely on detention



**Figure 20: Existing Soils and Drainage**

- facilities and vegetative areas – that can handle drought and excess moisture to absorb as much runoff as possible, and focus on the processes of evaporation and transpiration.

## CLIMATE

Winnipeg has four distinct seasons with extreme fluctuations in temperature, from an average summer season temperature of 26 degrees Celsius to an average winter season temperature of -13 degrees Celsius. The average spring and autumn temperatures are located in the middle of these two extremes, around 10 degrees

Celsius. In an entire year, there is an average of only 115 frost free days per year (Government of Manitoba).

Winnipeg International Airport:	
Elevation:	238.70 m
Longitude:	97° 13' W
Latitude:	49° 55' N
(source: Environment Canada)	

The region has a history of wet and dry precipitation cycles, with an average of 519mm (20.76") of precipitation per year, breaking down to an average of 404mm (16.16") of yearly rainfall and an average of 115mm (4.6") of yearly snowfall (Government of Manitoba).

The majority of rainfall within this region occurs in small storms with a yearly average of 76.9 days with rainfall between 0.2mm and 5mm, 23.3 days with rainfall between 5mm and 10mm, 12.5 days with rainfall between 10mm and 25mm and only 2.9 days with rainfall over 25mm. The majority of snowfall is within the lower end as well, with 54.7 days of snowfall between 0.2cm and 5cm (Environment Canada).

***Climate Observations:***

- Because of the frequency of small storms, low impact development standards dealing with small storm events would be very appropriate for this site.
- The cycles of wet and dry years, combined with the high water retention and low infiltration of the soils does affect the performance of some of the LID techniques. In dry years these systems would work extremely well but in wet years when the soil is already saturated, the ground surface will act as an impermeable layer and the stormwater will simply run off the surface. At these times the stormwater wetlands and pond areas are extremely important for holding large amounts of water, as they would historically function in this region during wet years.
- The cold temperatures and snowfall in this area affects the drainage techniques used. Any water storage device must be designed with enough headroom to accommodate snow melt over potential frozen surfaces.
- Areas for snow removal and storage must be considered in the design.

**LAND USES & ZONING**

Currently 84% of the Ridgewood South area functions as agricultural land (**Figure 21**). There is a large portion of this agricultural land which is covered in remnant forest, primarily aspen forest and some smaller areas of oak forest. Some of the agricultural land is also covered in marsh areas as previously mentioned. There is a strip of single family homes along Charleswood Road (6% of the site) and a park and sportsplex at the intersection of Fairmont Road and Ridgewood Avenue called Marj Edey Park (8% of the site). Within the industrial area, located at the eastern edge of the site, there is a driving range and a lumber store (2% of the site). Within Plan Winnipeg the site is designated as a residential area and is intended to complete the residential development within Charleswood.

The West End Water Pollution Control Centre is located south-west of the site. There is a 1km buffer surrounding that site where no residential buildings are allowed. There is also an airport vicinity policy area within the east part of the site. Within this policy there is a certain requirement for additional soundproofing within buildings.

The Ridgewood South Area has a history of development proposals that have been rejected by the City of Winnipeg, mainly because of lack of drainage and transportation infrastructure for the site. The City is currently working on a secondary plan for the site. An “Area Structure Plan” has been contracted out to an Engineering/Landscape Architecture firm within the City, in order to facilitate the development of the site. With the Area Structure Plan in place the developer will be aware of what type of development the City will accept for that plot of land and if the developer follows the same type of pattern this will speed up the development process. This way the developer doesn’t have to waste time and money working on plans that the city may never approve.

In order to accommodate residential development in Ridgewood South the land must first be rezoned from Agricultural lands to Residential and Park lands, and possibly Commercial lands. Because the land is designated as “Residential” in Plan Winnipeg it is unlikely that a rezoning to residential land would be rejected, although this would be dependent on the lot density that the developer wanted in the residential

area. At this time, this area would likely be only approved for lower density developments such as a small number of R1-4 lots (min. 4000sq.ft. lot) and the majority of R1-5.5 lots (min. 5500sq.ft. lot). With the current City system a subdivision that is less dense than this would likely be rejected. Currently the areas bordering Ridgewood South are composed of R1-20 (min 20,000sq.ft.lots), R1-5.5, some R2 (two family, within Westdale), and mostly R1-6 (min 6,000sq.ft.) lots.

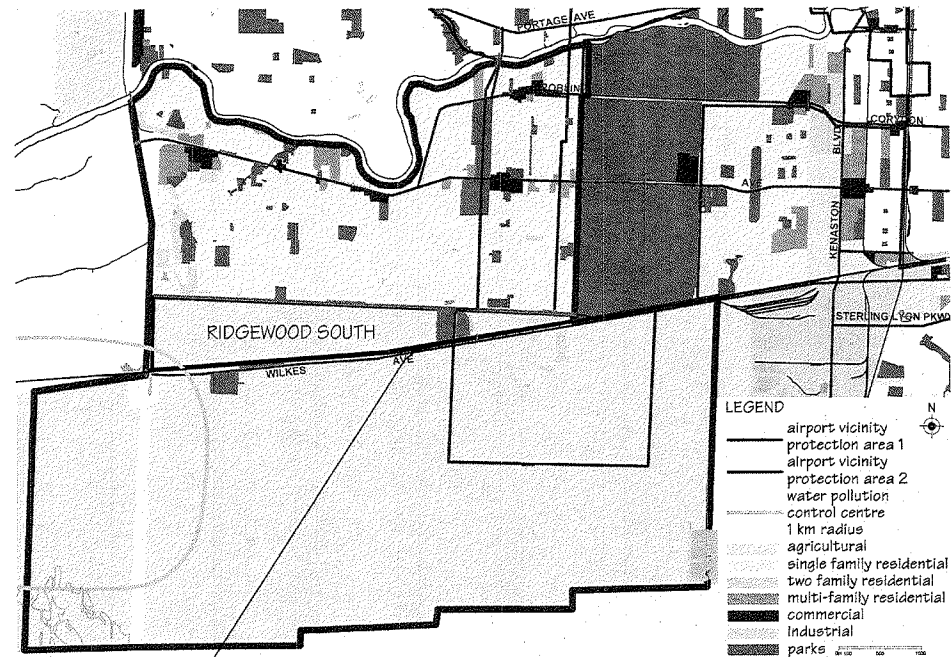


Figure 21: Existing Zoning and Policy Areas

**Land Use & Zoning Observations:**

- The site is located at the periphery of the city, surrounded by low-intensity and low-density development. This is one of the reasons the City would lean towards a lower density suburban development type. Yet the history of suburbs suggests that areas at one time believed to signify the edge of the city eventually become engulfed within the city when more and more areas surrounding it become developed. It is not possible to know for certain if this will be the case but designing every edge of the city with that assumption is not realistic.
- With the amount of natural lands present within this site and with the Assiniboine forest and the Fort Whyte Centre, both protected natural areas, nearby, it would be a shame to simply strip these beautiful habitat areas for housing, streets, and lawns. A residential lot can be physically replaced by another land use fairly quickly, but natural areas take decades if not hundreds of years to develop the structure that is presently found within this site's forests and grasslands.

- Ideally the city would develop more infill areas rather than develop residential areas on greenfield sites, but there is a high demand for housing within the south sector of the city and it is inevitable this site will be built-up in the near future. With this in mind, instead of simply creating a conventional residential subdivision that could be located anywhere within the city, it is felt that it is important to utilize the unique features of the site and create a neighborhood that conserves the special habitat areas and fits within its surroundings.

**CIRCULATION:**

**VEHICULAR:**

Currently there are five main roads that extend north-south through this site. Charleswood Road, Community Row, Harstone Road, Fairmont Road, and Elmhurst Road (**Figure 22**). Currently none of these roads are capable of handling all of the excess traffic that would arise from new development and therefore it required to construct a north-south arterial within this area. There are future plans to extend Moray Street (now called Charleswood Parkway) up to Wilkes Avenue with an overpass over the train

tracks. This would be sufficient to support the additional development.

There is a major east-west arterial south of the site, Wilkes Avenue, but to reach this arterial the CN mainline must be crossed and this causes much traffic congestion and safety issues. An east-west arterial is required for this site to accommodate the traffic for the new development as well as existing traffic north of the site. This arterial is to connect to the Perimeter Highway to the west and to the proposed Charleswood Parkway to the east.

**TRANSIT:**

The existing transit routes in the area do not come anywhere near the Ridgewood South area. Transit route #98 runs the closest to Ridgewood South, running east and westbound along Rannock and Eldridge and north and southbound along Laxdal and Elmhurst, with a short section south and northbound along Ridgewood Avenue between those two roads (Figure 22).

The City of Winnipeg has been undecided on whether they would invest in a rapid transit. If this

plan were to occur the closest rapid bus lane would be located along east and westbound along Portage Avenue and north and southbound along Kenaston Boulevard (Figure 23). The quickest access to these routes would be the future Charleswood Parkway.

**Transit Observations:**

The road design for the Ridgewood South site would have to consider the possibility for rapid transit, since transit is the primary alternative method available to replace the

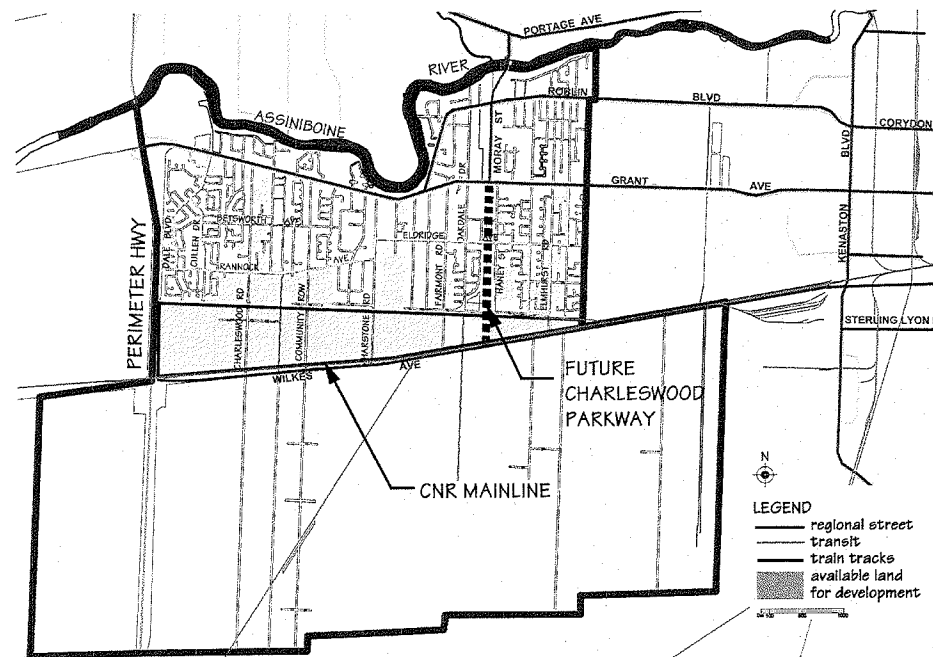
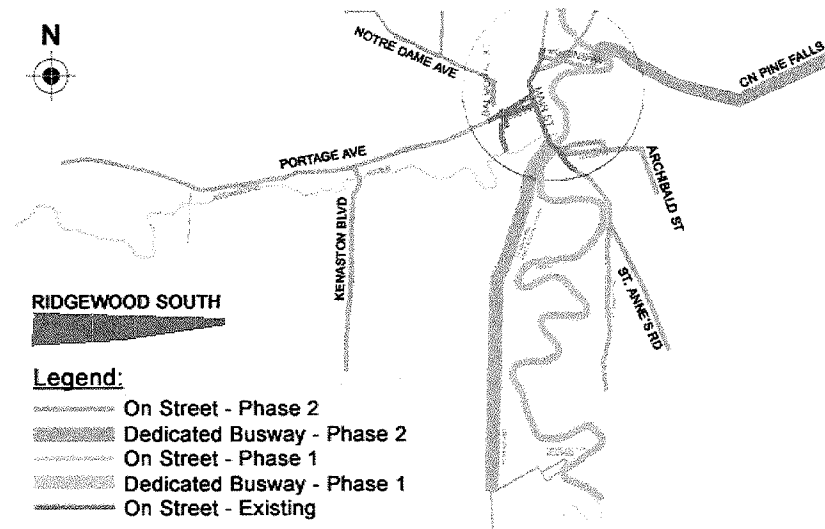


Figure 22: Existing Vehicular Circulation

vehicle in trips to and from work. This creates a more environmentally friendly method of getting to and from work as well as a more affordable option.



**Figure 23: Proposed Rapid Transit Routes**

***TRAIN:***

There is currently a well used double train track immediately south of the site, between the site and Wilkes Avenue. There are frequent trains along this track and this has implications in terms of vehicle crossings and noise attenuation. The City of Winnipeg requires a twenty meter noise attenuation buffer alongside train tracks of this nature. This buffer must include a berm or combination of berm and fence parallel to the railway ROW, with returns at

each end. There are also implications for house siting, with a minimum 30 meter rear yard setback from the railway right of way. The tracks also create a strong edge along the south side of the site, with limited possibilities for connections between the site and areas surrounding it from that edge.



**Figure 24: The train and deer on site**

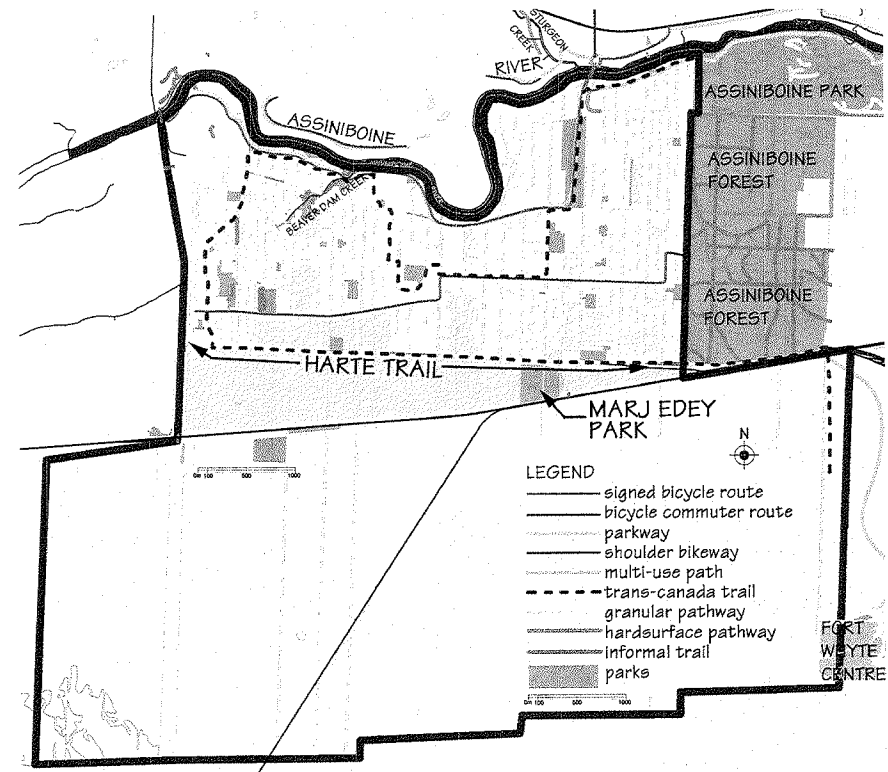
***PEDESTRIAN:***

Bounding the northern edge of the site is the Harte Trail, which is a well used walking and biking trail developed on an abandoned railway right of way (Figure 25, 26). There is existing vegetation aligning it for most of its length. This trail is also important as it is considered part of the Trans-

Canada trail. There are a large number of informal walking trails within the Assiniboine Forest and Assiniboine Park, as well as some hard surface trails. There is also a multi-purpose trail linking the Assiniboine Forest and the Fort Whyte Centre in the works. There are a few other scattered trails around Charleswood but they are limited to the park space in which they are located. Along the residential streets within Charleswood there are very little sidewalks. Most of the pedestrian traffic is limited to the roadways.



**Figure 25: The Harte Trail**



**Figure 26: Existing Active Transportation Circulation**

**DEMOGRAPHICS:**

The average number of people per household is quite consistent throughout Charleswood, ranging primarily from 2.7 to 3.1 people per household, where the City of Winnipeg average is 2.4. (see Figure 8 for the location of each of these neighborhoods) The smaller ranges are

found in Vialoux, with an average of 2; and in Marilton and Varsity View, both with averages of 2.3. The Elmhurst and Marilton neighborhoods have the lowest population change with 0 and -0.7%, respectively. The highest population change is found within Ridgewood South, with 75.7% (because of such a low population in that area); Ridgedale at 22.8%; and Wilkes South at 19.7%. The areas with the most negative population changes include Southboine at -12.2%, Westdale at -5.6%, Eric Coy at -6.2%, and River West Park at -4.5%. The City of Winnipeg average is 0.20%. Charleswood is composed of quite low density development, known for the large lots and large amounts of natural areas. The area with the highest population density is Westdale with an average of 2,846 people/km<sup>2</sup>, next is Elmhurst with 2,626 people/km<sup>2</sup>, then Varsity View with 2,154 people/km<sup>2</sup>. The lowest population density is not surprisingly found in Wilkes South (primarily agricultural land) with 18 people/km<sup>2</sup> and Ridgewood South (also primarily agricultural land) with 106 people/km<sup>2</sup>. The next lowest neighborhoods include Ridgedale, Eric Coy, and Marleton, with population densities of 920 people/km<sup>2</sup>, 1,216 people/km<sup>2</sup>, and 1,227 people/km<sup>2</sup> (in that order). All of these lower population

density neighborhoods are below the City of Winnipeg average of 1,304 people/km<sup>2</sup>.

**Demographics Observations:**

- Charleswood is a low-density suburb. Most of the lots are around the 6,000 square foot mark. Family dynamics are changing. There are currently a larger number of single parent families and many families with only one or two children. There are an increasing number of married couples that are deciding not to have children at all. The population is aging, with a large percentage of the population preparing or within the retirement age. Different housing types, different lot sizes and different neighborhoods are required for this varied urban population. Currently within its homogenous, low-density suburban pattern, the Charleswood area does not accommodate this broad variety of family types. The future Ridgewood South area has the ability to provide alternative housing types that are not currently available within this area.

*“...the broad diversity of today’s population means a broad diversity of opportunities for developers and builders” (Schmitz, 2003, 5).*

*“According to a recent study that explores what baby boomers want in their communities...’As the percentage of childless households increases, the market for smaller lots – if not smaller homes – is expected to increase. The declining presence of children suggests a growing market for denser, more walkable neighborhoods that adults find interesting” (Schmitz, 2003, 9).*

#### **SENSORY:**

Walking through the Ridgewood South site presently is quite different than it would be once developed. The site is obviously very open and can feel very windy within the open fields, but within the forested areas the wind is tamed and a number of sounds that are not heard otherwise are discovered. The singing of birds, the rustling of leaves in the wind, the sound of crickets and frogs are all heard within these spaces. The areas with the most noticeable wildlife sounds are those surrounding the wetlands, especially the large patch of wetland, aspen forest and grassland within area #2 and #3 on Figure 10. There are certain areas with noises that area not as pleasant as

these, including the Perimeter Highway and the train tracks when trains are going by. The sound attenuation berms and fencing will help reduce the noises in these areas.

#### **SITE SYNTHESIS:**

The Synthesis Map (**Figure 27**) summarizes the pertinent information attained through the site inventory process. The existing and proposed arterial roads, Roblin Boulevard and Charleswood Parkway, as well as the Perimeter and the train tracks at Wilkes Avenue are all considered optimal for movement along them but barriers to movement through them; they are therefore edges and separators of space. All of the areas that are brought to attention are all considered to be important to the future design of the Ridgewood South site.

The Natural Areas that are to remain are those that have been assessed at a grade of B/C or higher. The existing parks are important to highlight as they are part of the existing open space system surrounding the site and the design for this site would like to promote connectivity of proposed as well as existing open spaces. Finally, the existing commercial areas were analyzed in terms of

walkability to these locations. A 400 meter (approximately 5 minute walk) buffer as well as an 800 meter (approximately 10 minute walk) buffer were created

surrounding these sites in order to determine if any of these locations were within comfortable walking distance from the Ridgewood South site.

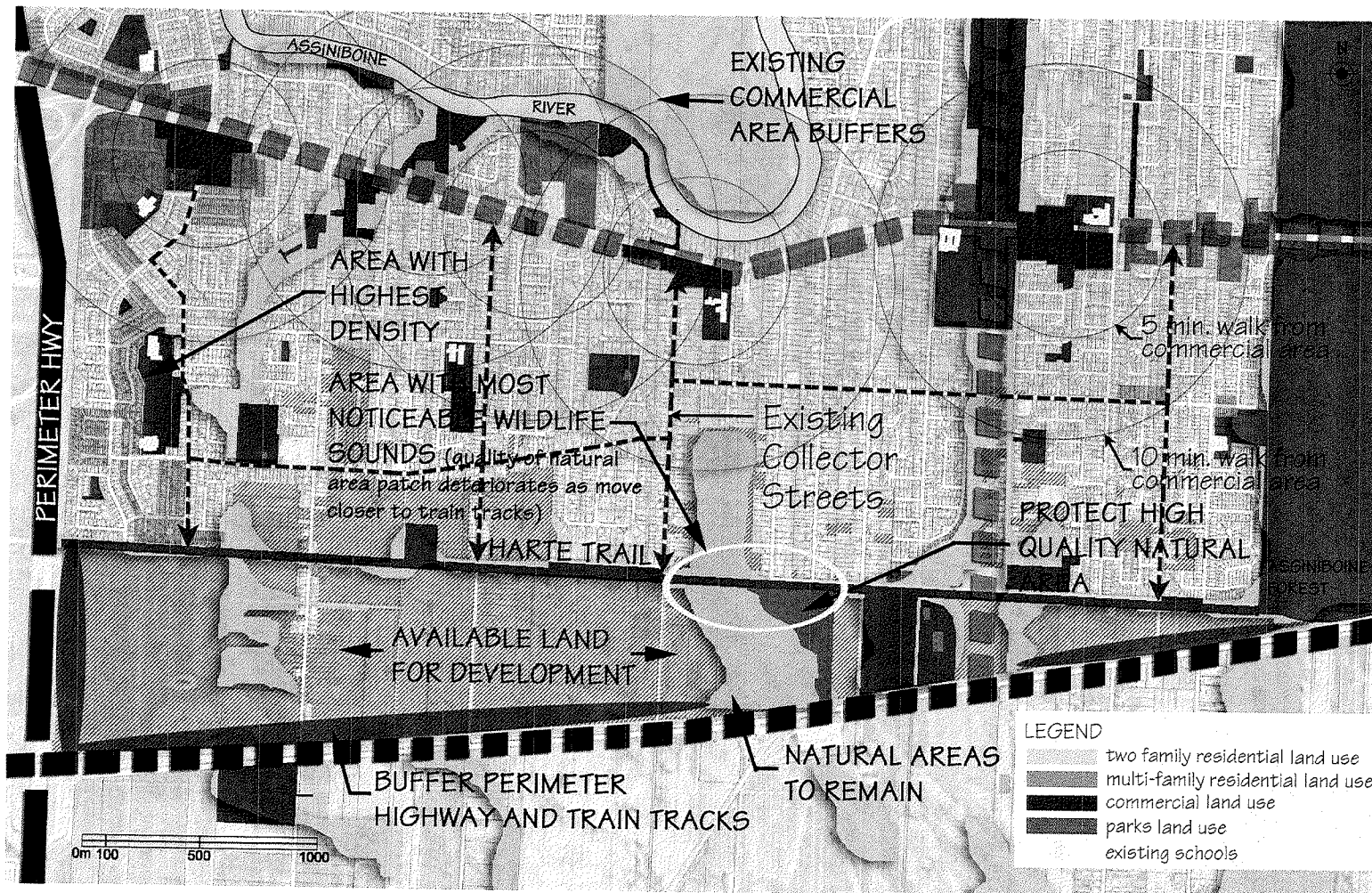


Figure 27: Synthesis Map

In order to design the residential neighborhood, the site layout was divided into three primary areas: circulation, open spaces, and drainage.

### VEHICULAR CIRCULATION: OVERALL

The first area to be covered is the vehicular circulation. This topic has been divided into two scales, the overall community wide scale, and the site specific scale. Essential points to be considered within the overall vehicular circulation of the site include the requirement to limit crossings over the train track located south of the site and to ensure enough connectivity between the Ridgewood South site and the neighborhoods to the north of it without creating too many vehicular crossings through the Harte Trail.

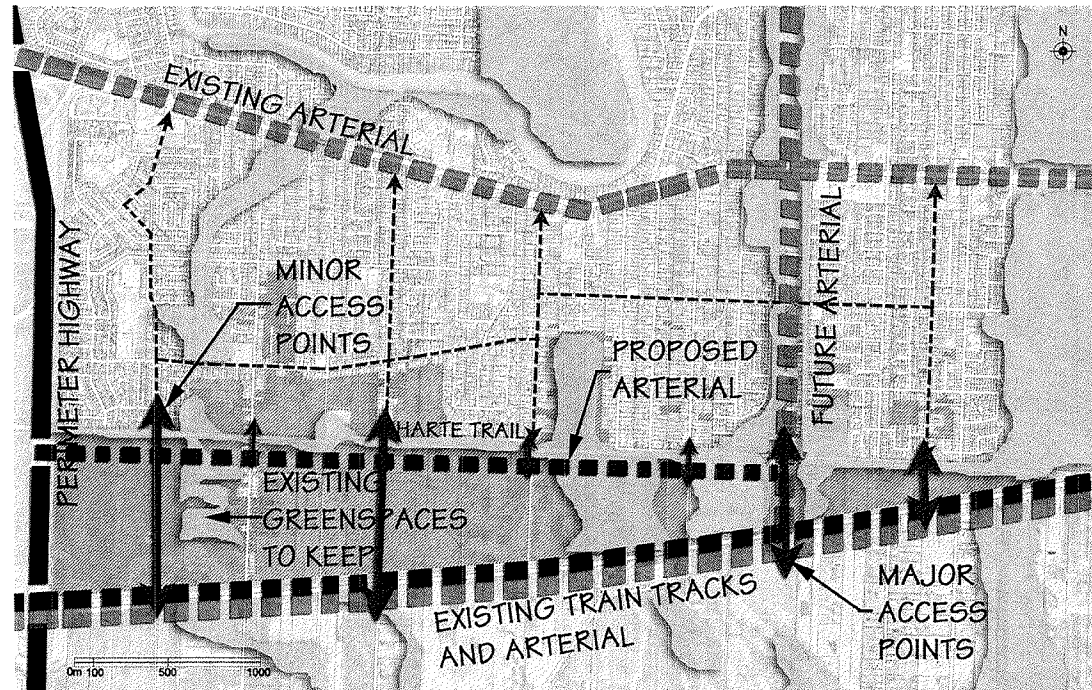


Figure 28: Vehicular Circulation Analysis

The location for the proposed east-west arterial suggested by the City of Winnipeg's Public Works Department is delineated on **Figure 28**. This road is located in a central location in terms of transportation, highly capable of servicing existing residents north of the site as well as those within the new development, but the location of this road would be detrimental in terms of connectivity between existing and proposed neighborhoods as well as its negative impacts on habitat connectivity.

## VEHICULAR CIRCULATION: SITE SCALE

As mentioned, an east-west arterial is required within the Ridgewood South site. According to a traffic study for this area by UMA engineering, the east-west connector can either be one 4-lane arterial or two 2-lane collectors. This road(s) is required to accommodate existing traffic loads from the neighborhoods immediately north of Ridgewood South as well as the future traffic from the new development.

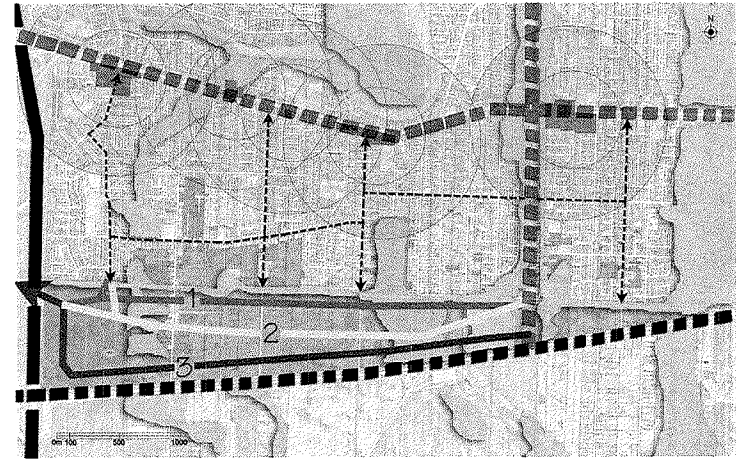


Figure 29: Alternative Arterial Road Locations

Table 7: Analysis of Arterial Road Locations

	1	2	3	1 & 3 collector	comments
1 reduce impervious cover	N/A	N/A	N/A	N/A	1 arterial has 4 lanes, and 2 collectors have 2 lanes each
2 conserve natural areas	X	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Option 1 crosses through large portions of existing natural areas. The collector option can act as one arterial until it has passed the open space and then divide into 2 roads.
3 control stormwater at the source	N/A	N/A	N/A	N/A	
4 multi-functional landscape	N/A	N/A	N/A	N/A	
5 pedestrian movement	X	X	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	An arterial acts as a divider in terms of pedestrian movement, because of traffic volumes and speed.
6 community	X	X	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	An arterial acts as a divider in terms of pedestrian movement, because of traffic volumes and speed.
7 Daylight stormwater runoff	N/A	N/A	N/A	N/A	
8 Bring open spaces as close as possible to all residents	N/A	N/A	N/A	N/A	
9 Open space as connective framework	N/A	N/A	N/A	N/A	
10 Immediate access to road for Neighborhoods north of Ridgewood south	<input checked="" type="checkbox"/>	X	X	<input checked="" type="checkbox"/>	Option 1 and 1&3 are the options that bring the road the closest to the adjacent neighborhoods
Total	1 <input checked="" type="checkbox"/>	1 <input checked="" type="checkbox"/>	3 <input checked="" type="checkbox"/>	4 <input checked="" type="checkbox"/>	

The City of Winnipeg defines a Minor Arterial as a street that “carries significant traffic flow between major traffic generators such as shopping centers, residential, commercial, and industrial subdivisions, etc.” This type of street has traffic volumes of up to 20,000 vehicles per day and a design speed of 80km/hr. Considering average traffic volumes and speeds of an arterial road, for the purpose of this project this type of road is considered to be a separator of community areas, acting like an edge. With this in mind, a matrix of the three possible arterial locations, as well as a double collector option (which combines arterial #1 and #3 into two collectors) were analyzed according the Principles that were developed to guide the design of this project.

From this chart it was determined that a combination of option #1 and #3 into a double collector was the best choice for this site. The primary problem of option #1 is that it acts as a divider between Ridgewood South and the rest of Charleswood and the Harte Trail. Option #3 acts as a barrier to the train tracks and keeps the Harte Trail accessible to Ridgewood South and the rest of Charleswood. The problem with this option is that the rest of Charleswood must cross through Ridgewood South to access the road. In the chosen option (#1&3) the traffic is split between two roads instead of being concentrated on one, thus creating a more comfortable pedestrian environment. The collector street does not act as a divisive force within the community because of its lower traffic volumes and speeds. This location will also accommodate traffic north of the site. Residents will thus be able to access existing green spaces easily by foot without crossing any major roads.

## PROPOSED COMMERCIAL AREAS

In order to create a pedestrian oriented community as well as a vibrant neighborhood it is essential to allow for a mix of land uses within the site. Currently the only commercial areas in the proximity of the site are located along Roblin Boulevard and Kenaston Boulevard, with the closest locations over a 20 minute walk away. By conducting an analysis of the pedestrian shed upon the site, it was determined that three commercial nodes would be required in order to allow pedestrian access to the majority of homeowners within this site. These commercial areas will be located along the northern collector, accessible to the residents of Ridgewood South as well as the community north of it.

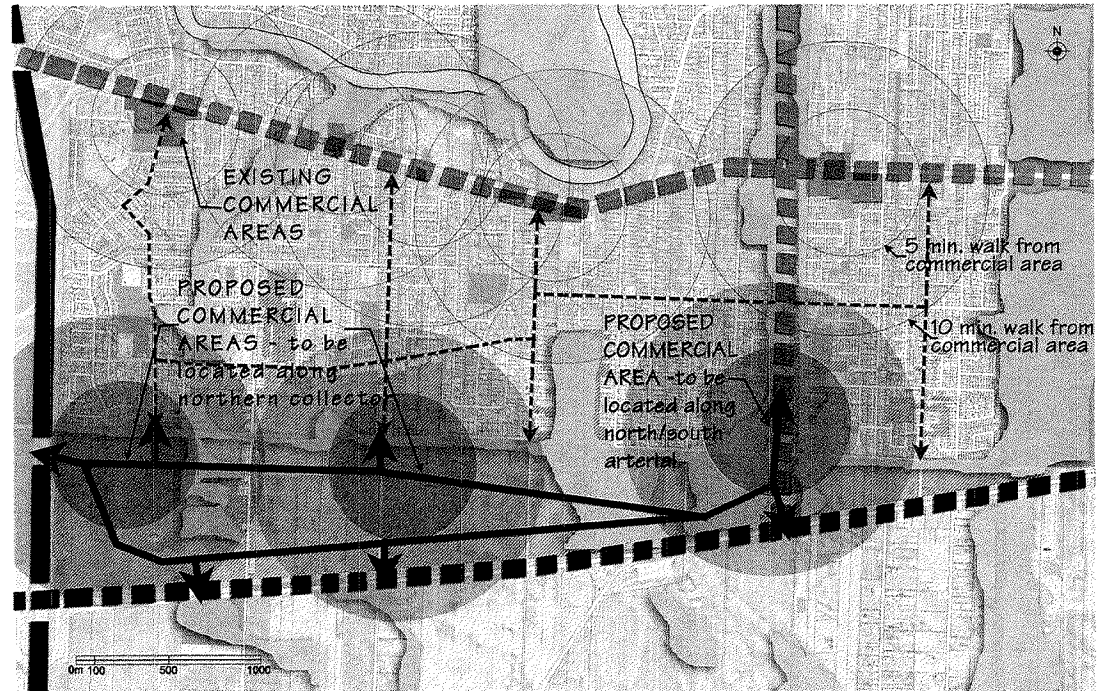


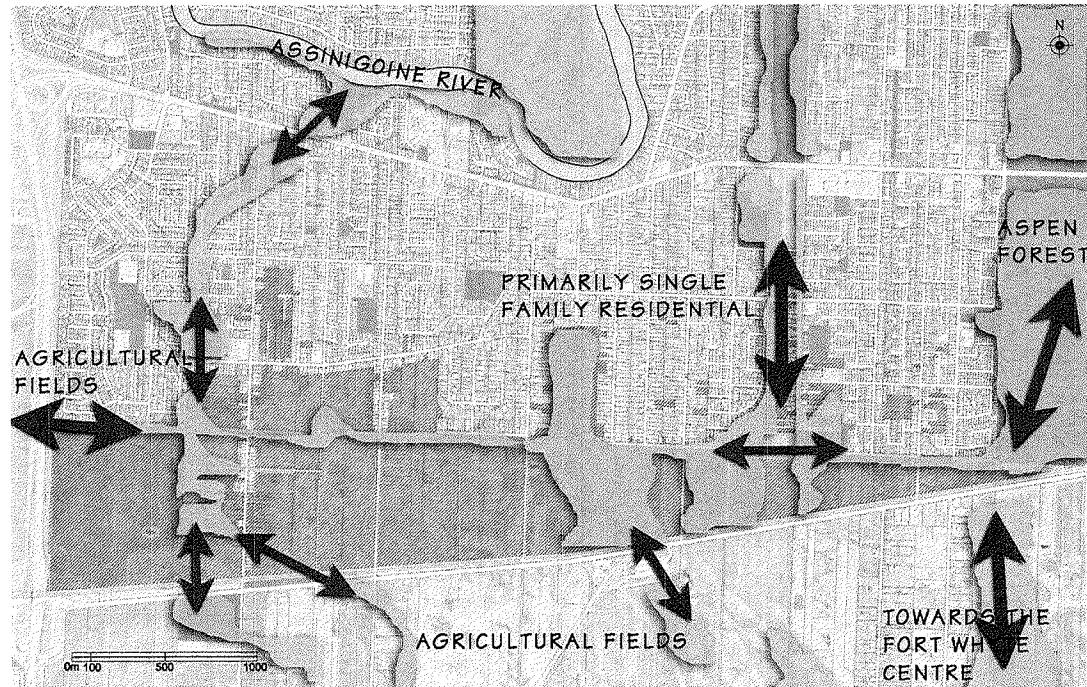
Figure 30: Proposed Commercial Nodes

*\*Emphasis on the Pedestrian*

*\*Emphasize Community*

## NATURAL AREA CONNECTIVITY - OVERALL

As mentioned, the site has great potential for open space connectivity. **Figure 31** illustrates the natural areas that are proposed to be protected along with those that currently exist. These patches exist on the edge between a residential matrix and agricultural matrix. At such a location there is great potential for high species diversity with those that survive well within a residential matrix and those that survive well within the agricultural matrix both inhabiting this location. “The edge, or interface between one habitat and another is often more diverse than the interior of the habitats themselves. Habitat continuity provides essential migratory routes and helps maintain wildlife populations” (Hough, 1989, 162).



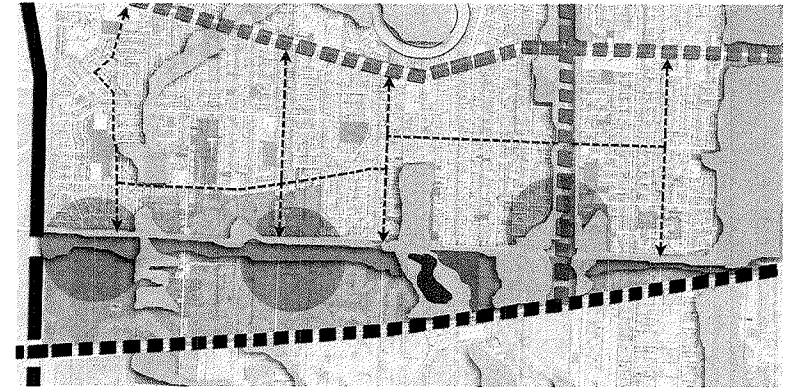
**Figure 31: Natural Area Connectivity**

**NATURAL AREA CONNECTIVITY – SITE SCALE:  
Analysis of Open Space Networks within the Site**

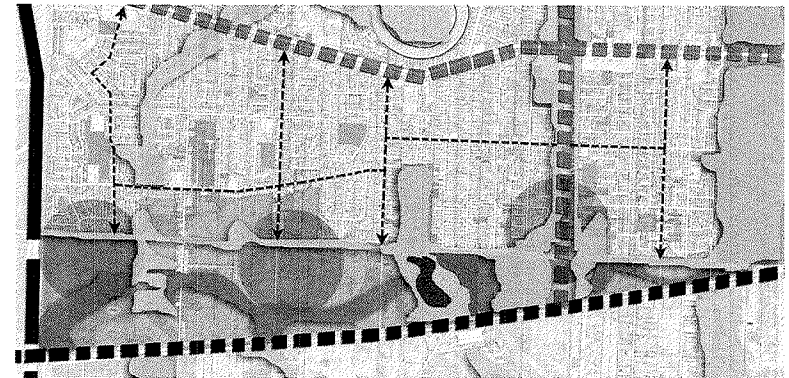
- concept 1: widening existing Harte Trail
  - pro: becomes a wider corridor, therefore better for wildlife habitat and movement
  - pro: open space network is central to the entire community of Charleswood
  - con: upon closer inspection this open space corridor is only within walking distance of half of the community
  
- concept 2: Meandering open space network within the proposed neighborhood
  - pro: meanders through the site creating interesting entrance nodes
  - con: not able to connect with proposed commercial node
  
- concept 3: central open space network
  - pro: central to entire community, within five minute walking distance from all residents
  - pro: able to connect all open space amenities, such as schools and parks as well as commercial nodes and existing forests.

*\*Create Connective Networks*

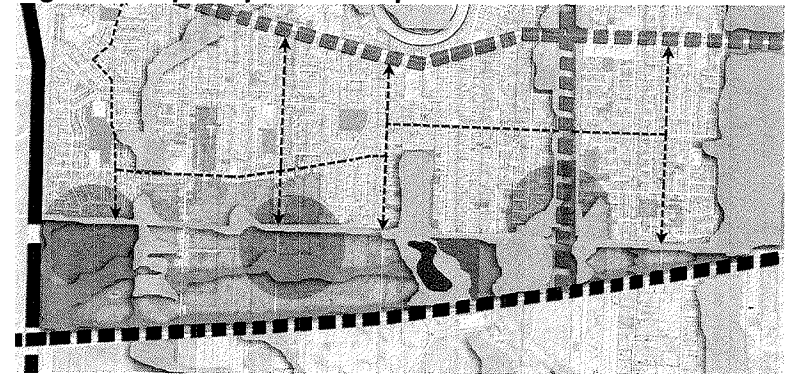
*\*Locate Open Spaces as Close as Possible to all Residents*



**Figure 32: Open Space Concept #1**



**Figure 33: Open Space Concept #2**



**Figure 34: Open Space Concept #3**

## PROPOSED SCHOOL SITE

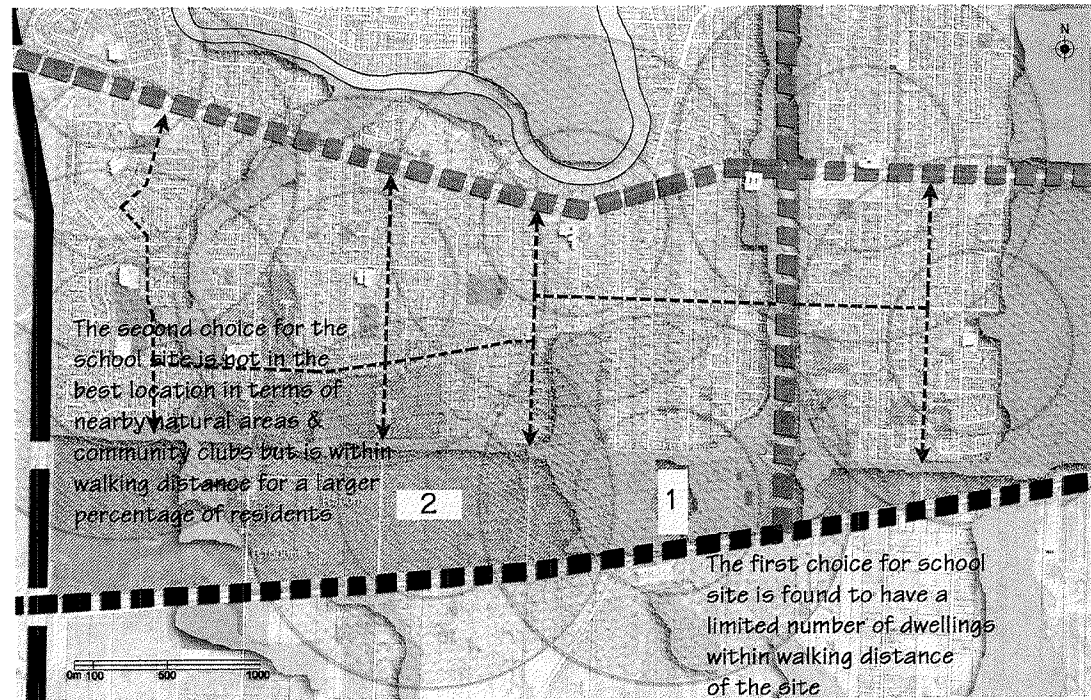
Space for a junior high and elementary school is required within this neighborhood. The school division would prefer these be located towards the east of the site.

The first choice for the school site was located on the eastern part of the site, between existing natural areas and an existing community club. This location would be ideal in terms of adjacent amenities. Because one of the principles for this neighborhood is to create a pedestrian oriented community, and with the intent to have open space amenity located as close as possible to most of the residents, the first choice

was eliminated. The site is isolated, not located within a five minute walk of any residents.

The primary means of reaching it would be by car. A second site was chosen that was more centrally located.

This site can be combined with the proposed commercial area creating an important community node.



**Figure 35: Analysis of Possible Schools and Playing Field Locations**

*\*\*Emphasize the Pedestrian*

*\*Emphasize Community*

*\*Locate Open Spaces as Close as Possible to all Residents*

## PROPOSED DRAINAGE AREAS

The site has been divided into four drainage areas. Each drainage area drains separately into the City of Winnipeg's existing land drainage system. These points are illustrated in **Figure 36** by the arrows north of the Ridgewood South site. Each drainage area works with the existing slope of the land. Because of this, area #1 is the most complicated, with four sub watersheds within it. This area currently drains southwards towards area B, while the remaining of the site drains towards the east, as part of the Red River Watershed, at a fairly consistent slope of approximately 0.11%.

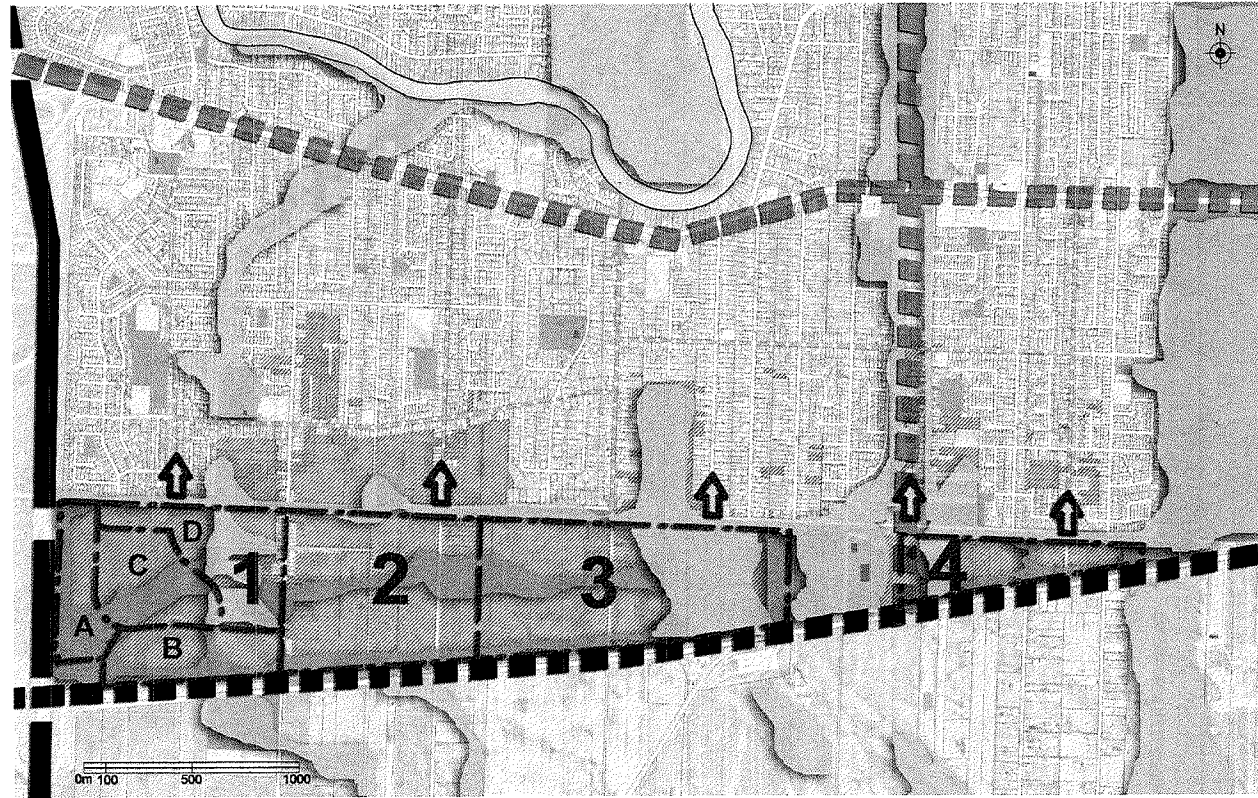


Figure 36: Proposed Drainage Areas

*\* Open space as Drainage Network*

*\* Create Connective Networks: hydrology*

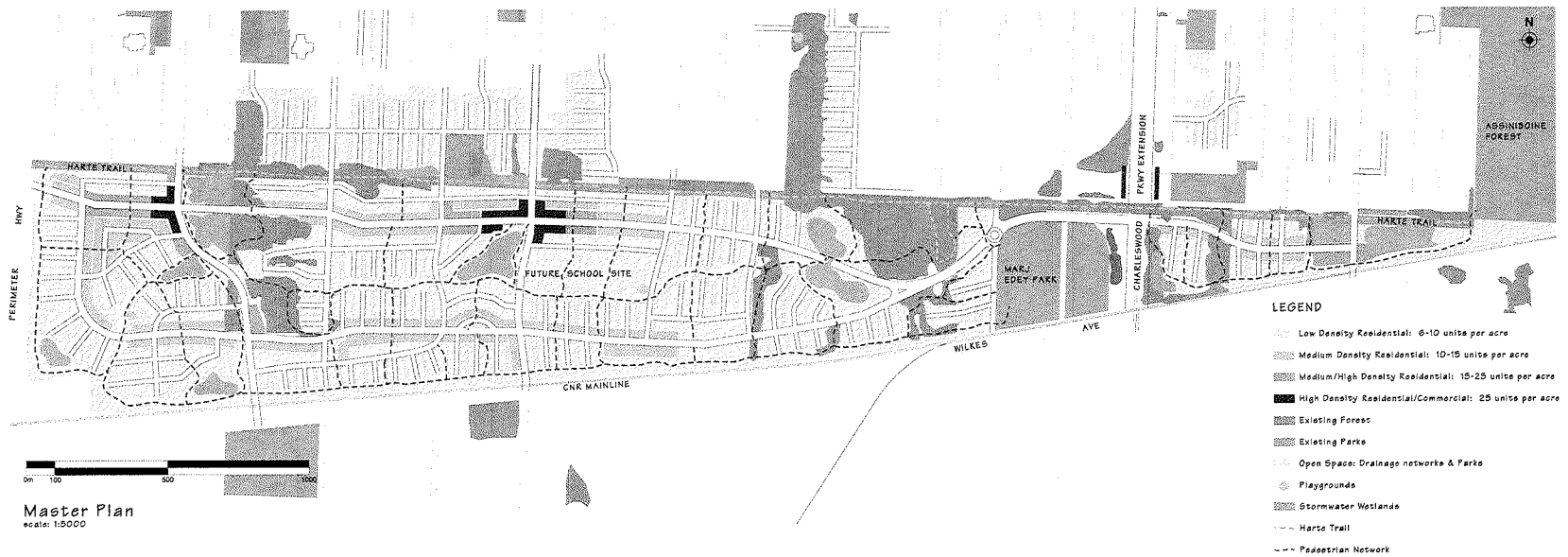
*\* Control Stormwater at the Source*

*\* Daylight Stormwater Runoff*

# ix.

# NEIGHBORHOOD PLAN

There are two plans at the entire neighborhood scale that have been developed. The first is the Master Plan, **Figure 37**, which reviews the proposed land uses, vehicular and pedestrian networks, the open space network, schools, playgrounds and conserved forest areas. The second is the Drainage Plan, **Figure 39**, which illustrates how the site will drain, where the proposed stormwater wetlands will be found, the vegetated swale system, as well as the approximate slope of the land for each area.



**Figure 37: Master Plan**

## LAND USE

There are three primary land uses found within the site: Residential, Commercial, and Parks & Open Space. A brief description of each type of land use is found below.

### RESIDENTIAL

#### *Low density Residential:*

- 6-10 units per acre
- Single family homes, lots from 372 to 557sq.m. (4,000 to 6,000 sq.ft)
- Front setbacks: 4-5m (13'-16.5')
- Maximum front driveway width: 3.5m (12')
- Building setback from lane right of way (ROW): 1m (3') min.

#### *Medium density Residential:*

- 10-15 units per acre
- Single family homes and Duplexes
- Narrow lots, from 279 to 372 sq.m. (3,000 to 4,000 sq.ft.)
- Front setbacks: 4-5m (13'-16.5')

- Building setback from lane ROW: 1m(3') min.

#### *Medium-high density Residential:*

- 15-25 units per acre
- Row houses, duplexes, stacked townhouses, & 2-4 story apartments
- Front setbacks: 3m (10')

### COMMERCIAL

#### *High density residential/ Commercial*

- density around 25 units per acre
- residential units above commercial, could also include office spaces
- Front setbacks: 0-2m (0'-6.5')
- Maximum building height: 4 stories

#### *Specialty commercial area: (area along Charleswood Parkway)*

- Oriented towards Charleswood residents and surrounding community
- More of a driving destination

## PARKS AND OPEN SPACE

### *School & Park site:*

- centrally located, within walking distance to the most number of homes
- Includes soccer field, & baseball diamond & playground
- This area will be considered a “mow area”.
- A community centre is located within the commercial area near the school in which there is a washroom area and meeting room(s) & daycare centre in which community meetings and drop-in classes can occur.

### *Greenway (linear park):*

- Multi-use trails (pedestrian and bicycle routes)
- Trails width: 3-3.65m (10'-12')
- Opportunity for cross country ski trails within this corridor in winter
- Approximately 40m (130') in width but varies
- Housing units located along the greenway will front onto it.
- Pedestrian level lighting will be incorporated along pathways, as well as waste receptacles and benches

- Greenways also function as drainage networks and as such drainage swales move through them.
- Small bridges will be located over swales at various locations to ensure connectivity when swales are full of water.
- The vegetation will primarily consist of native grasses and some trees in order to absorb as much runoff as possible. The roots of these grasses also help break up the soil and allow percolation of water into the ground.
- There will be certain “mow areas” in which more active recreation can occur.

### *Playground sites:*

- 3 total, include play equipment for kids aged 2-12 (one of which is included within the School/park site)

### *Wetland Parks:*

- There are four major wetland park sites
- The surrounding of most of the wetlands will be public in nature, with certain areas in which private dwellings front onto the wetlands.
- Each wetland will have public access and public amenities, such as trails and benches.

- The central wetland, near the commercial area and the school – which is called “the neighborhood core” – will also incorporate an outdoor classroom/outdoor gathering location.

### **OPEN SPACE**

The open space network is located through the center of the site, as well as along the western and southern edges of the site, buffering the Perimeter Highway and the train tracks. A multi-use pathway connects all housing areas with existing forests, parks, schools, and commercial nodes. Sidewalks are located along all local streets and collector streets, completing a 150 meter pedestrian grid. The major drainage infrastructure for the site, including vegetated swales and stormwater wetlands, is sited within the open space network.

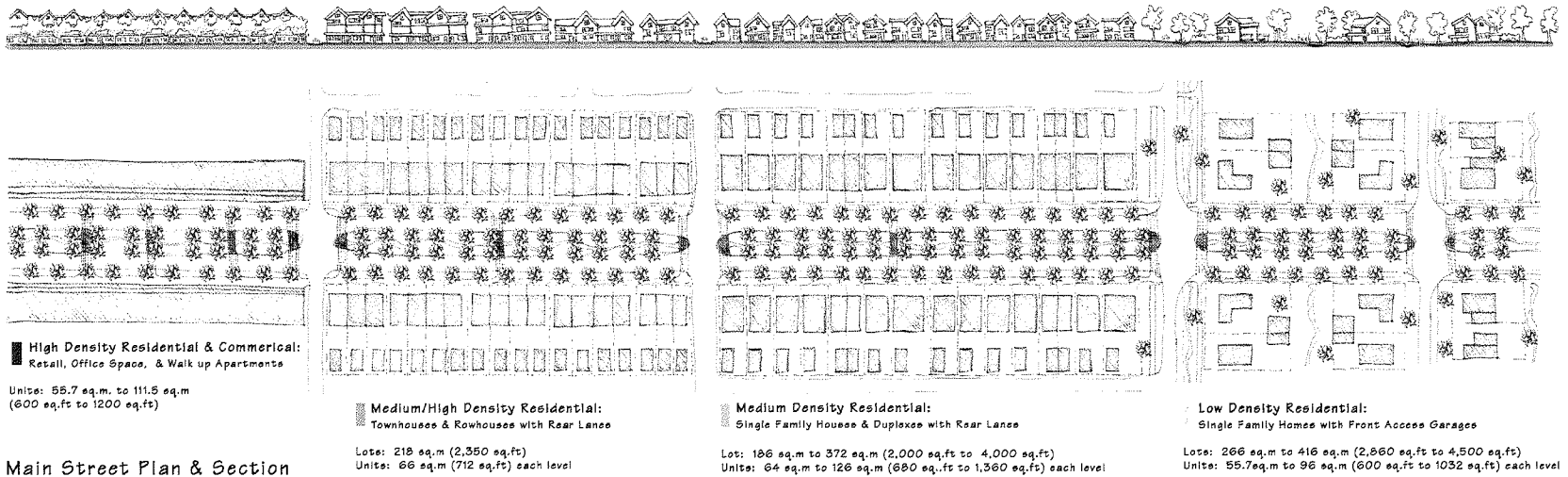
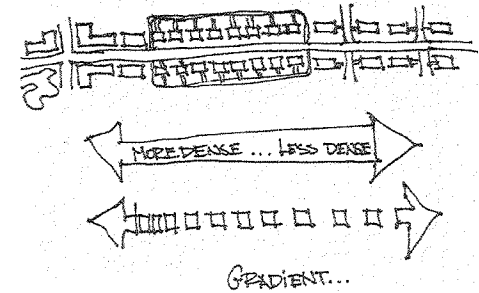
### **ROADS**

There are five different road types found within this site: the arterial, the collector street, the local street, the cul-de-sac, and the rear lane. The arterial is located along the extension of Charleswood Parkway

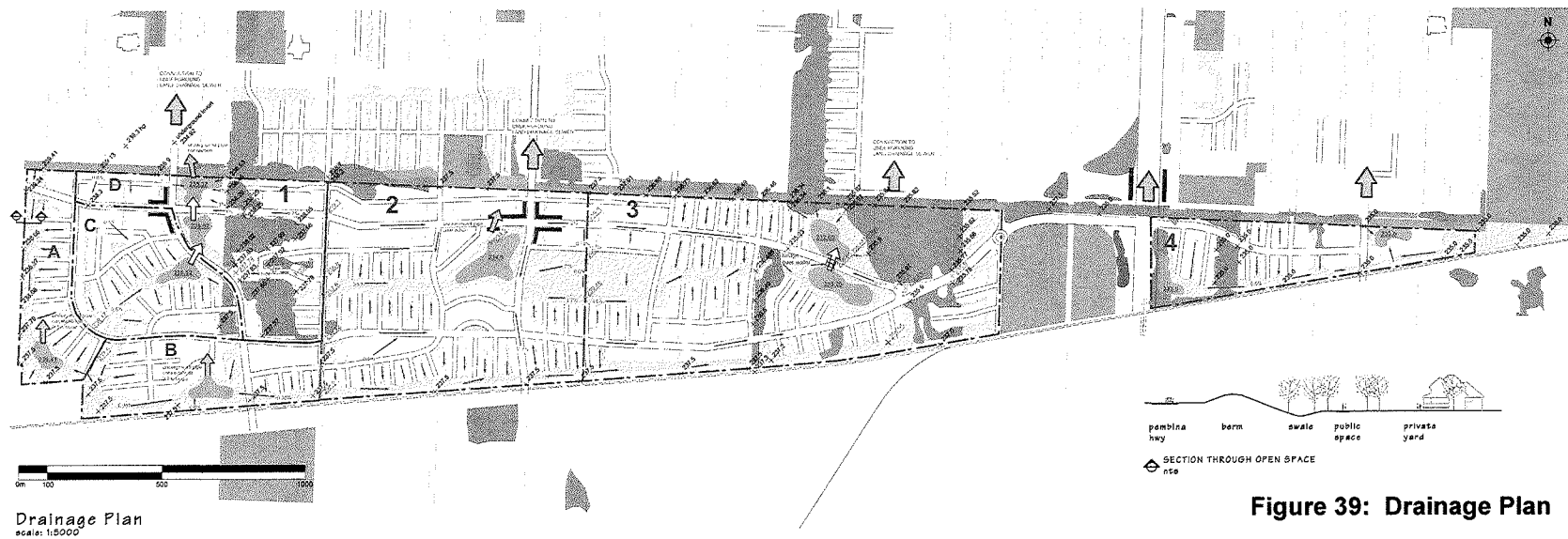
and links up with Wilkes Avenue through the use of an overpass above the train tracks. There is also a short arterial that is located north of Marj Edey Park. This road then splits into two collector streets that create a ring-road around the rest of the neighborhood. The northern collector has a wider right-of-way than the southern one because this road will also accommodate transit. During rush hour, there will be no parking along the northern collector and the lane will become a dedicated transit lane. Other than the ring road, there are two collector streets that run north-south within the site. They are located where the commercial areas intersect with the ring road and continue northward connecting the existing neighborhoods with the Ridgewood South site. The local streets ensure a connective vehicular pattern for the site. The vehicular circulation is laid out in a 300 meter grid. The cul-de-sacs are the streets that end most often at the site’s open space network. Finally, the rear lanes are primarily located along the collector streets, to ensure only rear vehicular access to the lots along these streets. This allows for narrow lots as well as no disruption to traffic from vehicles backing in and out of front driveways.

## MAIN STREET

The northern collector is designed on the basis of a density gradient. This gradient moves from little to no building density, an existing forested area, to a dense urban core. As one moves eastward along the main street, one passes the large remnant forest patch, then a section of cul-de-sac streets, the lowest building density on site, then a section of narrow lot, single family housing and duplexes, medium density residential, to a section of row houses and townhouses, medium/high density residential, finally arriving at the neighborhood core, where three to four story buildings are found lining the streets, in which high density residential and commercial uses are located. This gradient pattern is illustrated in **Figure 38**.



**Figure 38: Main Street plan and section**



**Figure 39: Drainage Plan**

The drainage infrastructure for this site includes a combination of overland flow through vegetated drainage swales within the open space network (shown in light green) that direct runoff into a series of storage areas, the stormwater wetlands (shown in blue). The site is divided into four separate watersheds in order to facilitate this overland flow. This allows each drainage area to have a minimum swale slope of 0.5% within which water flows toward the catchment wetland(s).

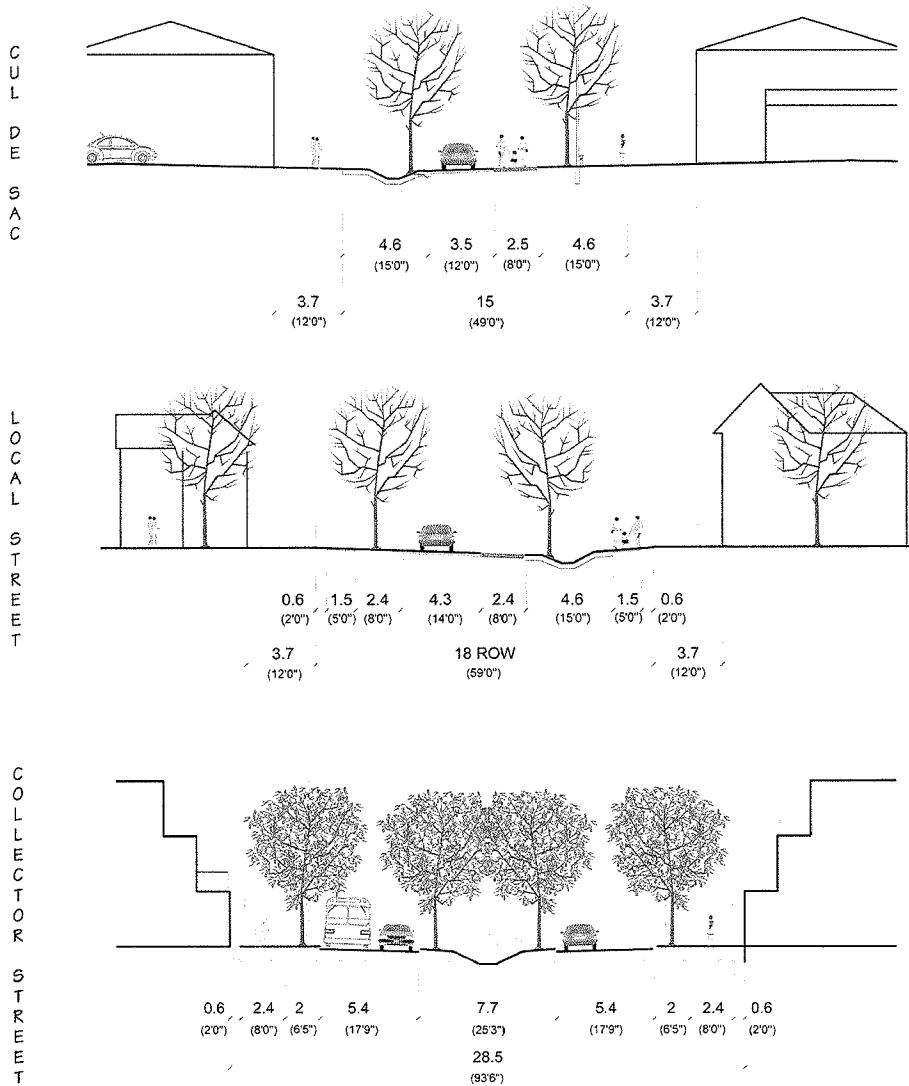
As mentioned, drainage area #1 has the most complicated drainage infrastructure. Because the existing land slopes towards the south-west corner, the site has been divided into a total of four sub-watersheds, each draining into a separate wetland. The wetlands in areas A and B are then drained in an underground pipe towards the city's existing land drainage sewer system. The wetland in area C drains into the pond/wetland system in the final area D that then drains underground into the existing land drainage sewer.

Drainage area #2 drains overland into a central wetland and then underground into the existing land drainage sewer.

Drainage area #3 drains overland into an attached pond/wetland system that is then drained underground into the existing land drainage sewer. This

pond/wetland system is connected under the roadway and can be seen as a person drives into the site.

Finally, drainage area #4 is split into two wetland catchment areas that then drain northward into the existing underground drainage system.



**Figure 40: Street sections**

**Road Drainage**

- Curbs are located along collector streets with runoff directed to a drainage swale within the central median, which has a notched curb system.
- There are no curbs along the remaining streets. Runoff is directed into the drainage swale that is located along one side of the street.
- The runoff from the cul-de-sac streets are directed into a rain garden that is located at the end of the street (see **Figure 44**).

In order to minimize impervious surfaces, all of the roads widths within the site are narrowed. The road surface within the cul-de-sac is narrowed from the conventional City of Winnipeg standard of 24.6' to a width of 20' and the pavement within the local streets are narrowed to a width of 22'. The collector streets are designed as two one-way roads. The northern collector is wider, since it accommodates transit, with a width of 17.9' in each direction, while the remaining collectors are composed of 16' widths in each direction.



**Figure 41: Detail Area**

The drainage area #2 (see Figure 39) was chosen as the area to be designed in further detail. This area encompasses all land uses found within the site as well as the neighborhood core. The neighborhood core is where commercial, residential, stormwater, and education all come together to create one large central node to the community.

In this chapter there are three detail areas that will be described. Each area represents a different scale within the community. The first area, Detail Area 1, is the individual household scale, where the cul-de-sac street layout is investigated further.

The second area, Detail Area 2, is the transition zone. This location is more

public than the first and is where stormwater, people, and roadways all converge.

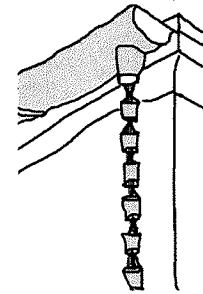
The final area, Detail Area 3, is the most public scale. This is the center of the neighborhood core, where the energy and excitement of the neighborhood is found.

# 1: Individual Household Scale

Neighborhood Homes & Park Space: The Cul-de-sac

The description of the detail area begins at the top of the watershed, at the individual household scale. A typical lot plan is illustrated in **Figure 42**.

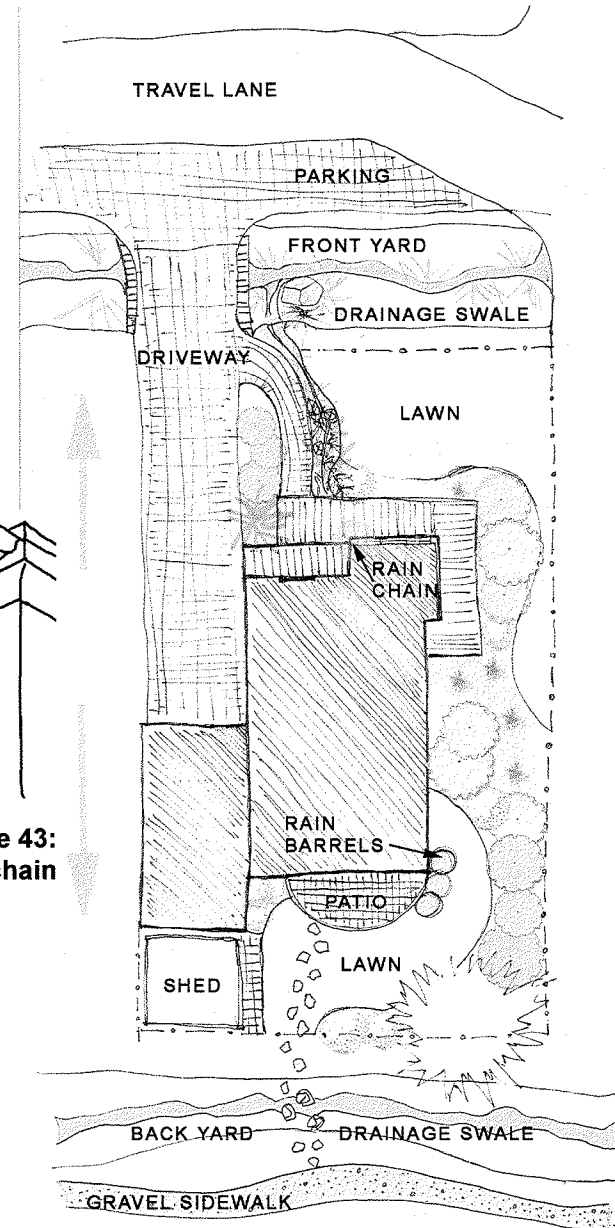
At the individual household scale, the highest point is located at the center of each lot. In the front yard stormwater runs off the roof, into the homes eaves drippings and down a decorative rain chain. The water then flows adjacent to the front walkway into the roadside swale. The movement of water can be seen from where it lands on the roof top until it reaches its destination of the front yard drainage swale. In the backyard, the runoff is directed into a storage system of rain barrels, utilized for watering the yard's landscaping. The overflow is directed into the back yard drainage swale, located within the public open space network.



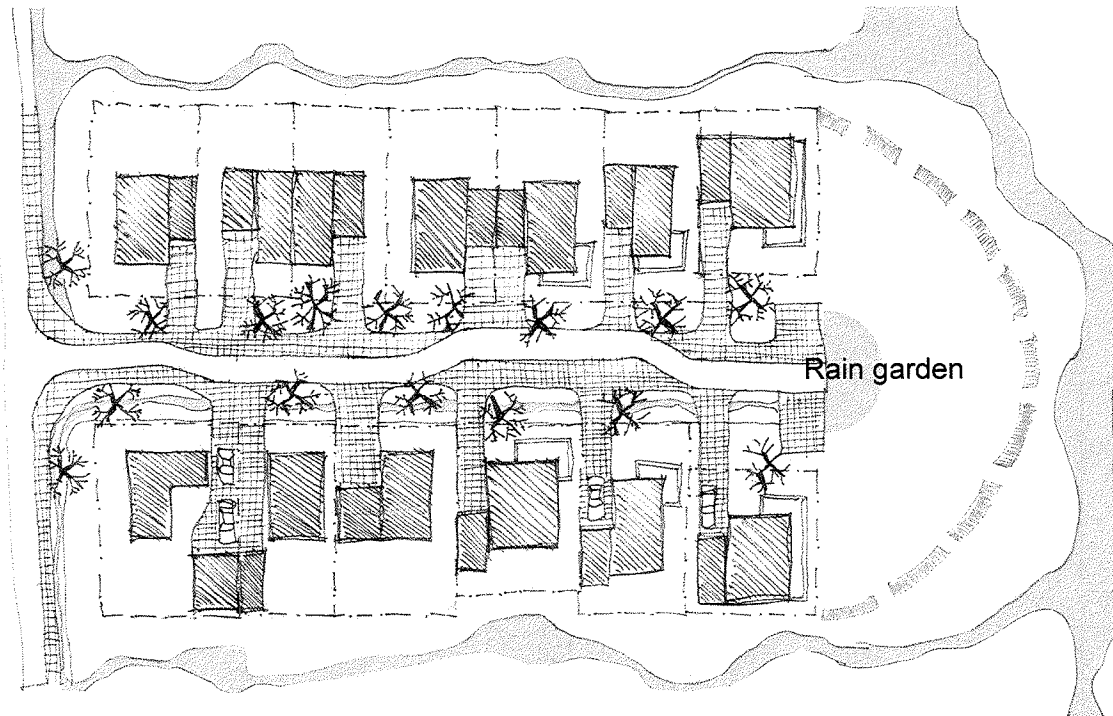
**Figure 43:**  
Rain chain

The cul-de-sac roads are designed as a shared roadway system.

This type of roadway is intended to create a safe space that the pedestrian and vehicle can share. The road is designed with a 12' travel lane and an 8' parking lane, see Figure 44. The travel lane meanders within the right of way in order to ensure slow vehicular movement. The roadway ends in a T-intersection to reduce the site's impervious surfaces.



**Figure 42:** Typical Lot Plan



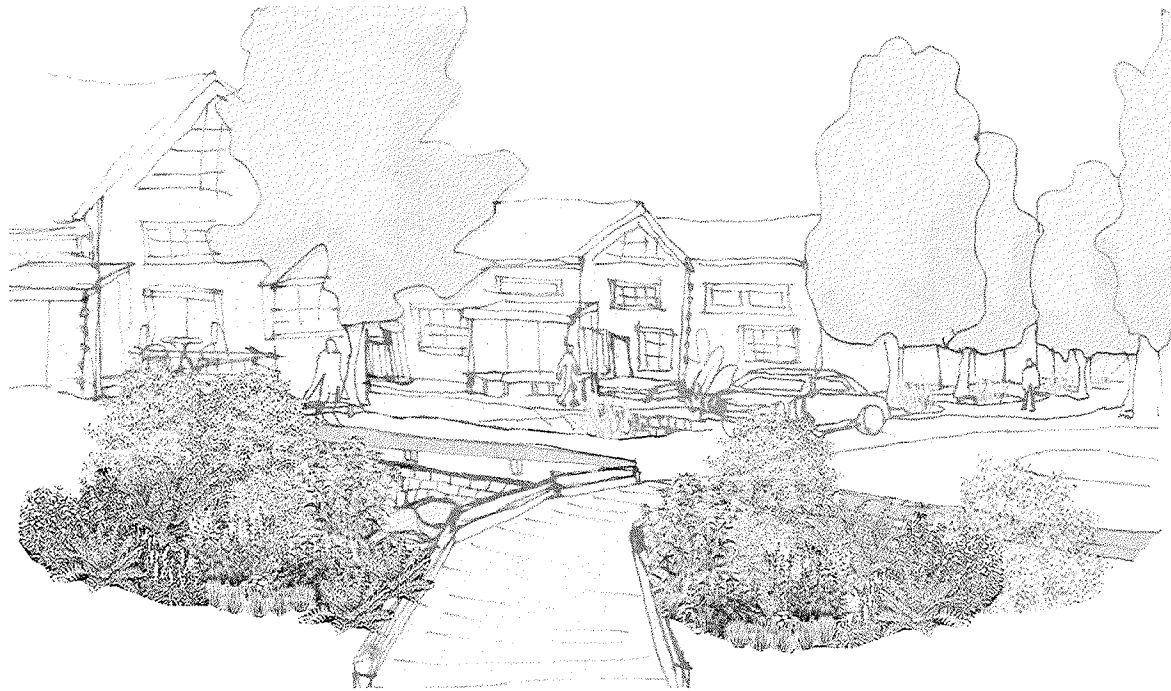
The runoff from the back yard drainage swales is directed into the larger overland drainage system found within the open space network. The roadway drainage swales are directed to a rain garden located at the end of each T-intersection. An illustration of the rain garden can be seen in **Figure 46**.



**Figure 44: Cul-de-sac plan and section**



**Figure 45: View walking through cul-de-sac**

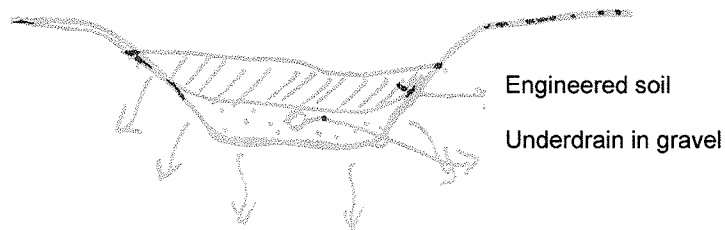


**Figure 46: The rain garden at the end of the cul-de-sac**

The rain garden is described in the engineering of stormwater - alternative methods section. The rain garden design guidelines are found in **Table 3**.

The runoff from the roadside swales is directed into the rain garden through a culvert under the pavement of the T-intersection. The rain garden area is then designed to absorb this water. The excess water that is not absorbed within seventy two hours travels

through an underdrain, located in a gravel bed beneath a thick layer of engineered soil, into the drainage swale located within the open space network.



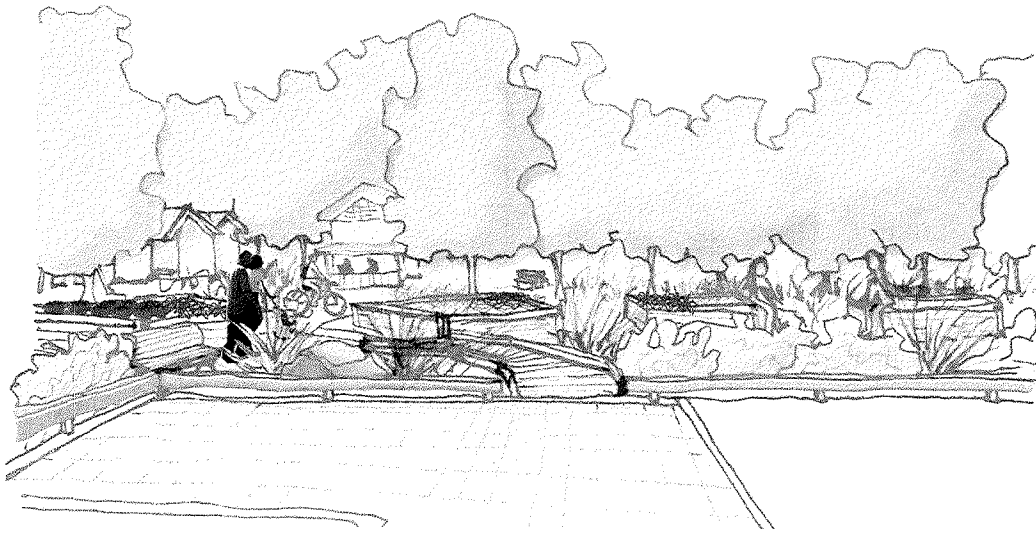
**Figure 47: Section through rain garden**



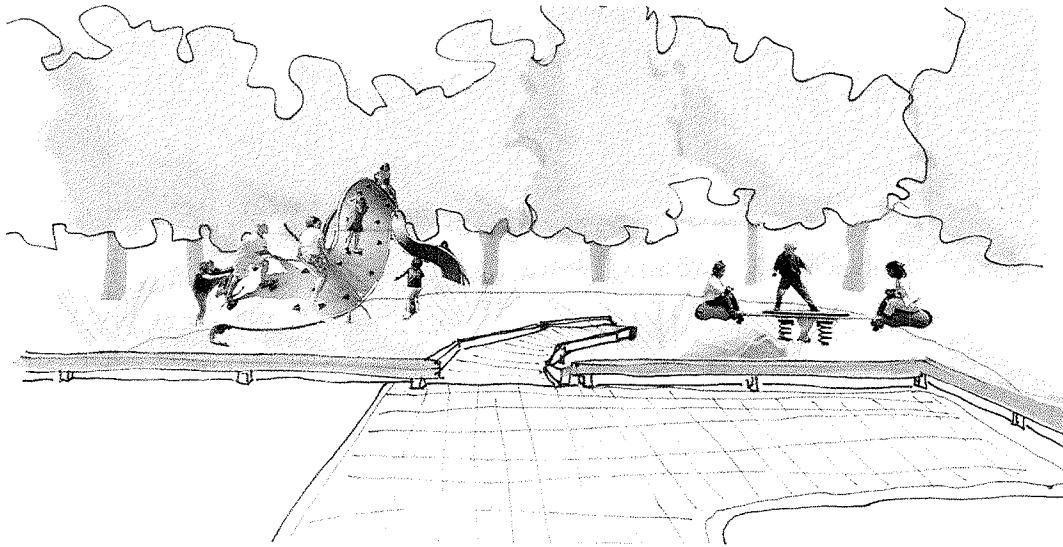
**Figure 48: Plan of open space network**

There are two connective networks found within the open space park. There is an interconnected system of multi-use paths overlapping a second system of vegetated drainage channels, illustrated in **Figure 48**.

As described within the Alternative Development section of this document, the cul-de-sac lots are minimized in order to provide the neighborhood with more open space. Because of the smaller lots, a portion of the open space network is designated to each cul-de-sac block. This area is located at the end of each T-intersection.



**Figure 49: View of community garden option within Cul-de-sac Park**



**Figure 50: View of children's play equipment option within Cul-de-sac Park**

In order to emphasize community within the neighborhood, the character of each of these areas is to be decided by the residents of the block. Similar to what was done in Village Homes; each block will be given a specific quantity of money in order to develop these cul-de-sac parks. It is up to the residents how they choose to landscape the areas and what features they will include. A couple of possible examples illustrated in **Figures 49 and 50** include a community garden and play equipment. By allowing the residents to decide how to landscape these areas, the open space network will have a variety of spaces and uses found within it. The people of the community will also be forced to meet and decide as a group what is best for their site. A sense of community is not always created simply from casual contact. By creating a setting in which neighbors are required to meet, and where neighbors have some control in their immediate surroundings, there is more opportunity for a sense of belonging and community to form.

## 2: The Transition Zone

Where Networks Converge: Water, People & Roads

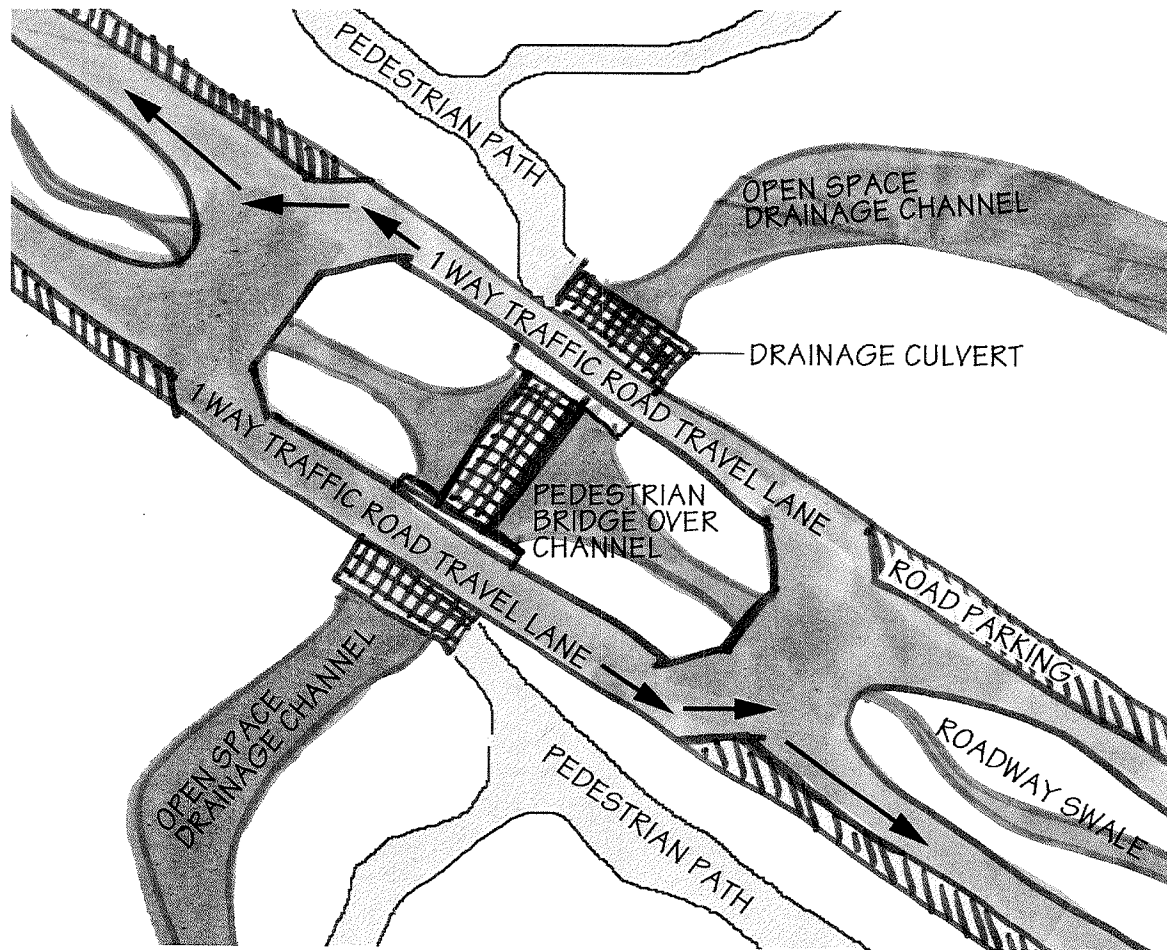


Figure 51: Mid block intersection plan

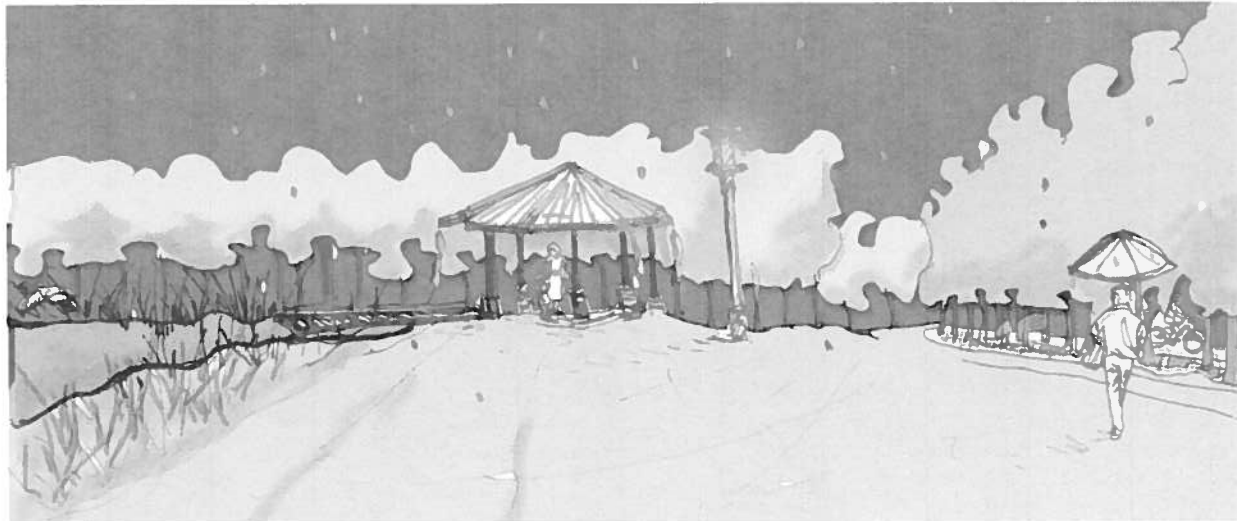
This area is the transition zone, where three networks converge: the open space network, the drainage network, and the road network.

Since the open space network crosses the road mid-block, a traffic calming measure was necessary to bring attention to people crossing the road. Because this area is where all of the significant networks within the neighborhood converge extra attention must be drawn to it. Instead of narrowing the road right of way at this location, it was decided to widen the drainage median. This is to bring attention to the convergence of water within this site.

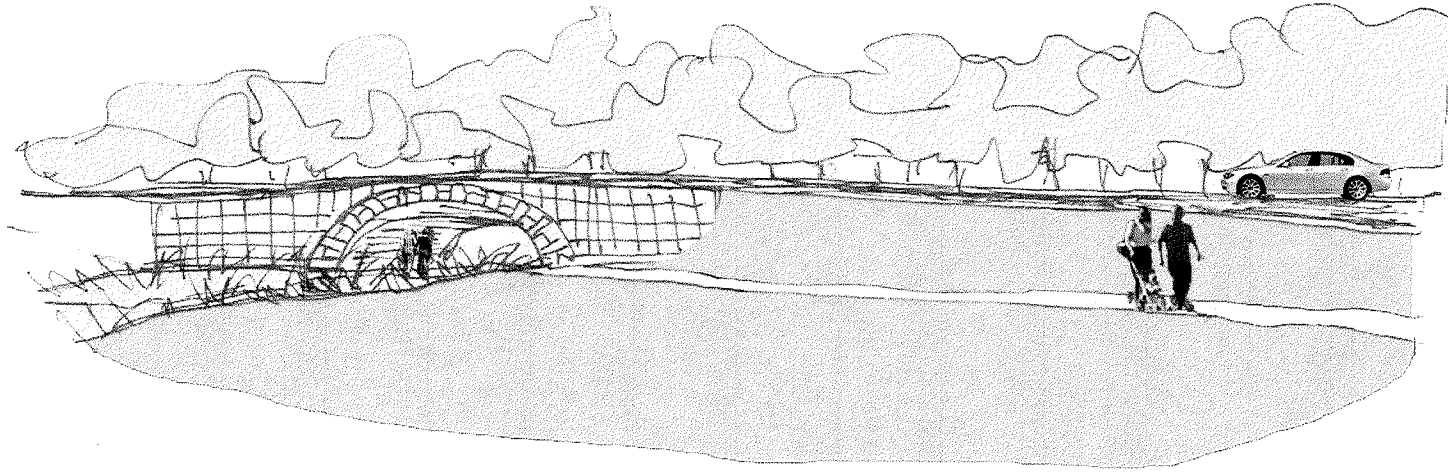


**Figure 52: View crossing mid-block intersection**

This mid-block intersection is located along the north-south collector street, which is composed of two one-way streets, with a parking lane on the right and a travel lane on the left. As the road nears the mid-block crossing, the parking lane disappears and the travel lane shifts into the right hand lane. This causes traffic to slow down thus creating a safer crossing location. Attention is also brought to this space since the median widens and a pedestrian bridge crosses it, creating more of a visual focal point. There is also opportunity to create more of a node at this site through the addition of a seating area or other uses within the widened median.



**Figure 53: View of Wetland Park adjacent to mid-block intersection**



**Figure 54: Pond/Wetland system located in drainage area 3**

Another location that deals with the convergence of the open space network, the drainage network, and the road network in a different manner is found within drainage area 3. When entering the site from the primary arterial, Charleswood Parkway, this is the first wetland park that is seen. In this location the three networks are dealt with in a different manner. The open space and drainage network move under the roadway, creating two separate layers of movement. This allows for a more fluid connection between the open space network and the large remnant forest patch located to the north of this point. This location requires a greater separation of networks because it is a stretch of road that would be much busier than the north-south collector mid-block crossings that were previously described.

### 3: Public Scale: The Neighbourhood Core

The Neighborhood Core is located at the center of the Ridgewood South neighborhood. It is at this location where the commercial/ mixed-use area, the stormwater wetland, and the school site are all found. The street intersection is composed of a roundabout rather than traffic lights since this is a method of traffic calming and enables the creation of a more pedestrian oriented site. The illustration below is a perspective of the main street roadway and median, with trees and three to four story buildings lining the road, and a large stormwater wetland to the left. The building immediately adjacent to the wetland would contain a restaurant with an outdoor patio and community space in which daycare, community facilities and meeting spaces would be found.

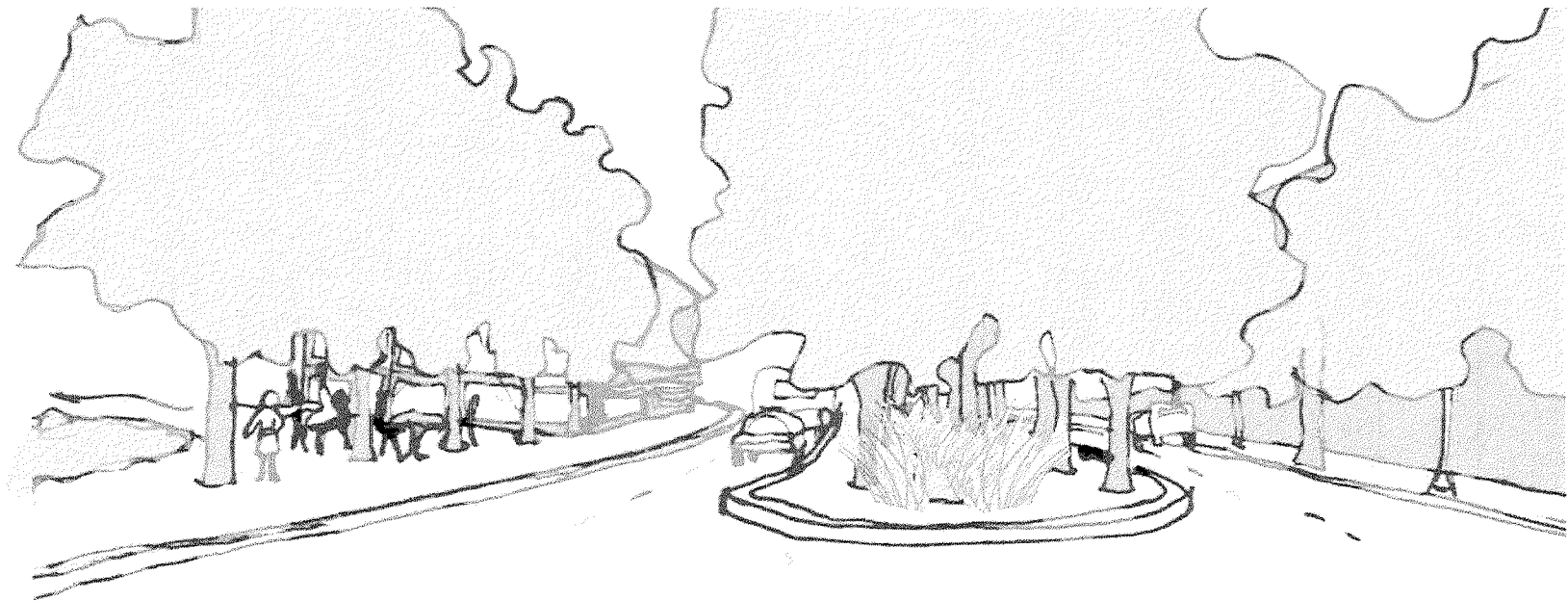


Figure 55: View down Main Street adjacent to wetland

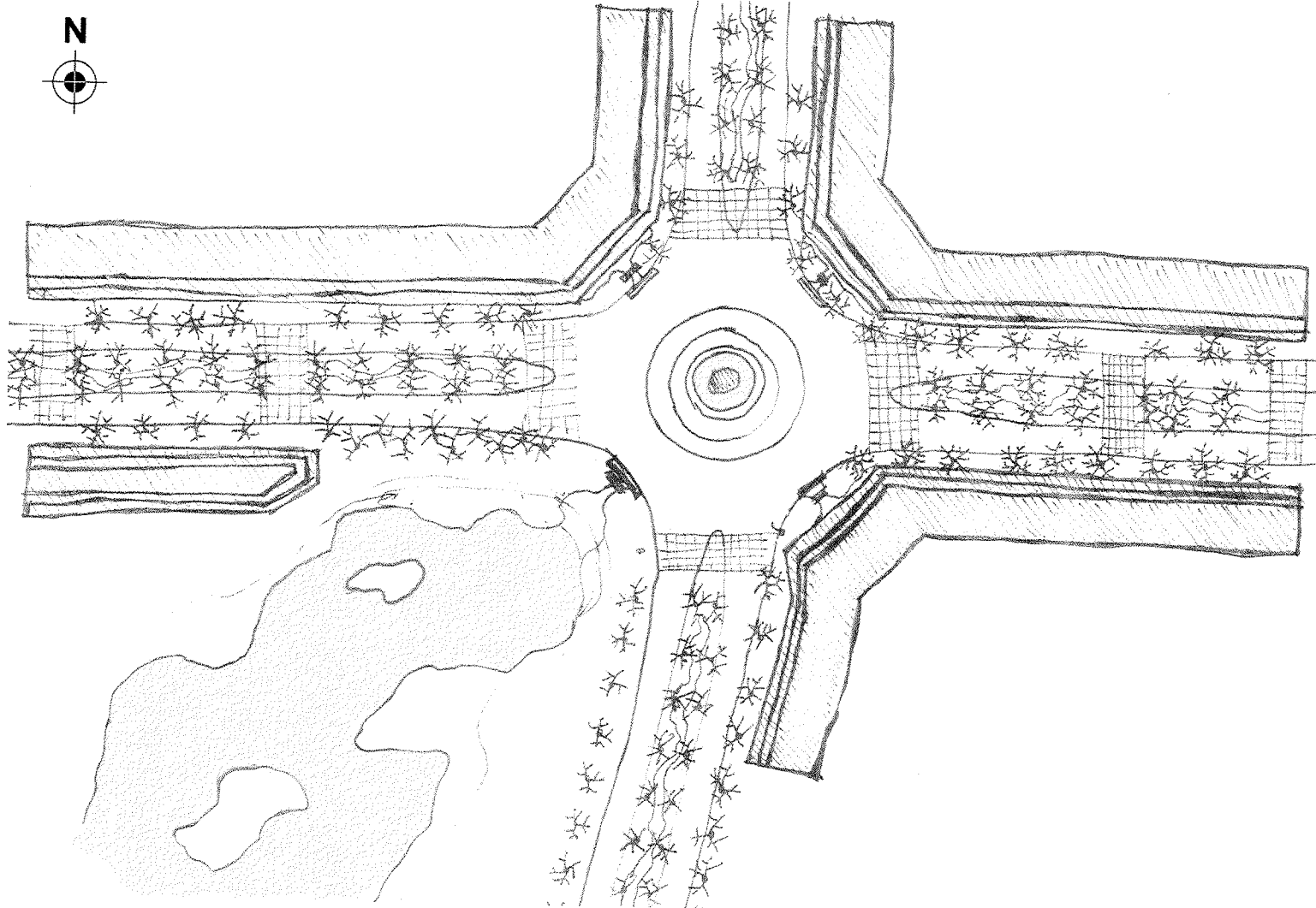
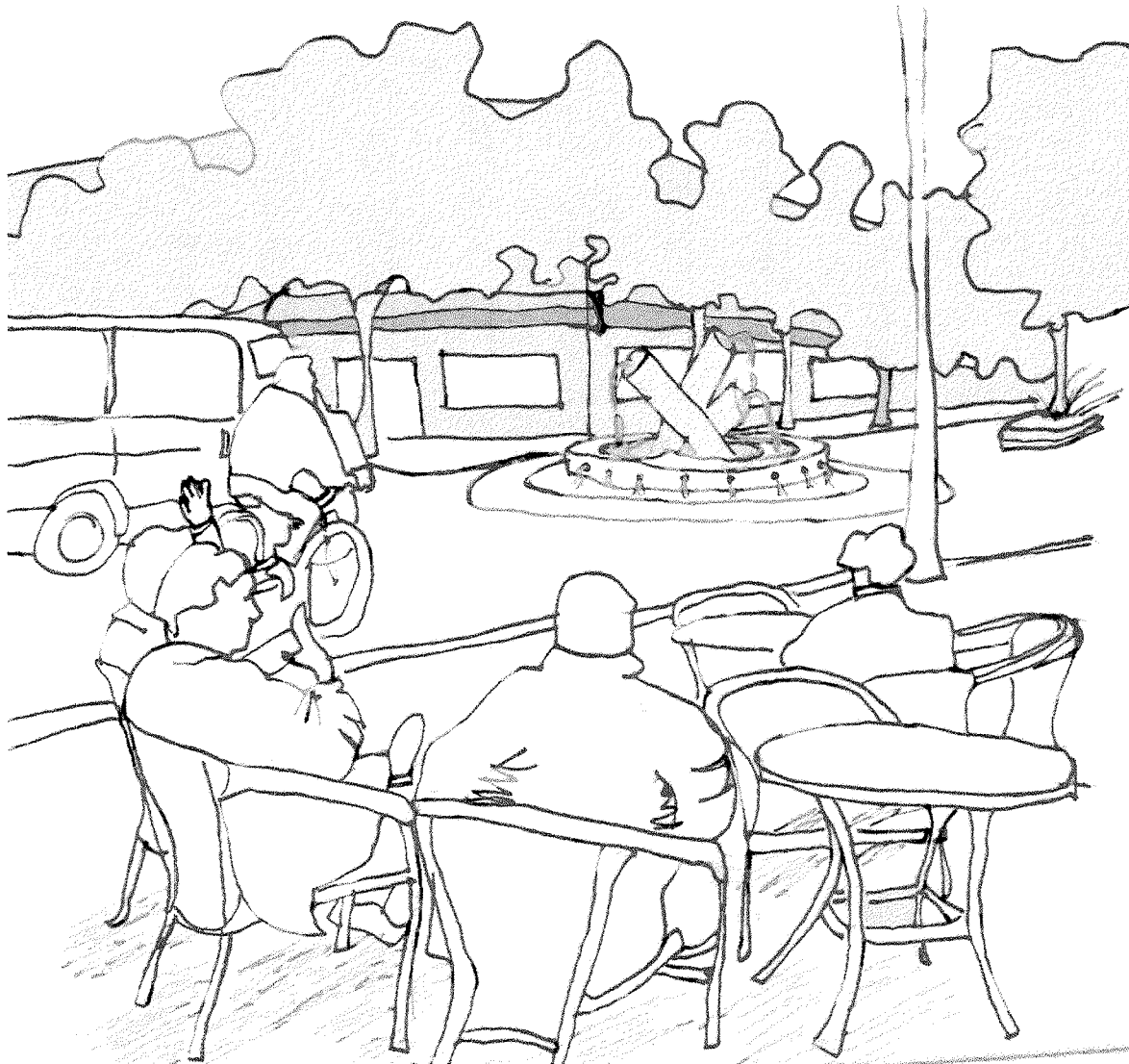


Figure 56: Plan of Neighborhood Core



**Figure 57: View from Main Street patio**

Figure 57 illustrates what it would be like to sit at the main street restaurant's outdoor patio, enjoying the company of friends and neighbors, watching people driving, biking, and walking by.

The large scale of the roundabout located within the center of this site creates a perfect opportunity for a focal point, one that celebrates water and the goal of this community, to bring water to the surface and to make it visible and enjoyable to the average citizen.

**WHAT MAKES THE PROJECT RELEVANT TO LANDSCAPE ARCHITECTURE TODAY?**

The quality of water is becoming increasingly important and the negative effects of development on water quality are becoming more apparent every day. The neighborhoods located within urban areas are where the majority of the population live and therefore grow up and learn about the environment that surrounds them. These should be the first places to be analyzed in terms of their impact on the larger landscape, as well as the first areas to change the way in which they are designed and built. If natural systems cannot be seen in our immediate surroundings how can their existence be expected to be understood?

Landscape architects have the ability to look at a site holistically, without being clouded by a rigid set of rules and boundaries. They have the ability to consider issues that one specific profession may overlook. Instead of designing a neighborhood looking at single purpose elements such as roads and traffic, drainage infrastructure, or land uses, the landscape architect has the ability to seek out information from the professionals in each field and combine all of this into one holistic site plan.

This project demonstrates how we can become more engaged with our community and the natural processes that support it. Within the design of Ridgewood South, stormwater was brought to the surface, through a system of overland swales and stormwater wetlands. This movement of water was made visible and the stormwater network became the connective framework of the entire site. The site's design connects people with the natural environment by locating the important natural process of the movement of water within their immediate environment. From one's home, one can see how rainwater falls on a roof, down the downspout/ rain chain, through the swales, towards the larger wetlands. The areas in which the water moves are not hidden away but celebrated and become the central connecting elements of the entire community.

The design of this site not only accomplishes the reconnection of people with the natural environment, but also with other people in their own community. A neighborhood is composed of more than roads and lots. It is where our homes are located, where we live, work, play and learn. This neighborhood was designed to encourage the interaction with residents and their neighbors as well as the natural systems of the surrounding environment.

When I think about my daughter and our walk down the back lane I realize that we can learn a lot about the world around us from children. Their minds are not clouded by assumptions on how things around them function. They look at the world around them in wonder, taking in every little trickle and drop of water with delight and amazement.

**WOULDN'T YOU LIKE TO LIVE/ PLAY HERE!**



- Arendt, Randall G. (1994). Rural by Design. Chicago: American Planning Association.
- Arendt, Randall G. (1994). "How to Create a Subdivision With Character: Cul-de-Sacs and Their Alternatives". *Planning*. May.
- Arendt, Randall G. (1996). Conservation Design for Subdivisions: A Practical Guide to Creating Open Space Networks. Washington, D.C.: Island Press.
- Austin, Maureen E. & Rachel Kaplan. (2003). "Resident Involvement in Natural Resource Management: open space conservation design in practice". Vol.8, No. 2: 141-153.
- Ben-Joseph, Eran. (1995). "Changing the Residential Street Scene: Adapting the Shared Street (Woonerf) Concept to the Suburban Environment". *Journal of American Planning Association*. Vol. 61, Issue 4: 504(12 pages).
- Ben-Joseph, Eran, & Michael Southworth.(1995). "Street Standards and the Shaping of Suburbia". *Journal of the American Planning Association*. Vol. 61, Issue 1.
- Bonsignore, Regina. (2003). "New Development Trends and Terms". University of Minnesota: Design Center for American Urban Landscape (DCAUL).
- Calthorpe, Peter. (1993). The Next American Metropolis: Ecology, Community, and the American Dream. New York: Princeton Architectural Press.
- Campbell, Craig S. & Michael H. Ogden. (1999). Constructed Wetlands in the Sustainable Landscape. Toronto: John Wiley & Sons, Inc.
- Canada Mortgage and Housing Corporation (CMHC). (2002). "Residential Street Pattern Design". Research Highlights.
- Canada Mortgage and Housing Corporation (CMHC). (2001). "The Headwaters Project: East Clayton Neighborhood Concept Plan. Socio-Economic Series: Issue 78".
- City of Surrey. (2000). "East Clayton Neighbourhood Concept Plan (NCP)".
- City of Surrey. (2004). "East Clayton North of 72 Avenue Public Open House #3". Surrey, BC: Planning & Development Department.
- City of Winnipeg. (1980). Plan Winnipeg: Water Supply, Sewerage & Pollution Control, Land Drainage, and Solid Waste Component. Winnipeg Development Plan Review: Waterworks, Waste & Disposal Division.
- City of Winnipeg. (1991). The City of Winnipeg Transportation Standards Manual. Streets and Transportation Department.

- Center for Housing Innovation (CHI). (2000). *Green Neighborhoods: Planning and Design Guidelines for Air, Water and Urban Forest Quality.* Eugene, OR: University of Oregon.
- Condon, Patrick M. (ed). (1996). "Sustainable Urban Landscapes: The Surrey Design Charrette". A Project of the University of British Columbia: James Taylor Chair in Landscape and Liveable Communities.
- Condon, Patrick M. (2005). "Case Study for a Smart and Sustainable New Community – East Clayton, Surrey, BC". Presentation: Smart Growth Canada Meeting.
- Corbett, Judy & Michael. (2000). Designing Sustainable Communities: Learning from Village Homes. Washington, D.C.: Island Press.
- Corbett, Judy & Michael. (2004). "Energy and the Human Environment: Toward Better Neighborhood Design". College of Human Ecology, Michigan State University: Human Ecology Monograph Series. Webpage accessed 07/15/2006. [http://www.lgc.org/freepub/land\\_use/articles/energy\\_betterdsgn/page01.html](http://www.lgc.org/freepub/land_use/articles/energy_betterdsgn/page01.html)
- Department of Defence (DoD). (2004). "Design: Low Impact Development Manual". U.S. Army Corps of Engineers: Unified Facilities Criteria (UFC).
- Dewberry, Sidney O. and Davis, eds. (1998). "Land Development Handbook: Planning, Engineering, and Surveying". New-York: McGraw Hill.
- Duany, Andres & Emily Talen. (2002). "Making the Good Easy: The Smart Code Alternative". Fordham Urban Law Journal. Vol. XXIX, No. 4: 1445-1468.
- Duany, A., W. Wright, S. Sorlien, L. Hall, M. Watkins, D. Slone, G. Hugalde, R. Merson. "Smart Code and Manual: Version 8.0". New Urban Publications Inc.
- Ehrlich, W.A., .A. Poyser, L.E. Pratt, and J. H. Ellis. (1953). Report of Reconnaissance Soil Survey of Winnipeg and Morris Map Sheet Area s- Soils Report No.5. Manitoba Department of Agriculture.
- Ellis, Cliff. (2002). "The New Urbanism: Critiques and Rebuttals." Journal of Urban Design. Vol. 7, No. 3: 261-291.
- Environment Canada. "Canadian Climate Normals 1971-2000". The Green Lane. Last modified 02/25/2004. Webpage accessed 06/10/2005. [www.climate.weatheroffice.ec.gc.ca/climate\\_normals/results\\_e.html](http://www.climate.weatheroffice.ec.gc.ca/climate_normals/results_e.html).
- Ewing, Reid. (1996). Best Development Practices: Doing the Right Thing and Making Money at the Same Time. Chicago: American Planning Association.

- Foss, Asa., (2005). "Low Impact Development: An Alternative Approach to Site Design". PASMemo: May/June.
- France, Robert L. ed. (2002). Handbook of Water Sensitive Planning and Design. United States of America: Lewis Publishers.
- Fuller, Mossbarger, Scoot & May (FMSM) Engineers, & Center for Watershed Protection. (2001). "Darby Creek Watershed Stormwater Management Strategies and Standards for New Development". Volume 1. Prepared for Darby Creek Watershed Task Force.
- Girling, Cynthia L., & Kenneth I. Helphand. (1994). Yard Street Park: The Design of Suburban Open Space. New York: John Wiley & Sons, Inc.
- Girling, Cynthia & Ronald Kellett. (2004). "Green Neighbourhoods at the Edge". *Landscapes/ Paysages*. Vol.6, No.1.
- Graham, Robert Michael. (1984). The Surface Waters of Winnipeg: Rivers, Streams, Ponds and Wetlands 1874-1984. The Cyclical History of Urban Land Drainage. University of Manitoba: Department of Landscape Architecture.
- Gordon, David, and Vipond, Shayne. (2005). "Gross Density and New Urbanism: Comparing Conventional and New Urbanist Suburbs in Markham, Ontario". *Journal of American Planning Association*, Vol.71, No. 1.
- Government of Manitoba. "City of Winnipeg Community Profile". Webpage accessed 06/12/2005.  
[www.communityprofiles.mb.ca/cgi-bin/csd/overview.cgi?id=4611040](http://www.communityprofiles.mb.ca/cgi-bin/csd/overview.cgi?id=4611040).
- Green Roofs for Healthy Cities. (2005). "About Green Roofs". Last updated 05/31/2005. Accessed 10/05/2005.  
[www.greenroofs.net](http://www.greenroofs.net).
- Hager, Mary Catherine. (2003). "Low Impact Development: Lot-level approaches to stormwater management are gaining Ground". *Stormwater Journal*. January/February.
- Harrison, Stephan, Steve Pile, & Nigel Thrift, eds. (2004). Patterned Ground: Entanglements of Nature and Culture. London: Reaktion Books.
- Hough, Michael. (1989). City Form and Natural Process: Towards a new urban vernacular. London and New York: Routledge.
- Jarvis, Frederick D. (1993). Site Planning and Community Design for Great Neighborhoods. Washington, D.C.: Home Builders Press.
- Kelbaugh, Douglas S. (2002). Repairing the American Metropolis: Common Place Revisited. Seattle: University of Washington Press.
- Kemp, David D. (1998). The Environment Dictionary. London & New York: Routledge.
- Kives, Bartley. (March 21, 2006). "City's natural imbalance: Most forested, grassy areas are found in south end". *Winnipeg Free Press*.

- Leyden, Kevin M. (2003). "Social Capital and the Built Environment: The Importance of Walkable Neighborhoods. *American Journal of Public Health*". Vol. 93, No. 9: 1546-1550.
- Liebner, Judy. (2003). "New Street Grids Blend Old Designs: Residents want connectivity Pattern inspired by Savannah". *Toronto Star (Canada)*, 09/20/2003.
- Lovelace, Debra Ellen. (1996). Application of Best Stormwater Management Practices in the City of Winnipeg. University of Manitoba: Department of Civil and Geological Engineering.
- Manitoba Natural Resources. (1998). "Land Drainage Review: Fall 1997 & Winter 1998 Open Houses, Summary and Recommendations".
- Martin, Michael David. (2002). "Replacing Alleys". *Landscape Journal*. 21:1.
- Massachusetts Low Impact Development Toolkit. "Low Impact Development Fact Sheet: Roadways and Parking Lot Design". Webpage accessed 11/20/2005. [http://www.mapc.org/regional\\_planning/LID/roadways\\_parking\\_lots.html](http://www.mapc.org/regional_planning/LID/roadways_parking_lots.html)
- McHarg, Ian and Jonathon Sutton. (1975). "Ecological Plumbing for the Texas Coastal Plain". *Landscape Architecture*. 65:no.1. 78-89.
- Metro. (2002). Green Streets: Innovative Solutions for Stormwater and Stream Crossings. Portland, Oregon: Metro.
- Metropolitan Area Planning Council (MAPC). (2000). "The Conservation Subdivision Design Project: Booklet for Developing a Local Bylaw". Executive Office of Environmental Affairs.
- Metropolitan Council/ Barr Engineering Co. "Minnesota Urban Small Sites BMP Manual (MSSC)". Webpage accessed 11/21/2003. <http://www.metrocouncil.org>.
- Naturalist Services. "Naturalist Services Branch". City of Winnipeg. Last updated 03/03/2005. Webpage accessed 10/10/2006. [www.winnipeg.ca/publicworks/Naturalist/hs/](http://www.winnipeg.ca/publicworks/Naturalist/hs/).
- NSW Department of Housing webpage. <http://www.housing.nsw.gov.au/radburn.htm>
- Pomeroy, Steve (Focus Consulting). (1999). Professional Attitudes Toward Alternative Development Standards. Toronto: ICURR Publications.
- Schmitz, Adrienne, et al. (2003). The New Shape of Suburbia: Trends in Residential Development. Washington, D.C.: ULI – The Urban Land Institute.
- Southworth, Michael. (1997). "Walkable Suburbs? An Evaluation of Neotraditional Communities at the Urban Edge". *Journal of the American Planning Association*. Vol. 63, Issue 1: 28 (17 pages).

- Sprin, Anne Whiston. (1984). The Granite Garden: Urban Nature and Human Design. United States of America: Basic Books.
- Strelow, Heike ed. (2004). Ecological Aesthetics. Art in Environmental Design: Theory and Practice. Initiated by Herman Prigann. Berlin: Birkhauser.
- Stormwater Manager's Resource Center (SMRC). "Better Site Design Fact Sheet: Narrower Residential Streets". Maryland: Center for Watershed Protection Inc.
- Sustainable Community Research Group. (2000). "A Checklist of the Qualities of the New Urbanism Design Philosophy". McMaster University. Accessed 03/05/05. <http://www.eng.mcmaster.ca/civil/sustain/designparam/checklist.htm>
- Szold, Terry S. & Armando Carbonell, eds. (2002). Smart Growth: Form and Consequence. Canada: Lincoln Institute of Land Policy.
- The Radburn Association webpage. "Radburn – A Planned Community". Last updated 01/04/2006. Viewed 03/05/2006. [www.radburn.org](http://www.radburn.org).
- United Nations Development Program. (2000). World Resources, 2000-2001: People and Ecosystems: the Fraying Web of Life. Amsterdam: Elsevier Science.
- University of British Columbia (UBC), Small Towns Initiative, Landscape Architecture Program. (2002). "Stormwater Planning: A Guidebook for British Columbia". British Columbia Ministry of Water, Land and Air Protection.
- Watson, Donald, Alan Plattus & Robert G. Shibley, eds. (2003). Time-Saver Standards for Urban Design. New-York: McGraw-Hill.
- Wikipedia. "Radburn, New Jersey". Last modified 12/2004. Accessed 04/10/2005. [http://en.wikipedia.org/wiki/Radburn,\\_New\\_Jersey](http://en.wikipedia.org/wiki/Radburn,_New_Jersey)

Kives, Bartley. (March 21, 2006). City's natural imbalance: Most forested, grassy areas are found in south end. Winnipeg Free Press.

Center for Housing Innovation (CHI). (2000). Green Neighborhoods: Planning and Design Guidelines for Air, Water and Urban Forest Quality. Eugene, OR: University of Oregon.

City of Winnipeg website. "Community Services". Accessed 11/05/2003. [www.winnipeg.ca/services/yourcommunity.stm](http://www.winnipeg.ca/services/yourcommunity.stm)

All aerial photographs were from the City of Winnipeg (2005), created by Atlas Geomatics, and adapted by the author.

All site photographs and drawings were created by the author.