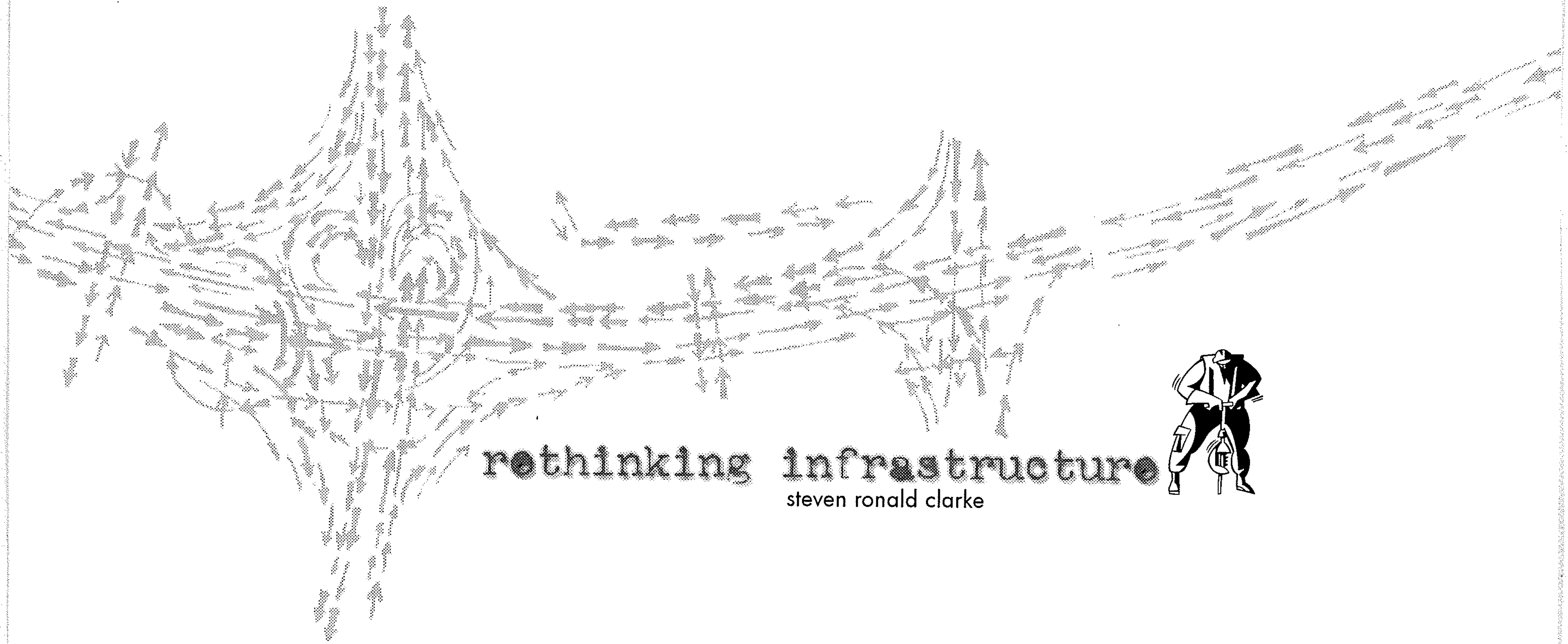

rethinking infrastructure

steven ronald clarke

a practicum submitted in partial fulfillment of the requirements for the degree of master of landscape architecture

department of landscape architecture, university of manitoba, winnipeg, manitoba, 1999

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RETHINKING INFRASTRUCTURE

BY

STEVEN RONALD CLARKE

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

of Manitoba in partial fulfillment of the requirements of the degree

of

MASTER OF LANDSCAPE ARCHITECTURE

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abstract

The intent of this practicum is to rethink the role of infrastructure and the ways in which it is integrated with the built environment. More specifically, the infrastructure within the street right-of-way (ROW) is examined using Pembina Highway, located in Winnipeg, Canada, as a case study.

A program analysis of the case study site was carried out to illustrate the vertical and horizontal relationships, and requirements of each element of infrastructure within the ROW. Information was gathered through an interview process which involved those professionals responsible for the design and maintenance of ROW infrastructure. As well, design standards and manuals were consulted, along with site visits along the case study site to clarify the data.

From this a series of design alternatives evolve for existing and new streets of similar type to the case study.

While rethinking the ROW, nine conclusions emerged:

- Consider the spatial requirements of the all the infrastructure.
- Plant street trees where they have sufficient spatial requirements to grow.
- Ensure elements of infrastructure work together as a unit.
- Consider the ecological opportunities.
- Make infrastructure visible.
- Design infrastructure collaboratively.
- Avoid the tack-on approach.
- Invovle the community.
- Make infrastructure meaningful.

To Kim

acknowledgements

This research began in the winter '96 term through a course elective. The paper I presented in Professor Alf Simon's infrastructure seminar course, Department of Landscape Architecture, served as the foundation for this practicum – thank you, Alf, for providing an inspiring class room environment and serving as chairman. As well, I must thank the rest of my commitee for challenging me; Mr Garry Hilderman, FCSLA, Hilderman Thomas Frank Cram, and Mr Deron Miller, MALA, Scatliff & Associates. I also thank the many people who I have met during my research for the information they have contributed to this study. I thank Mr Chris Macey, P. Eng., UMA Group, for taking extra time to review my process for the bioswale, and Mr James Urban, FASLA, for his contribution on street trees. I must especially thank my family and friends for their continued support and encouragement in my studies. I thank you all.

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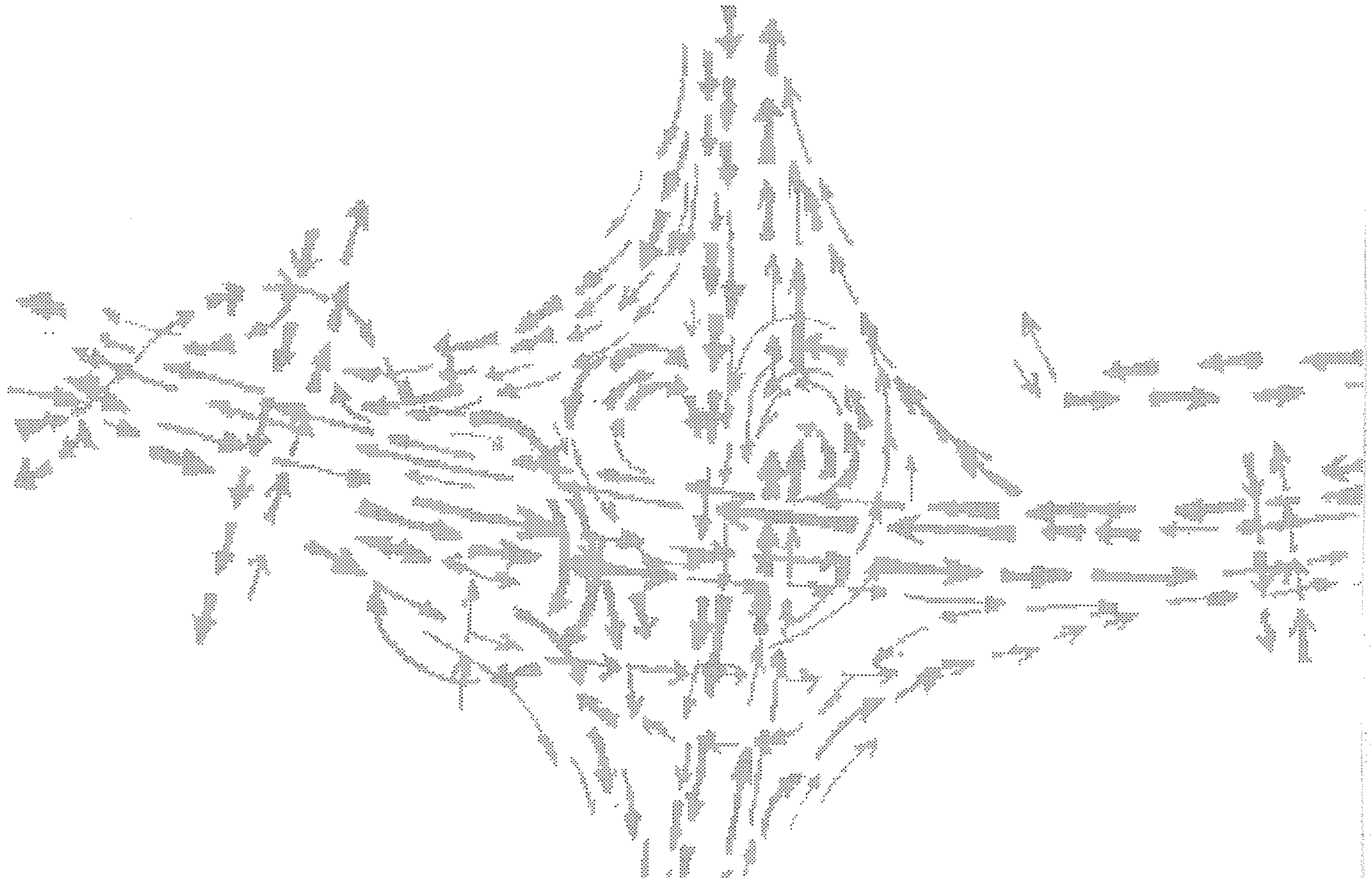

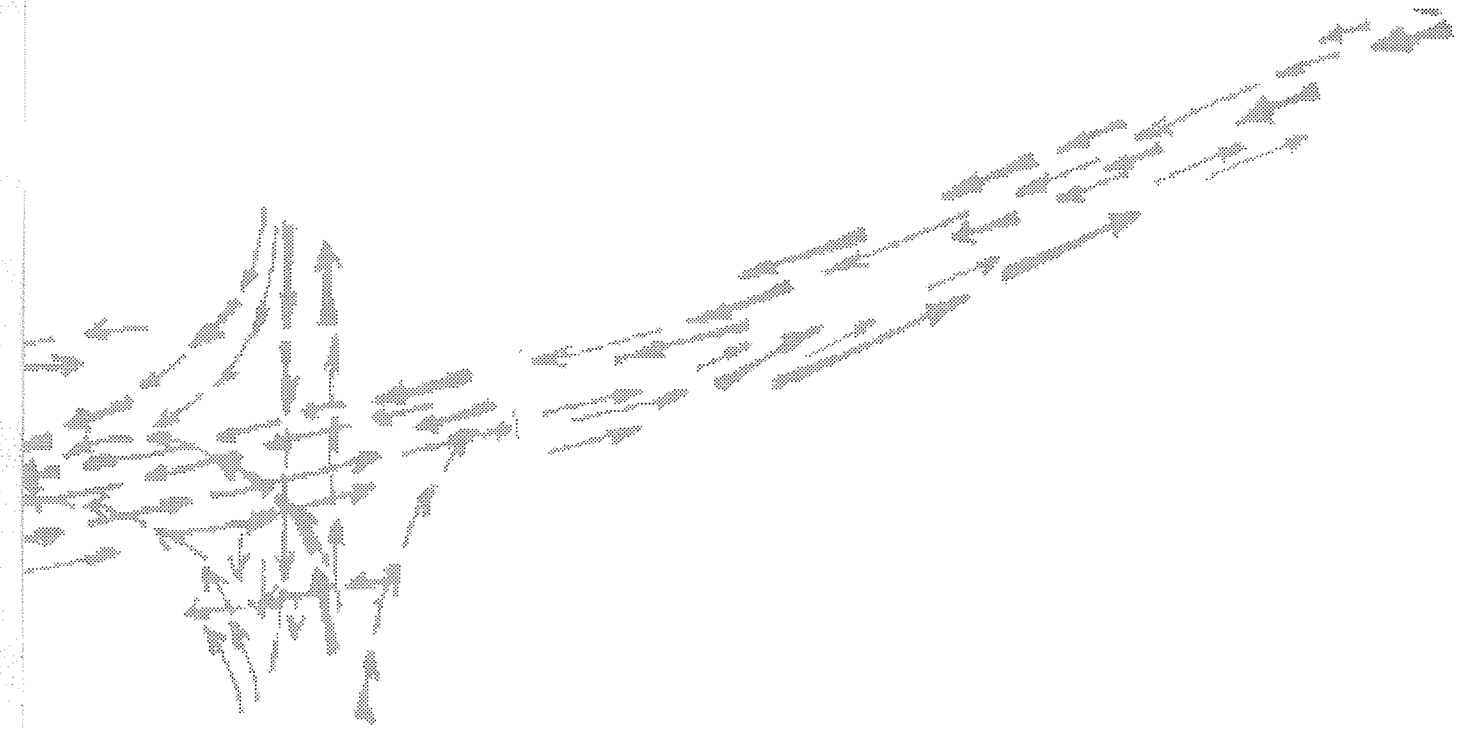

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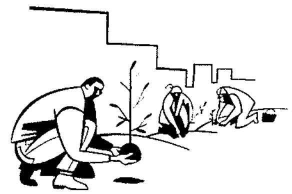
6.0 

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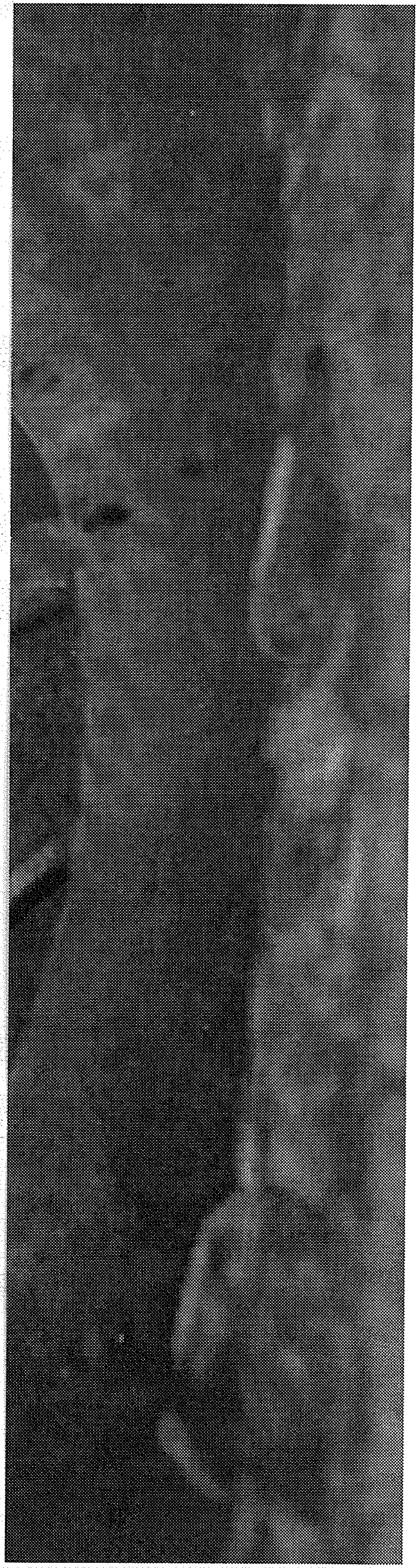
5.0 Design Intervention & Transformation

6.0 Rethinking the ROW



Infrastructure..."It's a puzzle"
Eddie Mendez, at bottom

◄ **1.1** NYNEX technicians peer into a three-storey deep manhole in New York City.

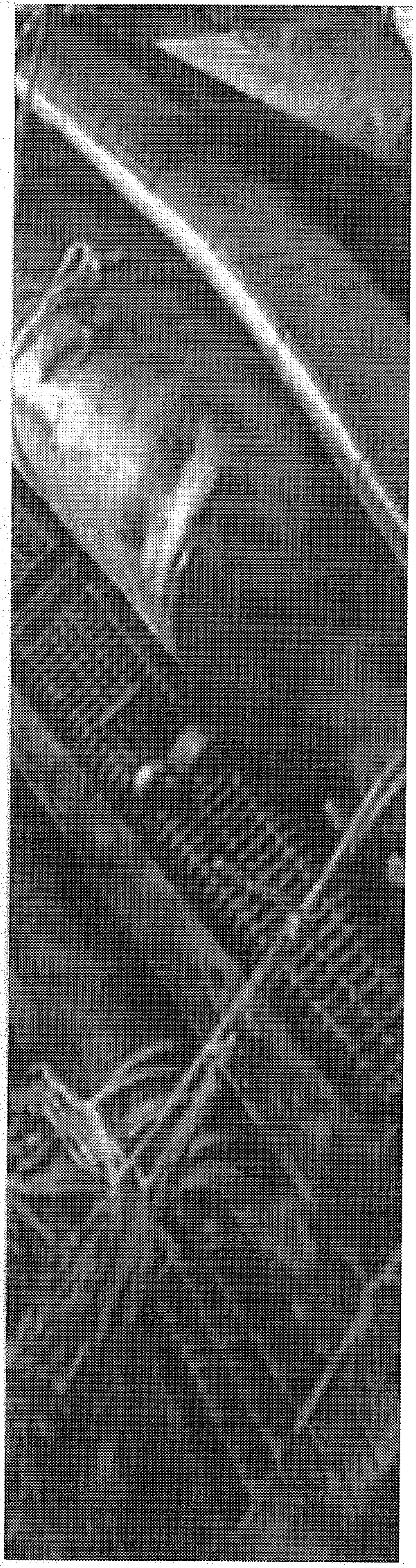
1.0 introduction

The intent of this practicum is to rethink the role of infrastructure and the ways in which it is integrated with the built environment. More specifically, the infrastructure within the street right-of-way (ROW) will be examined using Pembina Highway, located in Winnipeg, Canada, as a case study. The findings will serve to illustrate the vertical and horizontal relationships and requirements of each element of infrastructure within the ROW. From this a series of design alternatives will evolve for existing and new streets of similar type to the case study with the following goals in mind:

▶ to investigate an infrastructure that is expressive of process and place.

▶ to explore the notion of a multi-use system of infrastructure.

▶ to evaluate the benefits of a multi-use infrastructure. ■



"Nerve Surgery"
National Geographic

◂ **2.1** a NYNEX technician splices lines on New York City's 51 million km phone system.

2.0 what is infrastructure?

Infrastructure are the "guts," or "nerves" of our cities. It provides us with the resources we need to inhabit our cities. These essential systems are the network of city streets which allows us to drive to the store; the urban system of aqueducts, reservoirs, treatment plants, and pipes, which allows us to have drinking water at the turn of a tap; and it is the network of power lines, towers, transformers, and power stations that delivers electricity to our cities and our homes.

However, once something is labelled *infrastructure*, it quickly assumes a host of unfavourable connotations, the most common being that it's "ugly." As the guts of our cities, infrastructure is often relegated to a subterranean position. In those instances where we cannot bury it, we try to disguise it with plantings or artwork. In so doing, infrastructure has become synonymous with an eyesore.

This view of infrastructure appears to be commonly held by its primary designers – engineers. When describing the Main St.-Norwood Bridge project in Winnipeg, where the design of the bridge went beyond that of the engineered object and addressed aesthetics and area residents' concerns, an engineer consultant for the project described the intent of the design to be "less of an eyesore than a bridge often is" (Winnipeg Free Press: 1996). This view was echoed during a series of interviews for this practicum; several engineers indicated that such systems as overhead lines "look better if situated underground." Such comments imply that infrastructure by its very nature is unattractive. Other engineers emphasized that their objective is not to embellish the basic framework, a challenge that often falls to landscape architects after the fact, but to fulfil one specific need, such as the distribution of gas, or water, or communication networks.

Likewise, landscape architects' main role in infrastructure projects is normally to diminish the visual impact by strategically placing plantings or "streetscaping" to screen it from view. This message is reinforced time and time again.

Yet infrastructure was not always viewed as an eyesore. Infrastructure was seen as beautiful elements in the landscape to be shown off with pride. The Boulder (now Hoover) Dam, the Goldengate Bridge (figure 2.2), and the landscaped pathways around New York and Washington, D.C. are examples of infrastructure that still attract camera-happy tourists, foster civic pride, and inspire artists, as well as serving functional roles. These projects were constructed during the era of the great *public works* in America, which began in the late 19th century and progressed until the 1930s when new technologies emerged and were embraced. During this period, infrastructure developed that was monumental in size and scope, where it took on a public presence and played a role in civic life (figure 2.3) (Bruegmann : 1993, Rossenberg: 1996). These monumental projects were designed and built using a collaborative design approach where engineers, planners, architects, artists, landscape architects, and bureaucrats worked together (Bruegmann : 1993). Evidence of this design approach is displayed in the wide scope of the public works projects, which included schools and playgrounds as well as the typical engineered structures such as bridges, roads, reservoirs, and sewers, to name a few.

There was a shift in the character of public works projects, starting in the '50s, particularly the '60s and early '70s. Infrastructure projects began to shed their public presence and take on a purely functional and economical role. The specialized infrastructure of the engineer replaced the cross-disciplinary design approach of the public works to deal with technology that was evolving increasingly complex. As a result, the attention to design detail was lost and the projects took on an impersonal character as rigorous engineering standards and economics took precedent over the creation of cultural icons (figure 2.4). A shift in terminology took place: where we once had public works, we now have infrastructure, whose prefix literally means under, below or down (Bruegmann: 1993).

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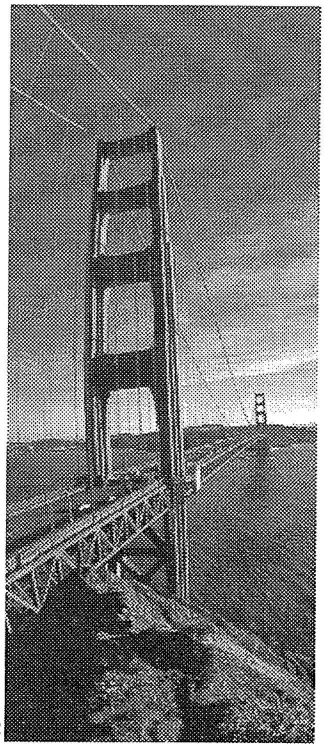
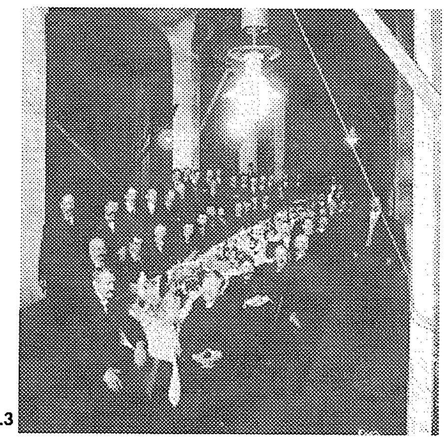


2.2 Golden Gate Bridge, San Francisco.

2.3 Banquet in a sewer, in celebration of completion of the project, 1912, Winnipeg.

2.4 Out with the old, in with the new – 1960.

2.3


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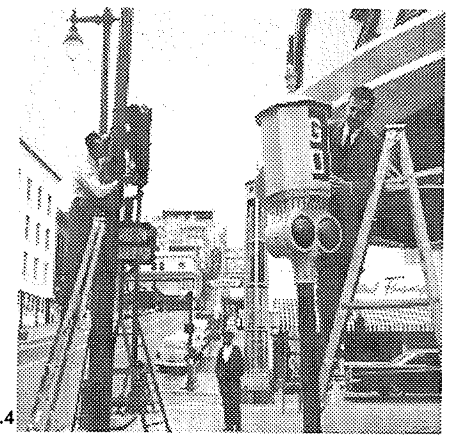

What are the Problems of Infrastructure?

With this shift, infrastructure began to be viewed as something to be invisible. The character of infrastructure shifted as new technologies were adapted, gradually relegating infrastructure to be placed underground or screened from view. By the 1970s, with over 20 years of hiding and disguising public works, we had in effect erased them from the collective consciousness. Before we knew it, we had a society that understood less about its city's basic services than it ever had (Bruegmann: 1993). While contemporary infrastructure are awesome works of technology, they are void of any humanistic element or ecological qualities. It is also economically costly.

Technology vs Humanism

The elements of infrastructure, while everywhere in our built environment, are difficult to perceive as understandable patterns. Even though we cannot see how infrastructure works, we take it for granted that when we turn on the tap, we will have running water. Much of today's infrastructure is generally buried, screened from view with landscaping or decorated with art to humanize or camouflage the facility (figure 2.5). Thayer (1994) describes this design approach as the physical manifestation of *landscape guilt*. This visible and spatial form is a sign of a conflict when people's affection for nature collide with a love-hate ambivalence toward technology. This is evidence of the tension among *topophilia*, love of land and nature, *technophilia*, fascination with technology, and *technophobia*, fear and remorse over the negative effects of technology. This conflict promotes the continued separation between technology and social systems in order to avoid witnessing the consequences of technical indulgence.

Technology vs Ecology

Infrastructure is generally forced upon the landscape with no consideration for the natural landscape and its ecology. From a biological standpoint, Lyle (1994) describes infrastructure as degenerative systems of linear, one-way flows that eventually consume and destroys the very environments that they are designed to support. Our system of storm water management, for example, typically involves a vast network of underground sewers eventually feeding into natural waterways. The sole purpose of this network is to control runoff, thereby limiting this system of infrastructure to a single-use. The ecological consequence of this system of storm water management is that urban runoff is a major contribution to water pollution – contaminants like oil from vehicles, heavy metals, toxic chemicals used in daily life, pesticides, herbicides and fertilizers are carried to natural waterways (figures 2.6) (Girling : 1996). Therefore, from an ecological standpoint, we cannot afford to continue to destroy our environments with our present form of infrastructure.

Economical Costs

The amount for building and maintaining our single-use infrastructure is economically costly. For instance, in the Vancouver region, the maintenance for one street lane per kilometre costs $10,000 per year, which does not include new construction, police service, and health care costs for air pollution and accidents (Suzuki: 1998). Another example of the cost of our infrastructure is evident in an analysis undertaken by the City of Winnipeg that concluded that present budgets to maintain major city streets and bridges is not adequate. An estimated $25 million per year is required to maintain the major street system for the City of Winnipeg in the "good" range on the Pavement Condition Index (figure 2.7) (City of Winnipeg: 1998). However, the current proposed budget and five year capital forecast allocates an average of approximately $10 million per year for major street repairs, rehabilitation, and replacement, leaving a shortfall of approximately $15 million annually. Under the City of Winnipeg's proposed level of funding, the resulting deferral of maintenance will change the average

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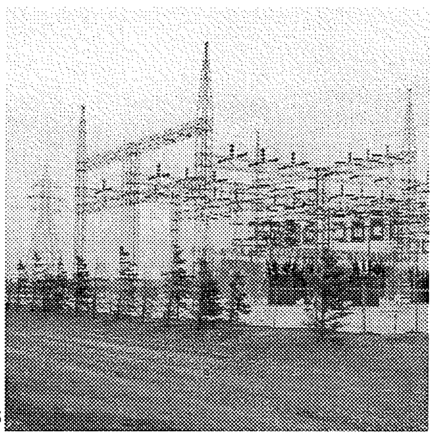

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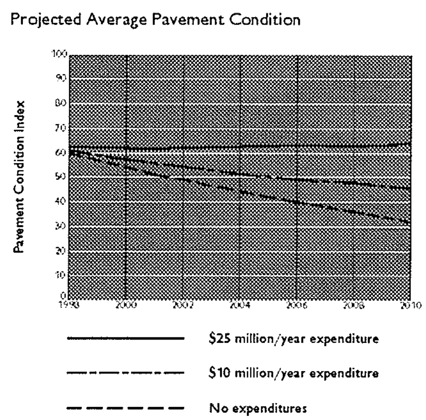


2.5 An attempt to screen a Hydro station with plantings, Winnipeg.

2.6 Contaminants entering a natural waterway.

2.7 Projected Average Pavement Condition for Winnipeg, 1998.

pavement condition to "fair" by 2010. Deferring street maintenance will have several consequences, such as streets that require more costly repairs than if general maintenance were carried out, and an increase in traffic accidents due to unsafe paving conditions, to name a few. Society cannot afford to sustain its present form of deteriorating infrastructure.

What is the Potential of Infrastructure?

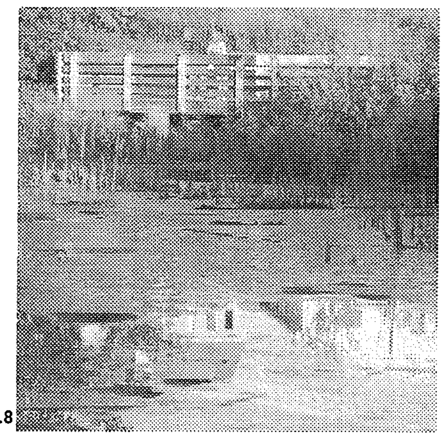
As essential components of our urban environments, the design of public infrastructure offers tremendous social, cultural, economical and ecological opportunities. Imagine an infrastructure that served as a park where a couple could go for a stroll, where kids could catch frogs, or where people could sit and admire the view, and that fulfilled functional roles. Envision an infrastructure that engages the public and becomes an element of everyday life. Picture a city that makes room for nature as well as urban life; the potential of infrastructure is endless. To explore these opportunities, we – the designers of infrastructure – must rethink the present single-use infrastructure as an innovative, creative, integrative and a multi-use form of infrastructure (figures 2.8-13).

The design of public infrastructure provides the opportunity for more professionals – engineers, architects, landscape architects, and artists, to name a few – to work together and rethink the role of infrastructure and the ways in which it is integrated with the built environment. It is clearly evident that we cannot continue to maintain our current single-use form of infrastructure. Therefore, there is a need to dissolve the boundaries between the design and engineering of infrastructure in order to create a new landscape aesthetic, not of the historic monumental type of infrastructure, but one that is expressive of process and place. ■

2.8 Heritage Lakes, Edmonton.

2.9 Water Pollution Control Laboratory, Portland.

2.10 Humber Bridge, Toronto.



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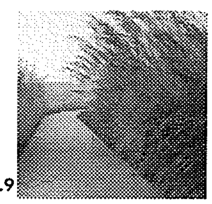

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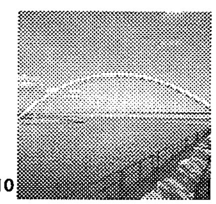

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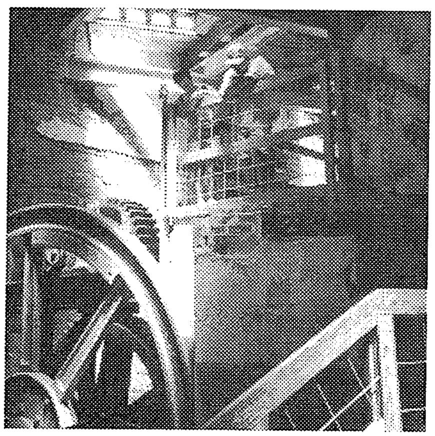

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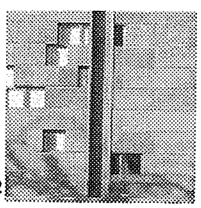

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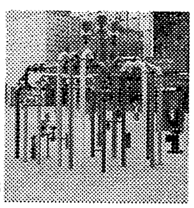

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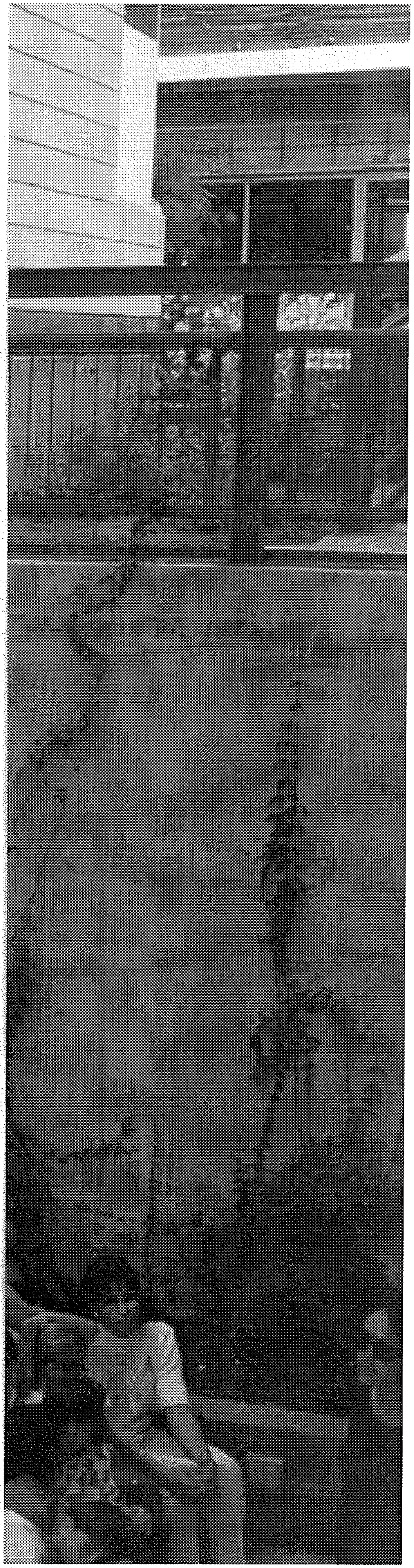
2.11 Waterworks, Philadelphia.

2.12 27th Avenue Solid Waste Management Facility, Phoenix.

2.13 Edmonton Street, Winnipeg.



"The New Infrastructure"

Ron Jensen, public works director, Phoenix

◂ **3.1** an amphitheater at the 27th Avenue Solid Waste Management Facility in Phoenix is used for public educational events.

3.0 how do we rethink infrastructure?

To achieve the goal of a new landscape aesthetic expressive of process and place, we must change the perceptions of infrastructure. *We*, the designers of infrastructure – engineers, landscape architects, artists, architects and the like – must explore the value of integrating infrastructure into the public realm and into the public perception. This is achievable by making infrastructure visible, designing collaboratively and making infrastructure meaningful.

Make Infrastructure Visible
Infrastructure that is visible and integrated with everyday life is meaningful. This visible form of infrastructure is *multi-use*, as opposed to the single-use system around which much of our infrastructure is designed. Designing public infrastructure to be integrated with the landscape, such as replacing the current sewer network with a system of streams and wetlands, is an example of a multi-use system.

Multi-use infrastructure provides the opportunity for visual, educational, and ecological activities to be integrated with infrastructure. A group of designers in Oregon accomplished just that; they developed a very visible ecological solution to storm water management for the Portland Water Pollution Control Laboratory (Thompson: 1999). A pond was designed to collect runoff, which originates from the site as well as from homes in the nearby 50 acre neighbourhood. Once in the pond, the runoff water infiltrates the soil where microorganisms help to break down any existing pollutants. The water then drains as ground water into the Willamette River. An overflow pipe bypasses the pond filtering system transports any superfluous water that may occur during very heavy storms. Besides the pond, bioswales are utilized on the ground in lieu of concrete catch basins, where runoff is slowed so that the soil can absorb it. They consist of channels lined with crushed stone and planted with lush wetland species. Besides groundwater runoff, rainwater from the roof of the research facility is directed to the bioswales. *Scuppers*, slender tubes affixed to the structure, direct water into the bioswales (figure 3.2). The water cascades from these pipes onto rocks below.

Designed to be integrated with the landscape, the Portland Water Pollution Control Laboratory project employs a multi-use system of infrastructure (figure 3.3). This very visible system of the stormwater management is integrated with natural and urban environments to create ecological and educational benefits from the water while functioning as a local collector of rainwater (figure 3.4). This approach will serve to regenerate the landscape of this neighbourhood into a vital and living part of people's experience of the city.

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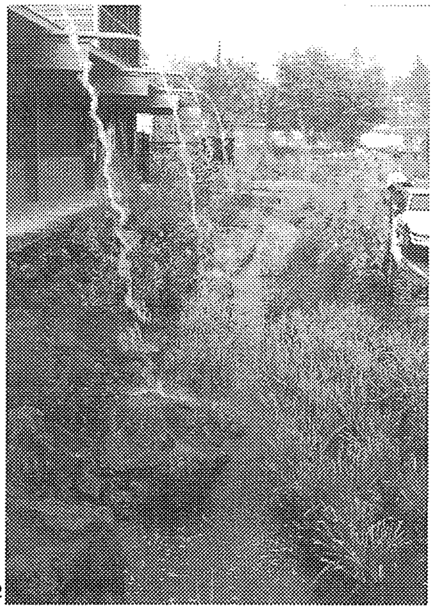

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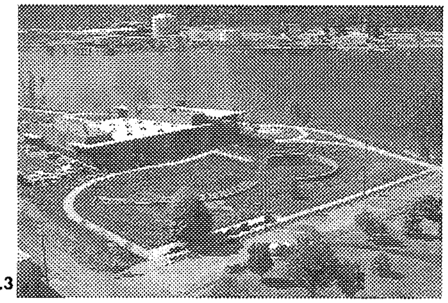

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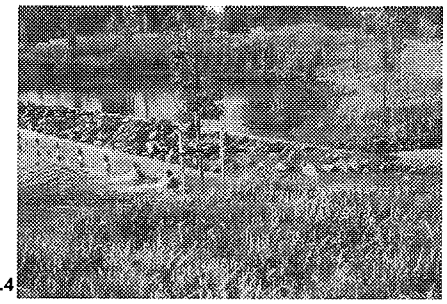
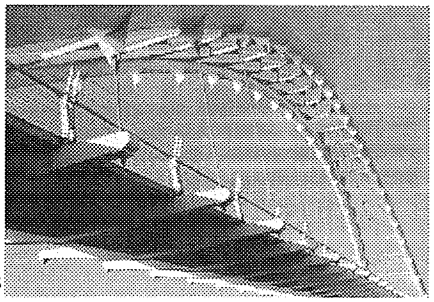


3.2 Scuppers direct rainwater into bioswale.

3.3 Water Pollution Control Laboratory after construction.

3.4 Stormwater in the flume.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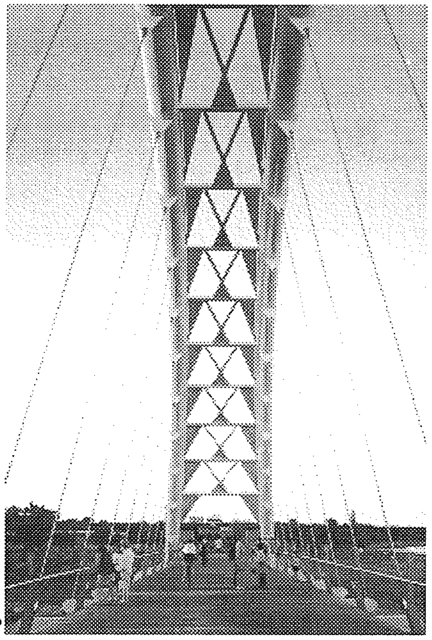
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Make Infrastructure Collaborative

A broad multidisciplinary approach to a project increases the knowledge base of the design team, opening the door for a greater range of opportunities. By freely exchanging ideas, engineers, landscape architects, artists, architects and the like may design infrastructure that succeeds on many levels. Such a group collaborated on the project outline and design detail of Humber Bridge in Toronto (figure 3.5). The historic significance of the site encouraged the client to establish a multidisciplinary design team (Carter: 1996). The project consisted of a series of bridges for both vehicular and pedestrian traffic at the point where the Humber River flows into Lake Ontario. The new bridge is designed for pedestrians and cyclists and is to serve as a landmark and gateway.

The Humber Bridge project transends the purely engineered approach to bridge design. The project not only fulfils its program requirements, but it also dramatizes its function and celebrates the public use of infrastructure through attention to design detail (figure 3.6). This accomplishment has been attained through the collaborative approach to infrastructure, where a multi-disciplinary design team worked together on the many stages of the project.

Avoid the Tack-on Approach

The benefits of a collaborative design approach to infrastructure can be lost if the design team does not work together through all aspects of the project. In an attempt to humanize infrastructure, the "tack-on" approach is often employed. This approach involves building a conventional engineered infrastructure project and then passing the work to an artist, for example, to decorate it with a piece of public art as a means of humanizing the project. In Phoenix, The Squaw Peak Parkway exemplifies everything that is wrong with the tack-on approach. The parkway is a five mile, six lane expressway, which included a $500 000 environmental art installation (figure 3.7). The freeway's alignment, soundwalls, and planting areas were defined by the engineers. Landscape architects and artists were brought to the project to decorate the freeway, rather than develop a true parkway. The walking trail is used by joggers; however, the park areas are under used by residents due to their strange shapes and proximity to the highway (Kroloff: 1995). Ted Cook, a landscape architect involved in the project, recognized the problem with the project: "There was no overall design philosophy controlling the project – if there had been, it might have been much better."

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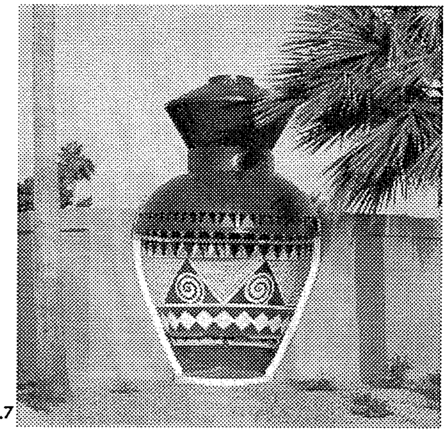

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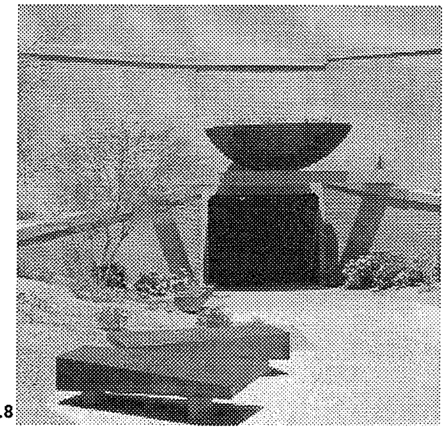

3.5 Bicycle pedestrian bridge, Toronto.

3.6 The structure of the bridge is intended to signal entry and movement.

3.7 Public art along the Squaw Peak Parkway, Phoenix.

3.8 A "placeless" parkway.

The Squaw Peak Parkway illustrates the lost opportunity of infrastructure if the engineers, landscape architects, and artists are not brought together to work as a team through all stages of the project. The project simply fulfilled its program requirements by employing public art. As a result, the under-used park lacks any sense of meaning to the area residents', as indicated by their absence. Instead, a very "placeless" parkway has been established (figure 3.8), which is overdesigned for the vehicle and underdesigned for the pedestrian. Had the designers of the parkway come together as a team, perhaps the unusual shaped park areas would have been resolved to meet the needs of area residents without affecting the flow of the expressway traffic.

Community Involvement

In order for the negative perceptions of infrastructure to change, the community must be encouraged to participate in the collaborative design approach. The diverse needs of the community which the project is to become a part of must be addressed in order for its potential to be realized (Brown & Morrish: 1995). The Main St.-Norwood Bridge Project, in Winnipeg, is an example of how the public was brought into the collaborative design approach (figure 3.9). After public out-cry against the new bridge proposal, a landscape architecture firm was brought to the design team in order to act as an interface between engineer and the public. In order to address some of the problems in communicating ideas with the public, the landscape architects to set up a series of public forums with the engineers to deal with the new bridge design. Through this process, the firm produced a series of walk throughs and fly-bys in order to illustrate to the public how the finished product will be perceived when constructed (figure 3.10). The communication of ideas and concepts of the bridge project to the public helped to change the negative perceptions of this project. Therefore, such participation increases the effectiveness and acceptance of the infrastructure project as a cultural amenity.

Make Infrastructure Meaningful

Placemaking is the transformation of spaces into places of meaning through physical design. As a professional practitioner of placemaking, it is a designer's knowledge of "place" and "placelessness" which is brought with them to the collaborative design team which opens the opportunity for infrastructure to reach its full potential. Unlike the Squaw Peak Parkway, the 27th Avenue Solid Waste Management Facility (figure 3.11), also located in Phoenix, instills a sense of meaning to its site. The facility was initially envisioned as a garbage transfer station where refuse would be sorted and then trucked to a regional landfill 20 miles away. A team of designers were brought in to review a preliminary scheme developed by an engineering firm. As a result, the designers reworked the project with the engineering firm to produce an amenity out of the necessity of recycling garbage. The revised design also shaved $2 million from the engineer's original budget estimates (Sorvig: 1995).

Unlike a typical engineered infrastructure project, the 27th Avenue Solid Waste Management Facility has become a place rather than an object. Rather than screen the project from view, the facility has been placed and designed to be highly visible. Within the facility, not only are functional requirements met, but educational ones are integrated throughout with observation windows, catwalks, and an amphitheatre (figure 3.1) overlooking the recycling floor. Aside from the structure of the project, the landscape was conceived as part of the whole design rather than as an after thought. As a result, the facility makes a connection to the landscape through a series of terraces and berms (figure 3.12), administrative and public spaces are merged with courtyards (figure 3.13) and views of the South Mountains and the Phoenix skyline are framed throughout the structure.

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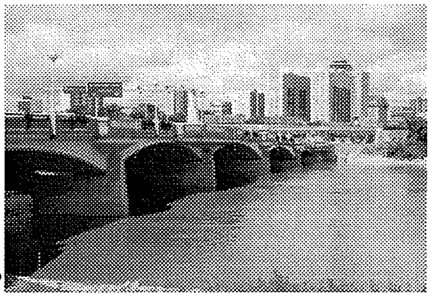

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3.9 Main Street-Norwood Bridge, Winnipeg.

3.10 Computer generated walkthrough of the project.

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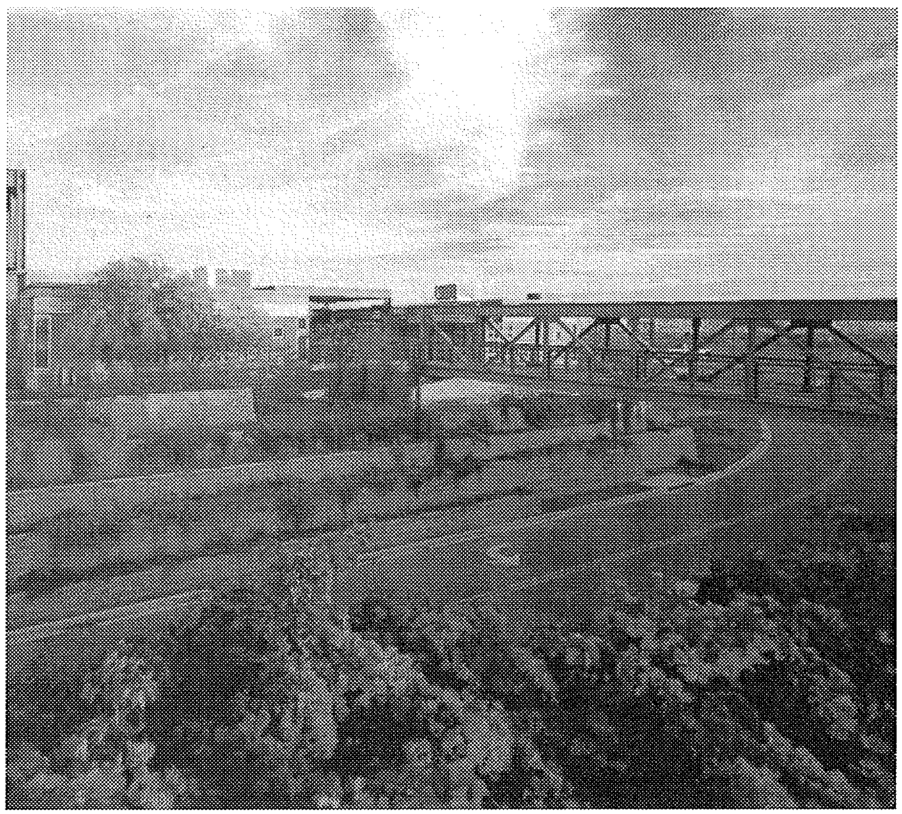

3.11 27th Avenue Solid Waste Management Facility, Phoenix.

The 27th Avenue Solid Waste Management Facility illustrates the benefits the involvement of designers, such as a landscape architect can have on an infrastructure project. Designers add to the design process by injecting creative thinking, crucial in turning an infrastructure project into so much more than an engineered object. Unlike engineers, who are trained to solve specifically defined problems, designers work with others to jointly discover the possibilities within a situation (Dunham-Jones: 1994). Most important, the designer's ability to work with others is an essential skill which can be used to educate and change people's negative perceptions of infrastructure.

Where are the Opportunities for Infrastructure?

Infrastructure, that is expressive of process and place, is attainable through the collaborative design approach. It is this type of approach that provides the opportunity for a multi-use form of infrastructure and contributes to changing people's perceptions. The examples illustrated are but a few of a number of recent projects that provide a glimpse into the future possibilities of infrastructure. It is clearly evident that infrastructure can become a cultural symbol rather than engineered objects devoid of cultural expression. ■

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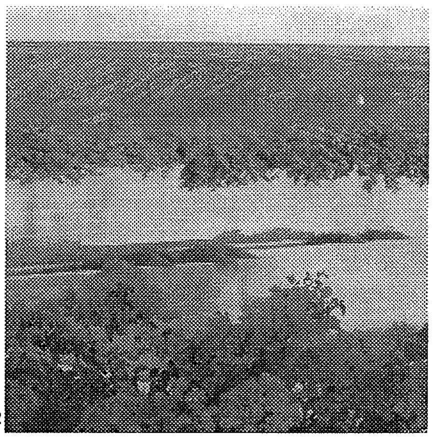

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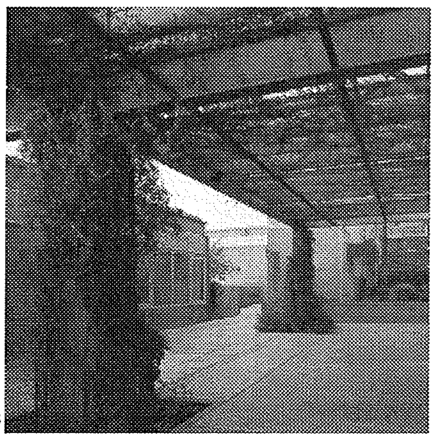
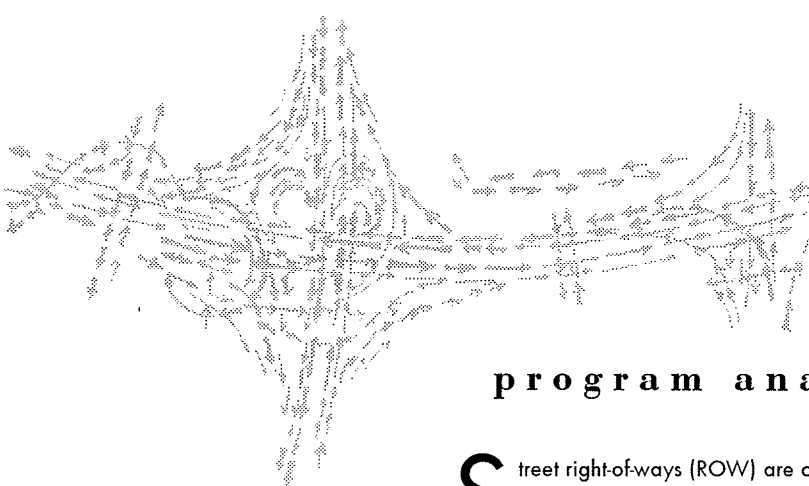


3.12 Terraces of the integrated landscape.

3.13 Courtyard space.

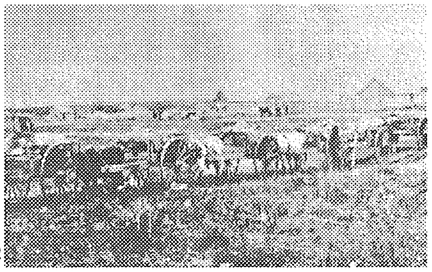
"Ghosts in the mist"
Winnipeg Free Press

◂ **4.1** City of Winnipeg workers paving and leveling concrete during a cool spring morning.



4.0 program analysis

Street right-of-ways (ROW) are classified in a hierarchy based on their function and design characteristics. The classification system is determined in Canada by Traffic Association of Canada (TAC) while in the United States, it is the American Association of Streets and Highways Traffic Organization (AASHTO). These classification systems have been modified by the Streets and Transportation Department of the City of Winnipeg to suit local standards. Each class of roadway has different cross-sectional design characteristics, including the number and width of lanes, width of ROW and width of pavement. This study, using Pembina Highway as a vehicle, will focus on the *major arterial street* classification. Here we will examine the existing conditions of the different systems of infrastructure as well as present design responses that serve to better integrate each system within the ROW.


4.2

History

Originally the Pembina Trail, Pembina Highway is the oldest trail in Western Canada. (Shipley: 1970). By the 1840s, this trail was serving as a highway for the business of freighting furs from Fort Rouge to St. Paul, Minnesota. Red River carts, pulled by an ox, cut a path that became the trail (figure 4.2). The driver could manage four carts for a brigade. When the brigades exceeded several hundred, creating a train, an experienced guide on horseback would command the entourage. The Hudson's Bay Company and local merchants made two round trips each year from Fort Rouge to St Paul, Minnesota.

Today, Pembina Highway, or Highway 75 South of the Perimeter Highway, now runs as far south as Dallas, Texas. Highway 75 provides access to U.S. Interstate 29 and Minnesota 94, approximately 100 km south of Winnipeg at the Emerson border crossing. Pembina Highway has evolved into a major arterial street or highway commercial strip where the automobile replaced the Red River cart (figure 4.3). Pembina Highway also serves as an arterial street for the neighbourhoods of Fort Rouge, Fort Garry and St. Norbert while linking the University of Manitoba to the downtown.

Geographical Patterns

As Winnipeg developed in an outward pattern from its core, Pembina Highway progressed in a southerly direction that has changed its geography over time. The major portion of Fort Garry remained an area of farms and market gardens until about the first decade of the 20th century when residential development began in the northern section.

Now four types of economic activities dominate the Pembina Highway: *hierarchial*, which serves the stable hinterland population, such as grocery stores and banks (figure 4.4); *highway-oriented*, which serves the mobile threshold population, such as gas stations and motels (figure 4.5); *urban arterial*, which serve space-extensive activities, such as lumberyards and nurseries (figure 4.6); and *specialized strips*, were competing businesses locate in the same proximity in the hope of attracting comparison shoppers (figure 4.7) (Ford: 1994). These economic activities combine to form the primary land-use pattern of commercial development along Pembina Highway. Other land-use patterns include parks, high-density housing, industrial developments, and community use such as schools and municipal offices.

Architecture

The architecture along Pembina Highway changed over time to facilitate the invention and acceptance of many new building types, such as gas stations, motels, and drive-thrus (figure 4.8). Clay Simpkins Cartage and Rental, once a business at 540 Pembina Highway, illustrates the new building type of the commercial highway (figure 4.9). This business opened in 1948 as Manitoba's first combination restaurant and service station (Solonecki: 1974). This business has since been demolished and replaced with a car dealership. In addition to the invention of the new building types, the architecture of the strip has been established to accept frequent and massive change. This site (figure 4.10) along Pembina Highway, has served numerous businesses – from a carpet store to a "virtual golf centre."

4.2 Red River cart train, 1870s, Manitoba.

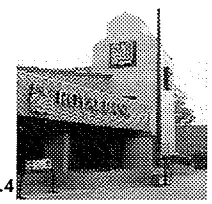
4.3 Pembina Highway: the commercial strip, Winnipeg.

4.4 Hierarchial.

4.5 Highway oriented.

4.6 Urban arterial.

4.7 Specialized strip.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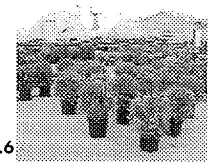
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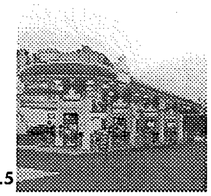
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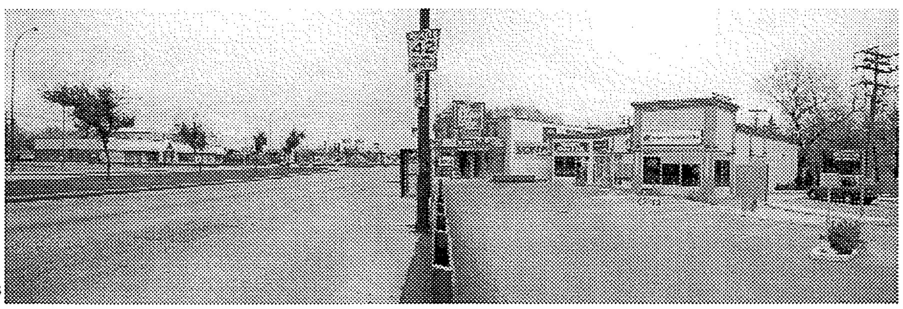
4.3

Existing Conditions

Figure 4.11 illustrates the existing location of underground and overhead services within the ROW of Pembina Highway at a given location. Surface infrastructure, such as paving, lighting and street trees, remain fairly consistently located within the ROW of Pembina Highway. However, the location of underground infrastructure may vary from block to block. This condition exists largely because Pembina Highway developed over a period of time, before the design standards were established. Examples include:

▸ The placement of the road was not determined by the traffic engineer, rather, Pembina Highway originally developed as a Red River cart trail. This trail evolved overtime into its present state, which has now been classified as a Major Arterial Street by the City of Winnipeg Streets and Transportation Department.

▸ Underground infrastructure, such as waste water and land drainage sewers, were placed in the ROW in a serendipitous manner – which ever utility arrived first, was able to position their infrastructure, and whomever arrived next, had to locate their in the left over space, and so on.

New Construction

If a Major Arterial street were constructed today, Figure 4.12 illustrates the standard layout that would apply. This cross-section was developed through the Underground Structures Committee, which consists of professionals responsible for the design of the utilities within the ROW. The placement of utilities within the ROW were coordinated with the primary design parameters of the traffic engineers – speed and capacity of travel (City of Winnipeg: 1991).

The specific design parameters for a major arterial street are as follows:

1. Function: designed to carry major traffic flows between major traffic generators such shopping centres, residential, commercial and industrial subdivisions.

2. ROW width: Spans 40 metres.

3. Traffic Lanes: Contains six lanes, however, it may be initially staged at four.

4. Direct access – to adjacent properties is not desirable and is normally not permitted.

5. Traffic Signals are used to control intersections.

6. Parking – permitted only where vehicular and traffic safety are not jeopardized.

7. Pedestrian movement – permitted at signalized intersections and pedestrian corridors. Sidewalks exist both sides of the street to accommodate pedestrians.

A summary of the basic geometric design criteria the design of a major arterial street:

▸ design speed: 80 km/h
▸ minimum radius: 280.0 m
▸ maximum superelevation: 0.04 m/m
▸ longitudinal gradient: 0.4 m min./5.0 m max.
▸ minimum tangent section length: 90 m
▸ minimum vertical clearance over all sidewalks is 3.35 m
▸ minimum vertical clearance over all street pavement is 5.0 m

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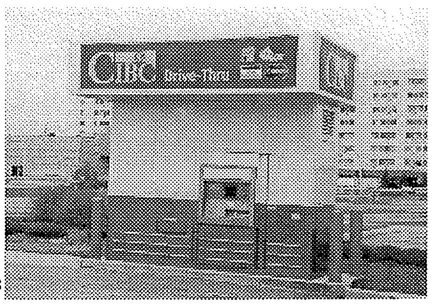

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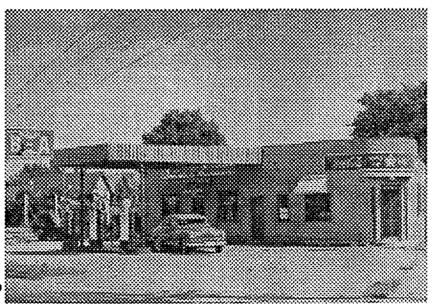
4.9


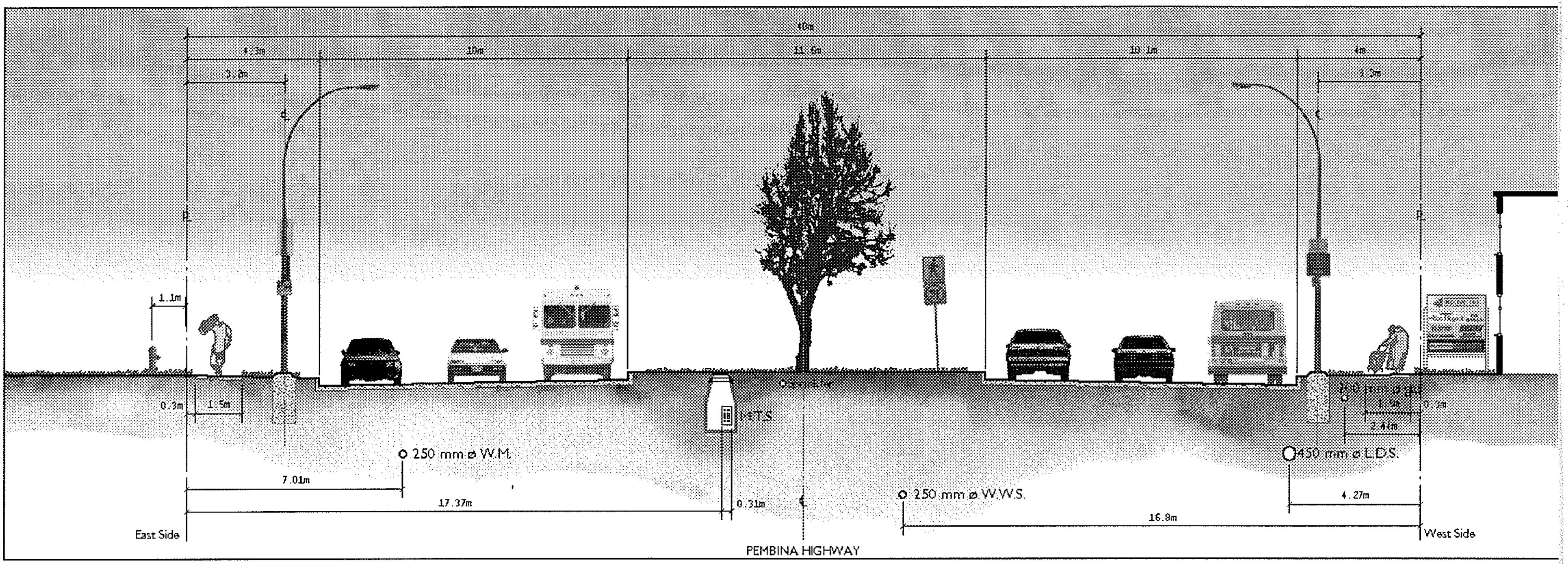
4.8 Drive-Thru bank.

4.9 Clay Simpkins Cartage & Rentals, 1948.

4.10 Typical commercial strip architecture.

4.11 Pembina Highway (existing conditions).

4.12 Major arterial Street (new construction).



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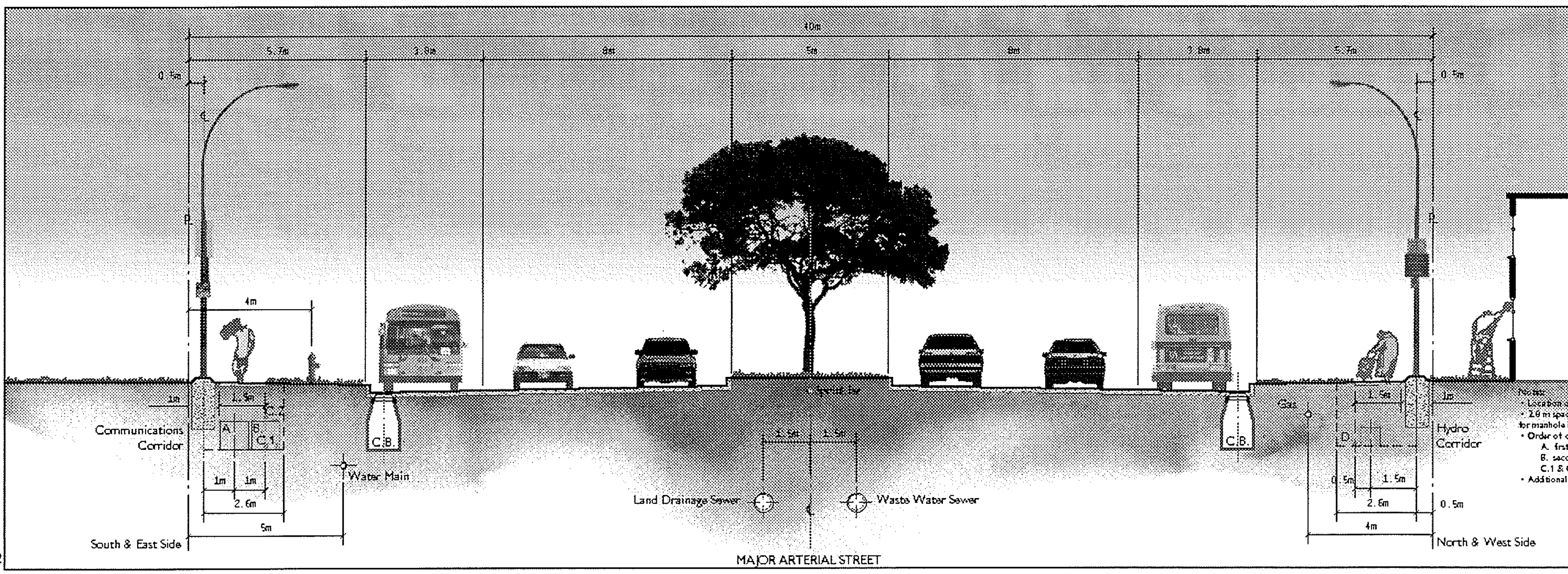


.12

It is clearly evident, with its wide traffic lanes, that the cross-section of the major arterial street is designed for efficient movement of vehicles. Now, let us examine each element within the ROW and determine a design response to each condition.

Program Analysis

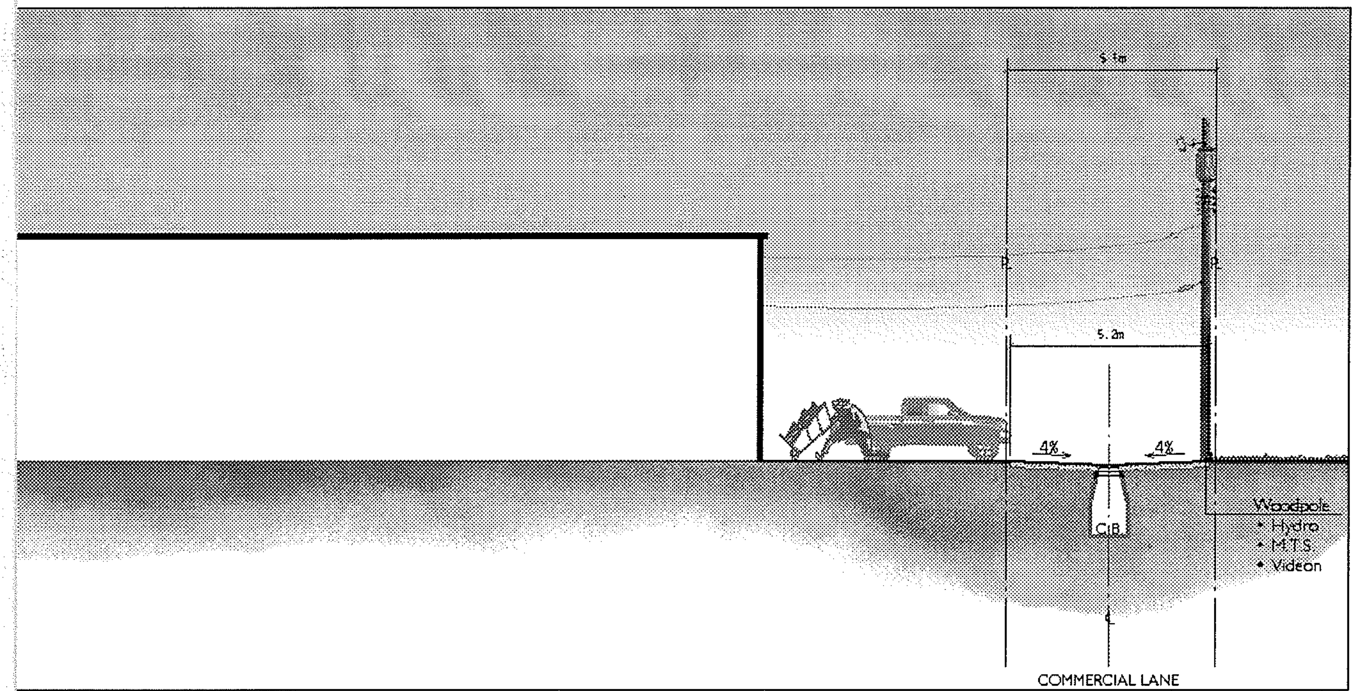
There are fourteen layers of infrastructure located within the ROW that must compete for space. They are:

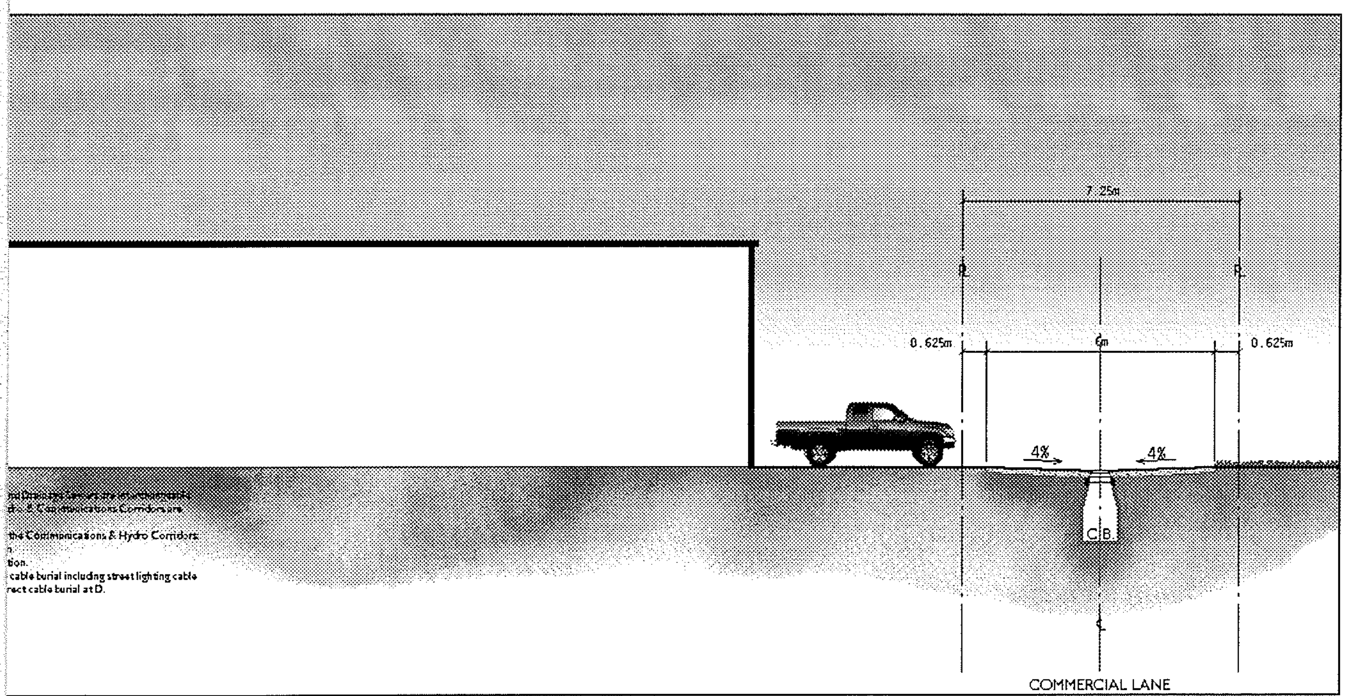
Paving
- street
- sidewalk
- bicycle facilities

Dry systems
- communications
- cable services
- electrical

Underground systems
- gas
- waste water sewer & land drainage sewer
- water

Miscellaneous infrastructure
- street trees
- street signs
- snow clearing and ice control
- traffic signals
- public transit





streets

Streets provide access to property, serve as linkages between land uses, and allow for the movement of people and goods. The primary objective in the design of any street system is to provide a safe, efficient and aesthetically pleasing access and circulation system for both the motorist and pedestrian. The City of Winnipeg has approximately 1,720 lane kilometres of regional streets, 4,350 lane kilometres of residential streets and 880 lane kilometres of back lanes. This network has a replacement value of about $1 billion, $2.6 billion and $373 million respectively (SIRP: 1998).

Components

▸ **Paved traffic lane:** usually reinforced concrete over a crushed limestone base and sub-base. This lane may have a layer, or series of layers, of asphalt overlays that serve to prolong the life and condition of the street.
▸ **Curb:** reinforced concrete

Maintenance

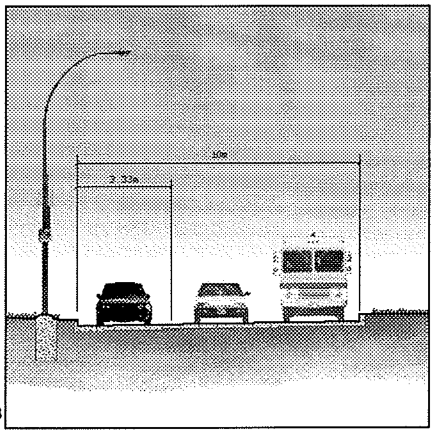
▸ Snow removal and ice control
▸ Pothole filling
▸ Sweeping
▸ Joint/crack repair
▸ Asphalt overlay: preventative maintenance that seals the concrete surface, restores drainage and can prolong the life of the street by 10-15 years.
▸ Complete reconstruction
▸ Annual surface distress surveys

Lifecycle

The lifecycle of a street in the City of Winnipeg is 25-30 years. However, through the use of overlays and concrete repairs, the City can increase this lifecycle by approximately 10-15 years.

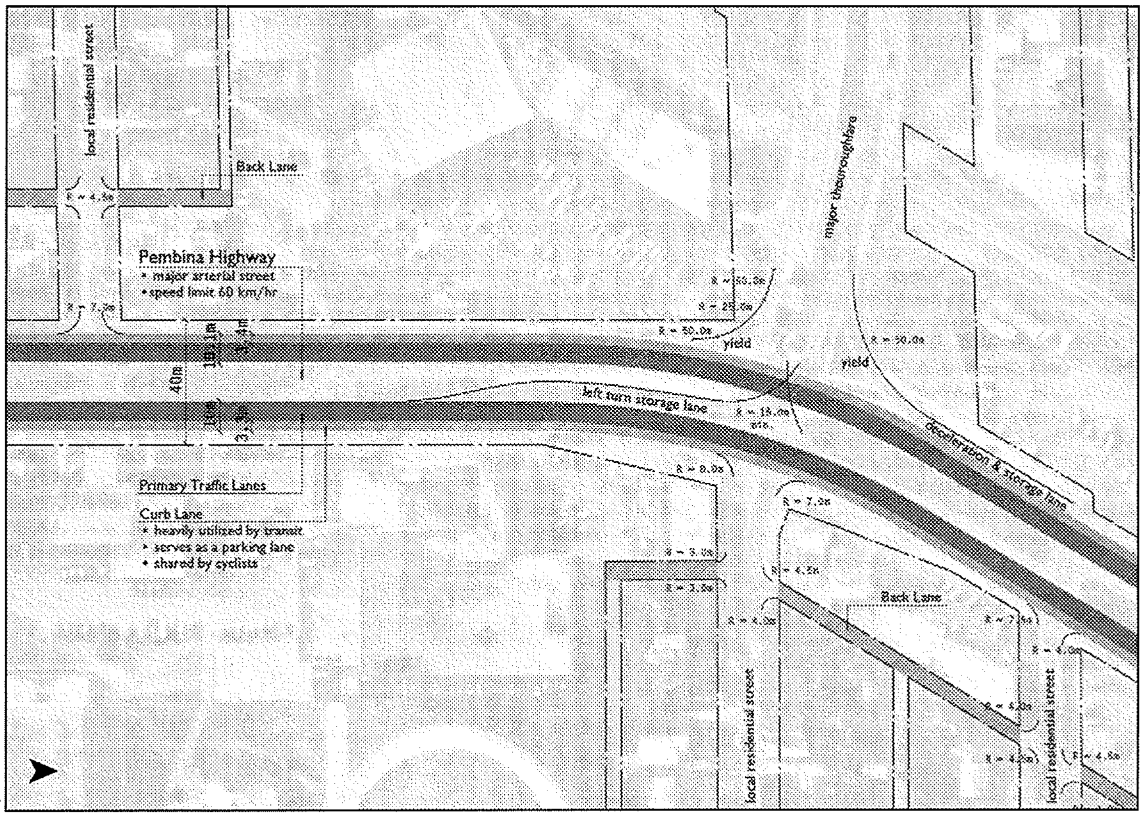
Problems

▸ Inadequate operating budget is causing undue deterioration of city streets.
▸ A repaired road, whether through maintenance or cutting for access to a utility, is never as good as the original. A replaced section of paving may not provide proper drainage and it is susceptible to moisture penetration. In addition to the repaired section of paving, the untouched pavement of the street may have developed microfissures as a result of cutting of the existing paving. These microfissures are areas that are susceptibility to moisture penetration and cracking.
▸ When construction costs are calculated, the social costs are not included. Examples of social costs due to street construction and repair include the loss of business, the impact of high traffic on alternative routes, and the cost of traffic delays, to name a few.
▸ Winnipeg's winter climate brings snow and ice to the city streets. Snow and ice affect the conditions of the road, such as causing slippery streets and road closure. As a result of winter climates, the City of Winnipeg must maintain a fleet of snow ploughs and ice control vehicles.
▸ De-icing materials are corrosive to the steel reinforcement of roadways, affecting the structural integrity and lifecycle of the street.
▸ Pavement *swelling* is caused by a freeze-thaw cycle to the soils.
▸ *Potholes* are created two ways. The first is where moisture penetrates an asphalt overlay at a crack where it affects the bond between the concrete and asphalt overlay, causing the overlay to fail and pop-out forming a pothole. The second cause of potholes is where moisture penetrates a crack along asphalt paving and freezes. The freeze-thaw cycle will then take its toll on the pavement surface, causing potholes. This problem is generally greater when there has been a wet fall, moisture freezes and is trapped during the winter months, thawing in spring.
▸ A short building season of city streets exists due to the winter months.



4.13

4.13 Existing traffic lanes, Pembina Highway.



4.14

4.14 Existing street conditons along portion of Pembina Highway.

Design Response

As a major arterial street, Pembina Highway has developed overtime to provide motorists with an efficient road system. However, the experience of the motorist along this street is lacking any visual interest and focus. An analysis of the street identifies the following design opportunities when rethinking the ROW:

Unit: the street must work as a unit with the other elements of infrastructure within the ROW to improve the experience of the motorist (figure 4.15). For example, a bikeway located adjacent to the street will provide an area for snow storage in the winter. This bikeway could provide a set-back for trees from the road to improve the driver's line of site, which would serve to increase safety along the street.

Location: Consider alternatives to the standard street pavement layout within the ROW. Figure 4.16 is one example of how the street can be placed differently within the ROW than the current standard recommends to allow for other opportunities such as a recreation corridor that will improve the street.

Definition: The most desirable human environments are those where there is a relatively strong degree of spatial enclosure (figure 4.17). The definition of the street is achievable through vertical elements, such as trees and building, strategically placed within the ROW.

Design Speed: The standard design speed of a major arterial street is 80 km/hr, which warrants an ideal lane width of 4.0 m. The existing speed limit along Pembina Highway is 60 km/hr, and its lanes are 3.33 m ± wide. Therefore, rather than apply the standard lane width, consider the actual speed of the road to be designed. Keep in mind that this standard is negotiable as it is primarily based on levels of driver comfort and not safety. Reducing paving without compromising driver safety feature these benefits:

- Slow and reduce runoff loads on our drainage systems.
- Provide more space for other design opportunities, such as a recreation cor ridor as illustrated in figure 4.16.
- Less paving means less material costs.

Sight/Stopping Distance: the design of a safe and efficient street depends upon the ability of the driver to see ahead while moving along the roadway. ■

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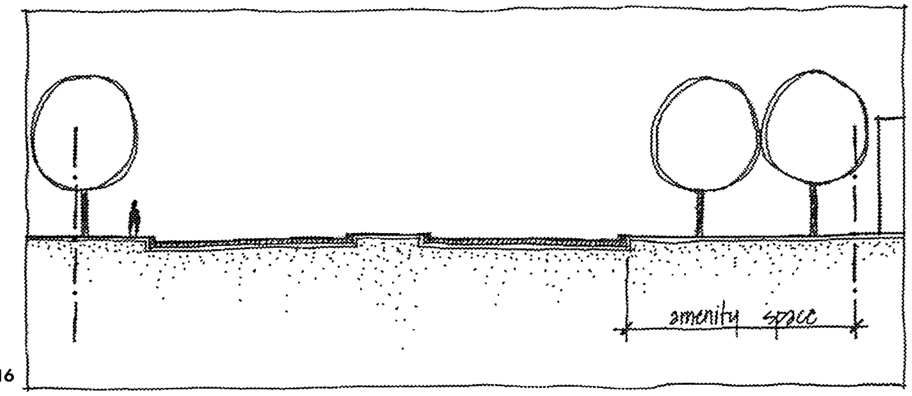

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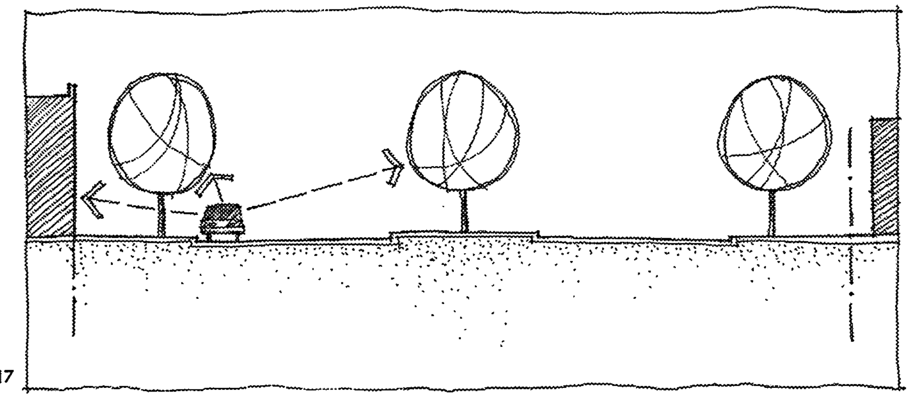

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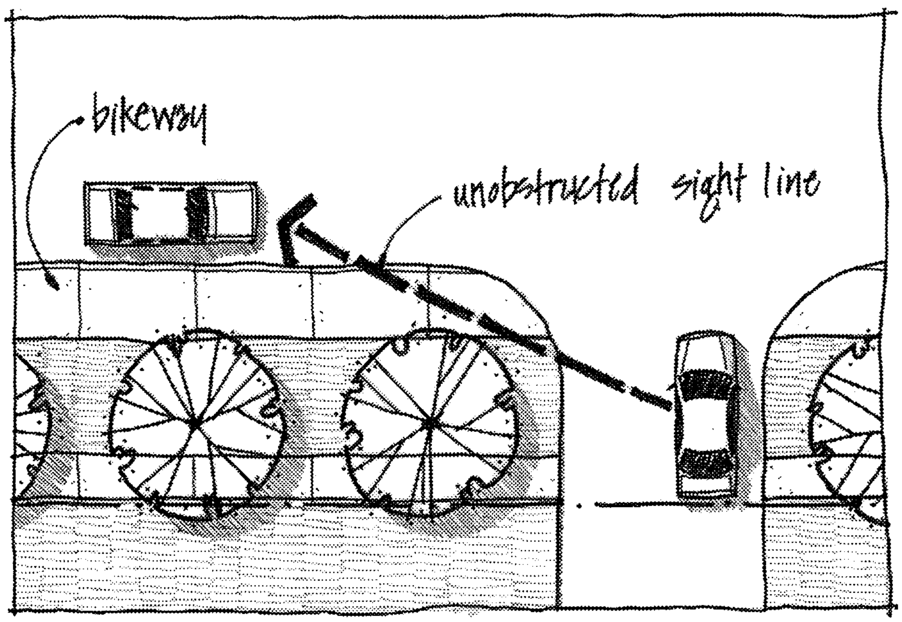
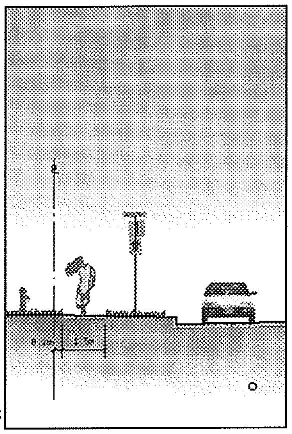


4.15 Working as a unit.

4.16 Locate traffic lanes to create an amenity space.

4.17 Definition – creates visual interest and focus.

sidewalks



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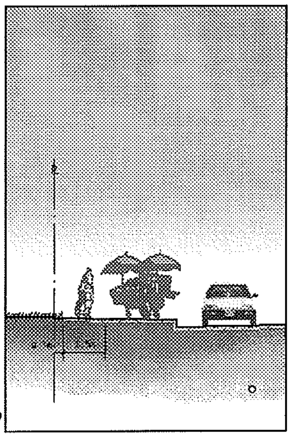


4.19

The sidewalk provides access for people to circulate through the urban landscape. The City of Winnipeg has approximately 3,100 kilometres of sidewalks which has a replacement value of roughly $163 million (SIRP: 1998).

Components

- **Path:** usually constructed of non-reinforced concrete over 100 mm base of crushed limestone. Pavers laid over a lean concrete base may also serve as a sidewalk surface. The preferred grade of a sidewalk is from 0-3 %, with 5% being the maximum. The typical cross slope of a sidewalk is 2%.
- **Boulevards:** provides a buffer zone between the pedestrian and vehicular traffic. This area may either be grass or paved (figures 4.18-19).

Location

Sidewalks are placed into the leftover space between the street and the ROW. The minimum design guideline width of a sidewalk in the City of Winnipeg is 1.5 m (figure 4.20. This provides enough room for two adults either to walk abreast or to pass each other on the path. The sidewalk is placed 0.3 m from the property line with grass boulevards reserved for trees and utilities. This off-set from the property line gives the pedestrian space along the sidewalk so they do not to brush a wall with their shoulder (Pushkarev: 1975).

Maintenance

Sidewalk maintenance is achieved in two ways: in conjunction with street maintenance and as stand-alone projects. Here are the maintenance requirements of sidewalks:

- Snow ploughing and sanding.
- Asphalt mending is used as a temporary method of maintenance.
- Sweeping occurs in the spring along high pedestrian areas only.
- Complete reconstruction of the sidewalk.

Lifecycle

- Concrete sidewalk **25-30 years**

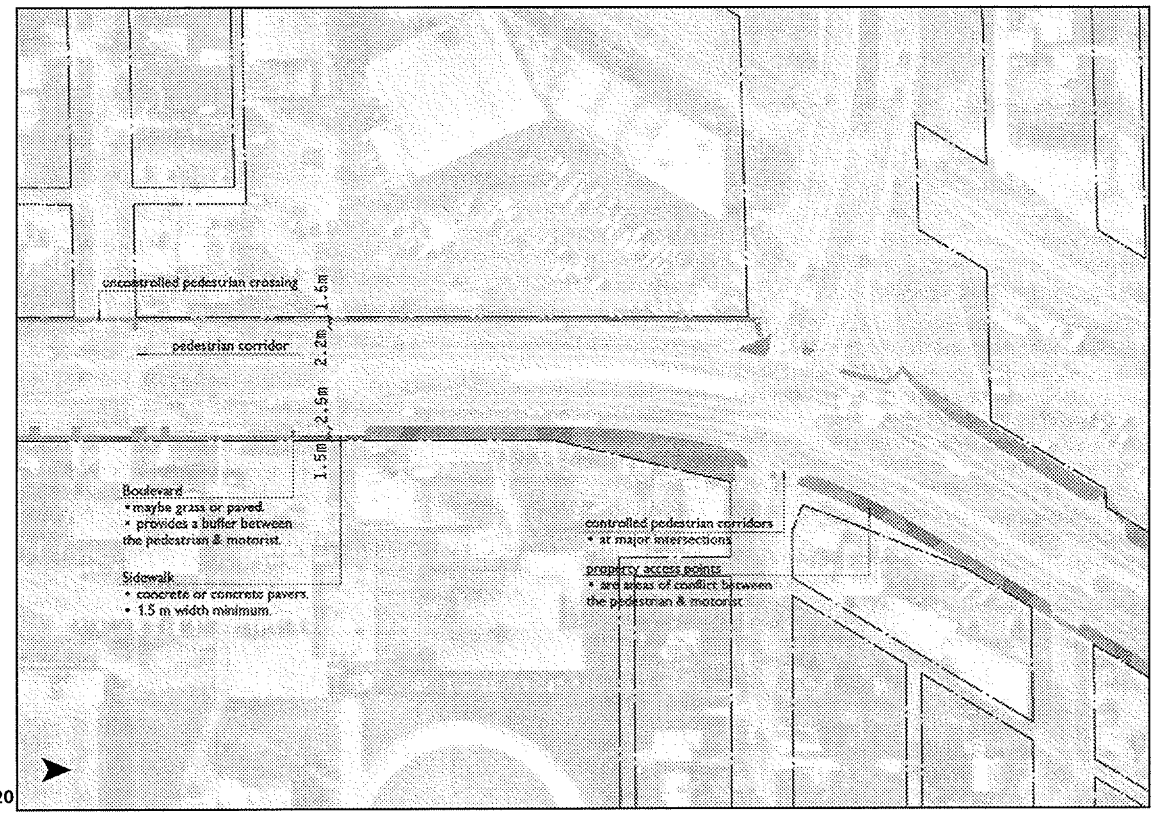
Problems

- Heaving, or kicking of sidewalks occurs when the ground heaves under the pavement.
- Compaction of base materials is not possible adjacent to buildings.
- Winnipeg's winter climate brings snow and ice to the city sidewalks. Snow and ice affect sidewalks by causing dangerous conditions such as slippery sidewalks, or high amounts of snow will make sidewalk unusable, to name a few examples. As a result of winter climates, the City must maintain a fleet of snow ploughs and ice control vehicles.
- A short building season of city sidewalks exists due to the winter months.

4.18 Typical sidewalk with grass boulevard.

4.19 Typical sidewalk with paved boulevard.

4.20 Existing sidewalk conditons along portion of Pembina Highway.



4.20

Design Response
The sidewalks along Pembina Highway serve pedestrian circulation. However, there is no consideration for the experience of the pedestrian along this street. An analysis of the sidewalk identifies the following design opportunities when rethinking the ROW:

Unit: The sidewalk must work as a unit with the other elements of infrastructure within the ROW to improve the experience of the pedestrian (figure 4.21). For example, a bikeway located between the sidewalk and the street will provide a buffer, which will serve to improve pedestrian comfort. In addition, trees or a bioswale could be placed to create a greater horizontal as well as vertical buffer for the pedestrian from the street. Besides working as a unit with other elements to provide a buffer, the sidewalk can be utilized as a location for underground infrastructure. When maintenance crews have repaired infrastructure located beneath a sidewalk, the impact on traffic is significantly less than if the repair were to occur on the street.

Access: Sidewalks must be accessible to all types of pedestrians as well as required maintenance vehicles. Therefore, curbs and other barriers must not prevent pedestrian movement where desired.

Definition: The most desirable human environments require a relatively strong degree of spatial enclosure (figure 4.22). The definition of the sidewalk is achievable through vertical elements , such as trees and building strategically placed within the ROW.

Sensory Factors: engaging the senses — sight, smell, sound, touch and taste – will add to the delight of the pedestrian experience (figure 4.23). This is achieved by creating interest and focus for the pedestrian through plantings, surface textures, and other various elements within the ROW.

Amenities: considerations for human comfort will allow people to sit and walk in leisure (figure 4.24). Considerations such as trees offer sunlight and warmth when it is cool and shade and warmth when it is cold. Trees as well as other plantings, architecture, and meaningful detailing will also provide visual interest for the pedestrian, which will improve the experience of the sidewalk. ■

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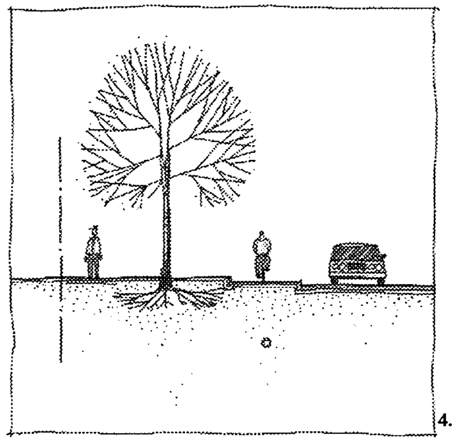

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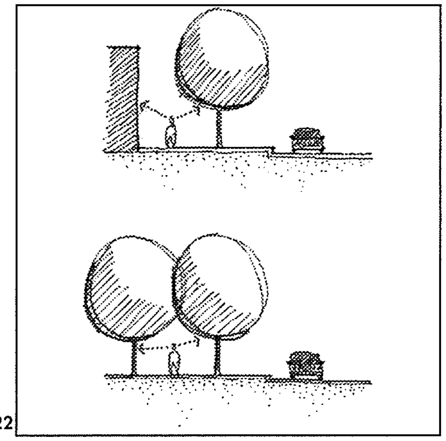

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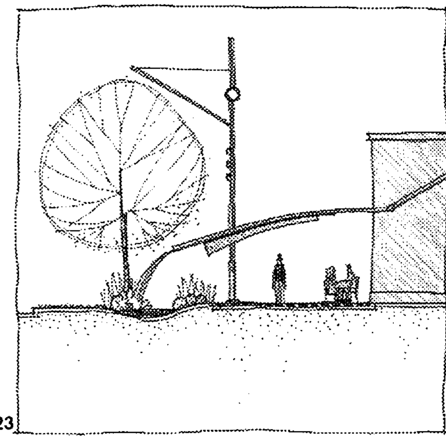

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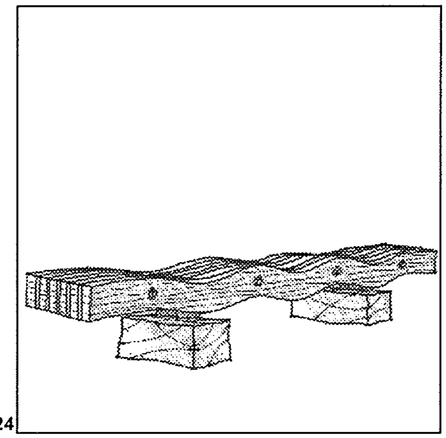


4.21 Working as a unit.

4.22 Definition – provides visual interest and focus, as well as improves pedestrian comfort.

4.23 Sensory factors.

4.24 Amenities with attention to design detail.

bicycle facilities

Bicycle infrastructure, or a *bikeways*, do not exist within the Pembina Highway ROW (figures 4.25-26). However, where they do exist, they may be classified as either of the following (City of Winnipeg: 1993):

Bicycle Paths (Class I) type of bikeway placed away from the street to create a separate facility for the cyclist (figure 4.27).

Bicycle Lanes (Class II) type of bikeway where there is a portion of roadway designated for the cyclist. This lane is delineated by pavement markings and signage (figure 4.28).

Bicycle Routes (Class III) type of bikeway where the roadway is shared by the cyclist and motorist. A road is identified as a bicycle route when it provides continuity with other cycling facilities or when it is a preferred route by cyclists through a busy corridor (figure 4.29).

The design standard for a bikeway, like the design of a roadway, is largely determined by the volume and type of traffic and speed of bicycle travel.

Components

- Path with an asphalt, concrete or crushed limestone surface. Paths with grades greater than 5% are undesireable as cyclists find ascents difficult The following path widths are recommended for the design of bikeways in the City of Winnipeg:
  - Shared lane **4.3 m**
  - Separate path:
    - one way **2.5 m min.**
    - two way **3.0 m min.**
  - Signage
  - Barriers/separators

Maintenance

- Paved surfaces require sweeping, repainting of lines, and surface restoration.
- Crushed limestone surfaces require scarification, smoothing, and compaction of the upper layer to maintain an even surface. Additional material is added to the surface every few years.
- Sign maintenance.

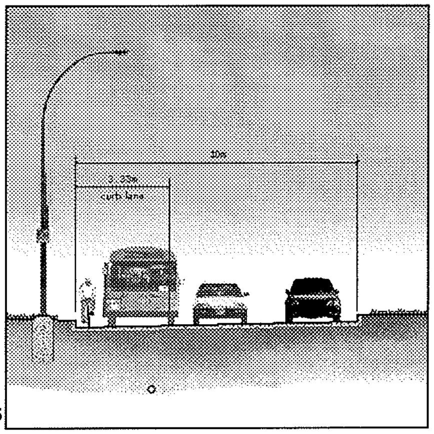
Lifecycle

The lifecycle of a bikeway is dependant on its materials and various site conditions:

- Asphalt path **20-25 years**
- Crushed limestone path **5-10 years**

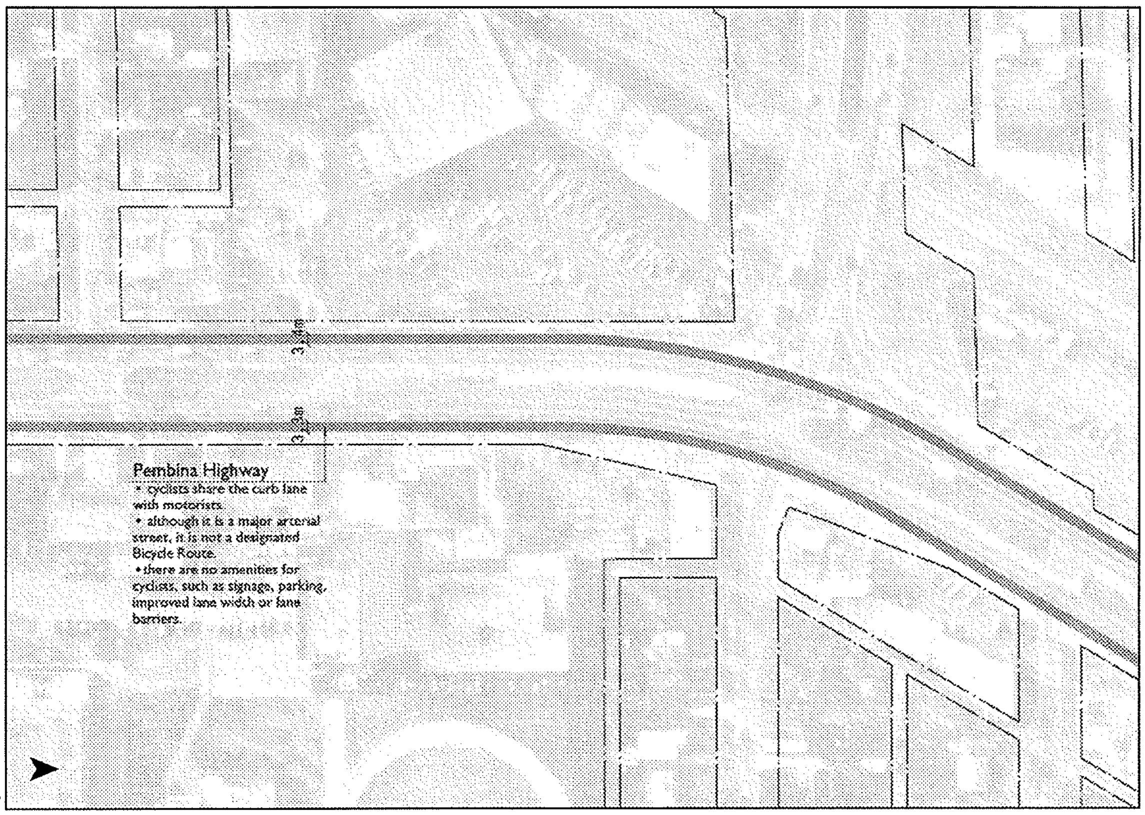
Problems

- The absence of facilities along a major arterial street such as Pembina Highway is a problem. Where bikeways exist, there is usually a lack of connectivity between them.
- The narrow lane widths of many existing roads contribute towards a decreased level of comfort for the cyclist, particularly when vehicle traffic is heavy.
- Intersections that contain turning lanes and merging and weaving traffic pose dangers to the cyclist.
- Drainage grates with slots running parallel to the path or asphalt cracking that occurs parallel to the path pose a danger to cyclists as their wheels may become lodged in the crack.
- Accidents occur between the automobile and the cyclist.
- Asphalt paths are susceptible to cracking due to subsoil movement, which results in costly maintenance and repair.
- Concrete paths are expensive to install.
- Crushed limestone paths are not suitable for all types of recreation.



4.25

4.25 Typical conditon for cyclist along Pembina Highway.



4.26

4.26 Existing bicycle conditons along Pembina Highway.

Design Response

As a Major Arterial street, Pembina Highway offers many bicycle traffic generators – schools, parks and recreation facilities, community activity centres, employment concentrations, and shopping and commercial centres – within the desired cyclist range of 5-10 km (Harris & Dines: 1988). The design of a bicycle facilities within the ROW requires the following considerations:

Unit: As detailed for the street and sidewalk, bicycle facilities must work as a unit with the other elements of infrastructure to improve the quality of the ROW.

User Groups: There are primarily two types of cyclists that must be considered for the design of a bikeway – *commuter* and *recreation*. However, a greater range of design opportunities can be established by including other user groups – joggers, inline skaters, to name a few. This multi-use approach to design allows for the development of a *recreation trail*, rather than a bikeway (figure 4.30).

Adequate Space: the width of the path must be designed to accommodate the speed, volume and type of traffic. As well, the path must be clear of obstacles.

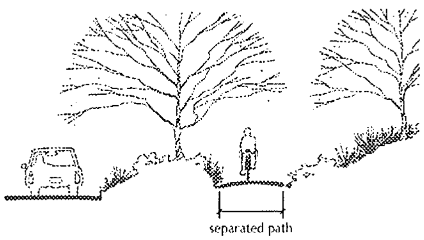
Design Speed: is based on the preferred speed of the faster cyclist. In general, the a minimum design speed on paved bikeways is 35 km/h.

Sight/Stopping Distances: the physical distance required by the cyclist to see an obstruction and come to a complete stop must be accommodated.

Surface Materials: Asphalt or concrete provides a smooth, stable surface, making them the preferred material for most bikeways. Crushed limestone paths must be avoided within the ROW as they are not suitable for all types of bicycles and other types of recreational uses.

Protection: From a painted line, to a 150 mm concrete curb, to a 0.8 m New Jersey barrier, these devices offer varying forms of protection from hazards for the cyclist.

Amenities: considerations for human comfort and convenience will enhance the experience of those using the bikeway. Tree canopies over the bikeway, for example, will offer shade for the cyclist as well as reducing the amount of rainfall reaching the cyclist as much as 20 - 40 %. In addition to human comfort, conveniences for the cyclist, such as bicycle racks for parking and rest stations, will ensure the bikeway as an amenity. ■



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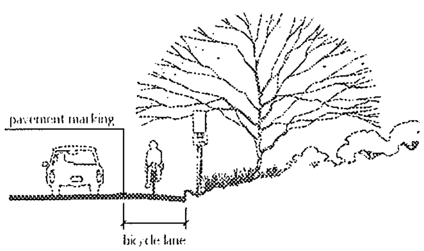

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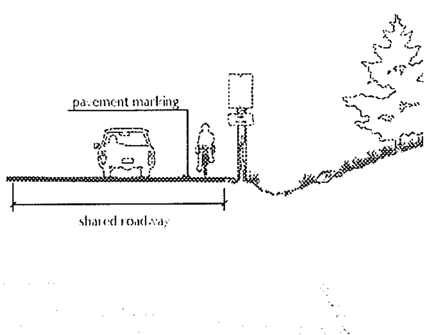

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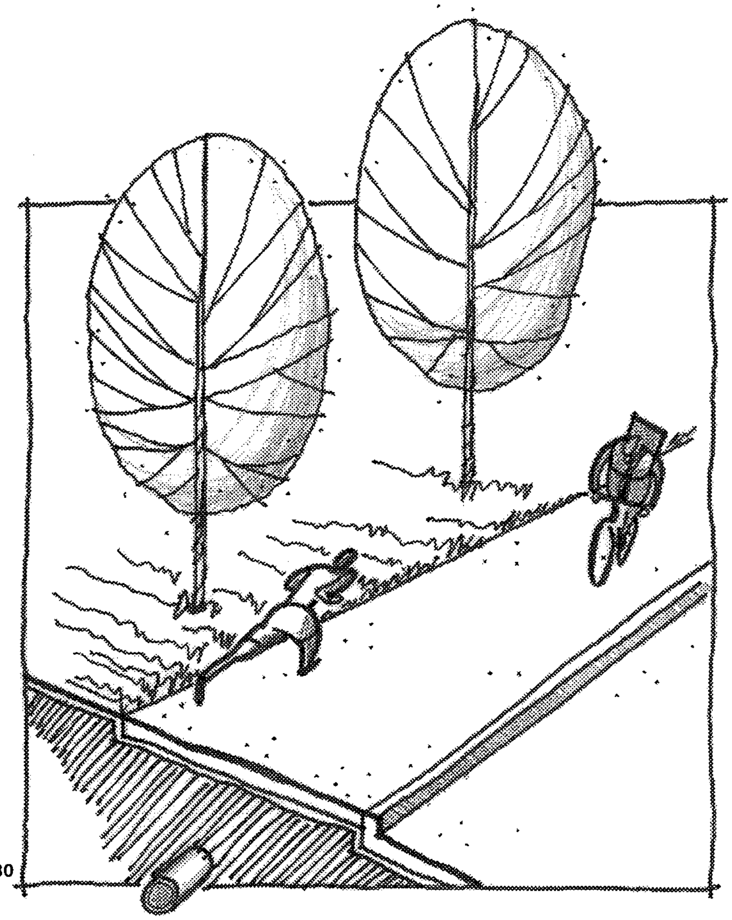


4.27 Class I – separate facilityt.

4.28 Class II – delineated path.

4.29 Class III – shared roadway.

4.30 Shared recreation path.

communications

The primary provider of communications infrastructure is Manitoba Telecom Services Inc. (MTS). This private utility offers an extensive range of local, longdistance, wireless, directory and online multimedia services through an all digital province-wide network.

Distribution can begin at any phone in the city. A computer converts the audio signal to a light pulse. This pulse is carried by fibre optic cable to a series of switches, where they are received at a central office. From here, the signal is routed to their destination point through a series of switches, via fibre optic trunk cable. At the destination point, another computer converts the light pulse back into an audio signal.

Components

Plastic insulated copper cable and fibre optic cable are the primary components of the communication network of infrastructure. This cable is located within the ROW either overhead or underground:

▸ **Overhead distribution** (figure 4.31) is achieved using wood poles, where the cable is affixed. Hydro and/or Videon cable may also share the wood pole. Along with cable, metal boxes attached to the poles, will contain other elements that support the communications network, such as switches, splices and amplifiers.

▸ **Underground distribution** (figure 4.32) may either consist of direct buried cable or cable that is placed within a concrete conduit. This concrete conduit will contain a number of pipes (65 mm PVC) where the cable will be placed within. Manholes, which are approximately 1.5 m width x 3.0 m length x 1.8 m deep, provide access points to this underground distribution system. Pedestals placed above ground within the street ROW house elements such as switches, splices and amplifiers.

Location

The standard location of communication services within a major arterial street ROW places it under the south and east sidewalk. However, along Pembina Highway, the primary communications corridor is located underground, within the median boulevard, while the distribution lines are located overhead along the back lanes (figure 4.33). Underground cable is typically placed at a depth of 1.0 ± m.

Maintenance

Underground services:

▸ Inspections occur at manholes that are ten years or older.

▸ Damaged cable contained within conduits is replaced with new material.

Overhead services:

▸ Require annual maintenance and inspections. Bucket trucks and ladders access are utilized for gaining access to overhead services.

Lifecycle

▸ Overhead services **15-20 years**

▸ Underground direct buried cable **20-25 years**

▸ Underground conduit services **25 years or more**

Problems

▸ Digging by third parties damage pipe.

▸ Digging can damage or cut cables.

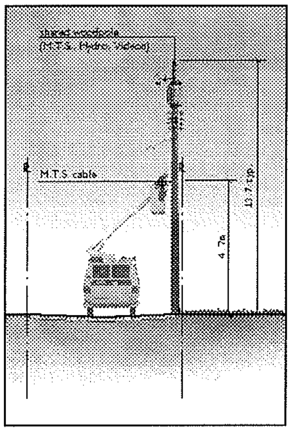
▸ Vehicles coming in contact with poles can cause damage.

▸ Trees can damage overhead services.

▸ Snowploughs can damage pedestals.

▸ Cable will be degraded by water only if its integrity has been broken.

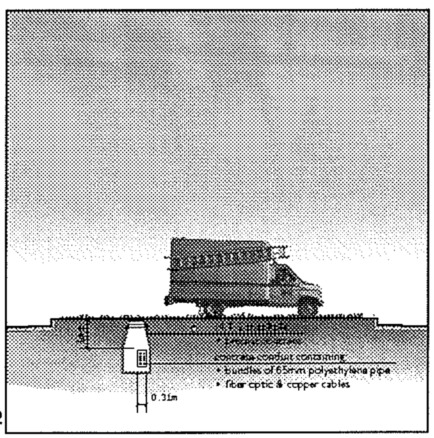
▸ Overhead services can be affected by a number of climatic factors. For example, icing and wind can bring down cable and disrupt service.



4.31

4.31 Overhead distribution.

4.32 Underground distribution.



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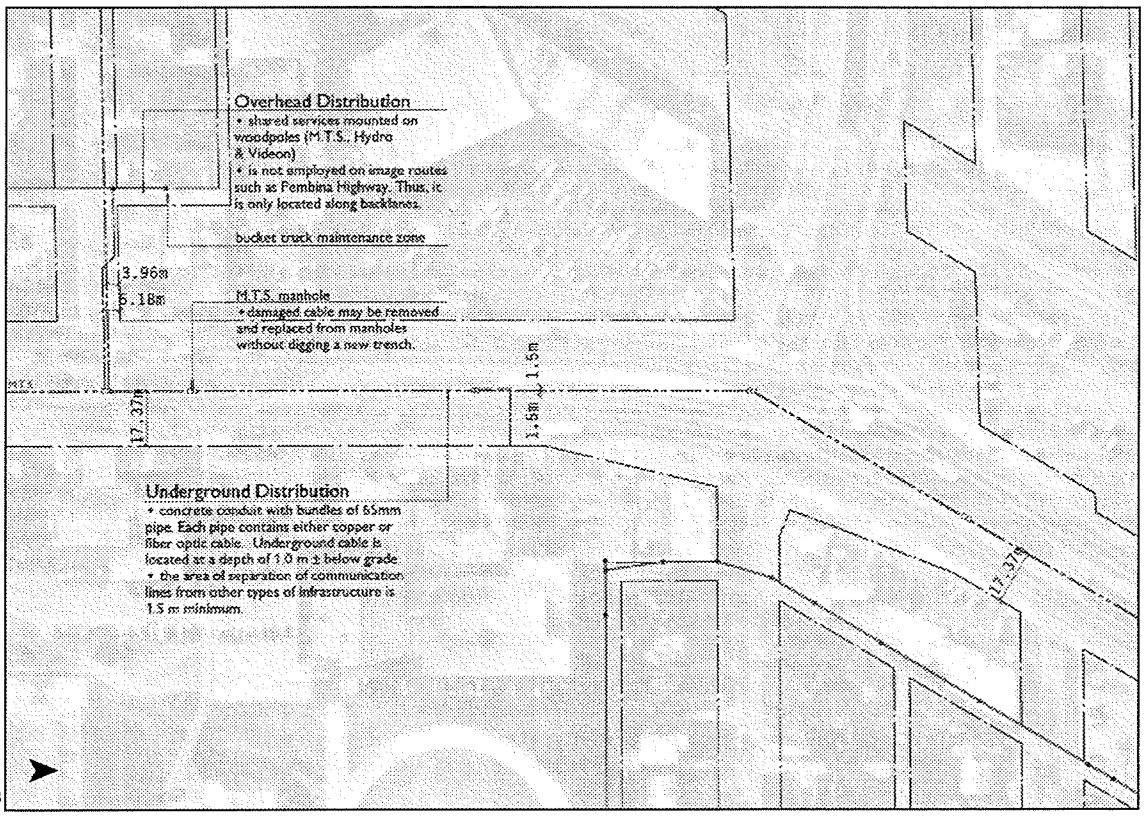
4.33 Existing communication utilities along portion of Pembina Highway.



4.33

Design Response

Dry services such as cable television, communications and electrical utilities may go either under or above ground. An analysis of these dry services identifies the following design opportunities:

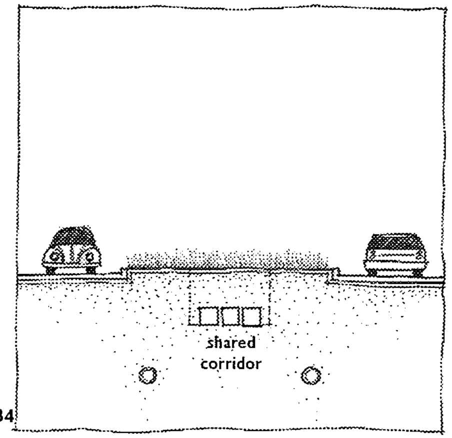
Unit: As previously described, communications infrastructure can be located underground in a trench or overhead attached to woodpoles (figures 4.34 - 35). This utility will share distribution locations within the ROW with cable and electrical systems. By space sharing with within the ROW, the amount of space required for distribution and servicing of utilities is minimized. This result is not only cost effective, but frees more space for other opportunities within the ROW, such as spatial requirements for trees.

Location: Sidewalks are good locations for underground services, such as a communications corridor. Here the corridor is easily accessible as the sidewalk provides an area for maintenance needs.

When these utilities are located overhead, they cost one-tenth that of underground ones. Locating services overhead requires a number of considerations, the first being the relation to the street. A pole for overhead services must be located away from the road to minimize the effects of a vehicle collision into it. The second consideration of locating overhead infrastructure is its proximity to trees. Trees must not interfere with overhead lines, as fallen branches may pull down a cable, cutting off service. This condition will result in tree pruning or removal if it is considered to be a potential problem.

Amenity: These utilities have the potential to be amenities within the ROW. When utilities such as communication lines are located underground, their manholes are visible. These become opportunities to add to the delight of the street through meaningful detailing. Figure 4.36 is an example of a manhole cover in Seattle, on which there is a map of the city and an indication "you are here." This manhole cover illustrates how meaningful detailing will improves the pedestrian experience of the street by providing direction and adding a sense of delight to the street.

The primary reason for placing utilities underground is aesthetic – because "it looks better". Instead of treating this overhead infrastructure as if it were an eyesore, consider additional uses to be part of its design mandate. To illustrate, the area where the pole of the overhead structure emerges from the ground becomes plaza space that will support a variety of roles – market garden, outdoor cafe, magazine stand and vendors (figure 4.37). These small businesses can plug into these structures and set-up temporary shops, or adjacent property owners may have their businesses spill out onto these plazas. As a result, people will be able to interact in a positive manner with this infrastructure rather than having it screened from view. ■



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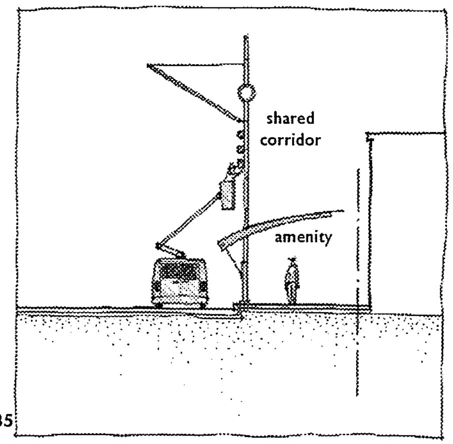

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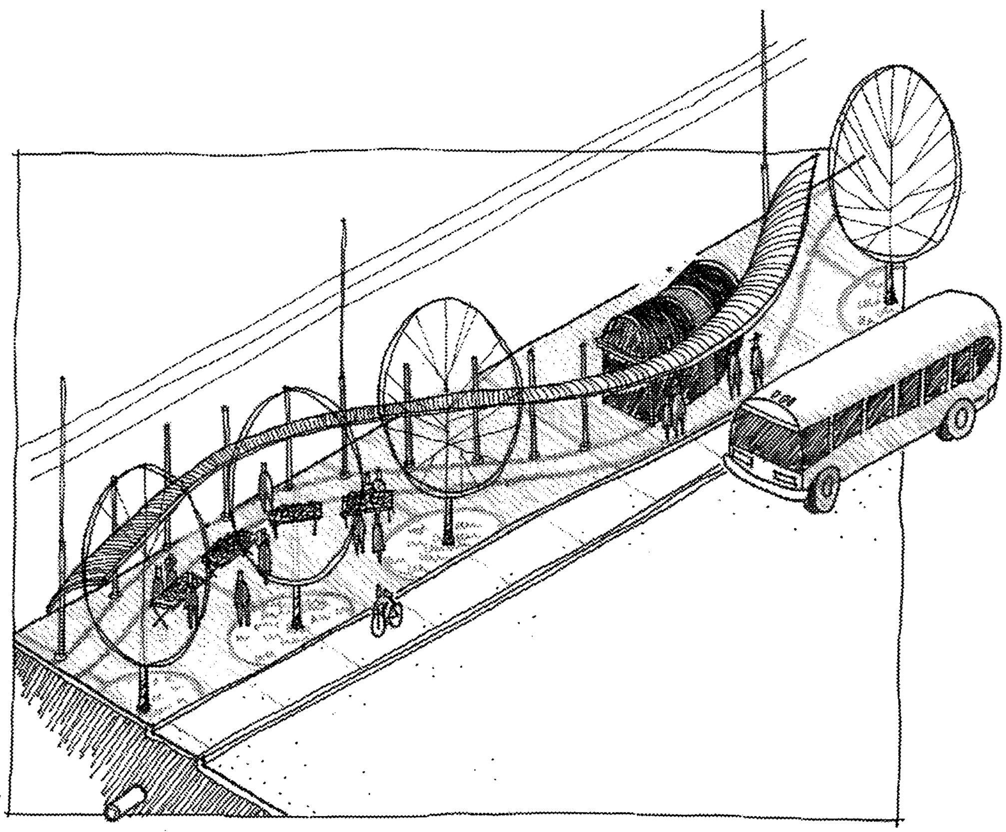
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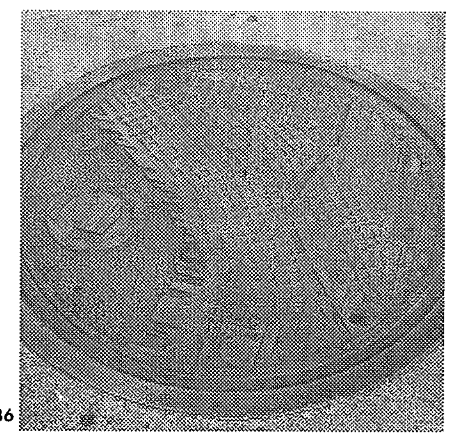
4.34 Shared underground utilitiy corridor.

4.35 Shared overhead corridor with attached amenities.

4.36 Manhole cover, Seattle.

4.37 An overhead utility corridor plaza.


4.36

cable

This fibre optic system of infrastructure provides an intelligent cable system with two way capabilities. Videon Cable is the provider of cable services, such as cable television and internet access, west of the Red River in the City of Winnipeg.

Distribution begins at the *headend* at Videon Cable at 22 Scurfield. The headend is the receiving point for satellite signals as well as local off-air channels and North Dakota television stations received via microwave. The headend demodulates, decodes and processes the TV and FM signals before they are redesignated to the appropriate channel number on the Videon customers' television set. These signals are distributed from the headend along an underground *main line cable*. The signals are then converted from light back into radio frequencies at the fibre optic node. These radio frequencies are amplified and fed along a *trunk line* throughout Winnipeg west of the Red River. *Feeder cables*, which may either be placed overhead or underground, branch off from the trunk cables at intervals to transport the signals to pedestals on the surface where smaller drop cables are attached and fed to different homes.

Components & Location

Cable infrastructure is located within the communications corridor. Along Pembina Highway, Videon rents space within the MTS trench and Manitoba Hydro woodpole (figures 4.38-39). The components located overhead or underground are:

- ▸ Fibre optic cable.
- ▸ Amplifiers are located in manholes for underground service and on the wood pole for overhead service at intervals of approximately 200 m.
- ▸ Pedestals are located in manholes for underground service and on the wood pole for overhead service.

Maintenance

- ▸ Overhead services require annual maintenance and inspections. Bucket trucks and ladders are employed to access overhead services.
- ▸ Underground services require annual inspections at manholes. Spatial requirements for service vehicles are required around manholes.

Lifecycle

- ▸ Overhead services **25 years**
- ▸ Underground services **25 years**

Problems

- ▸ Digging can damage or cut cables.
- ▸ Vehicles coming in contact with poles can cause damage.
- ▸ Trees can damage overhead and underground services.
- ▸ Snowploughs can damage pedestals.
- ▸ If a cable is crushed, it will transmit a poor signal.
- ▸ Ground water will, over time, degrade cable.

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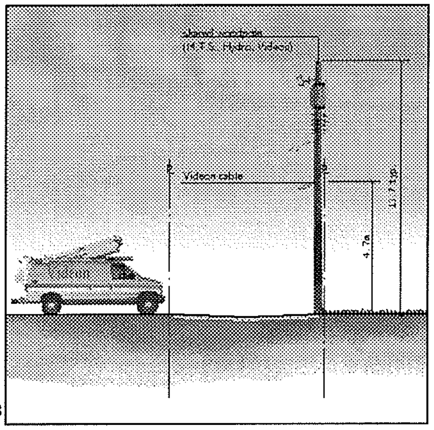
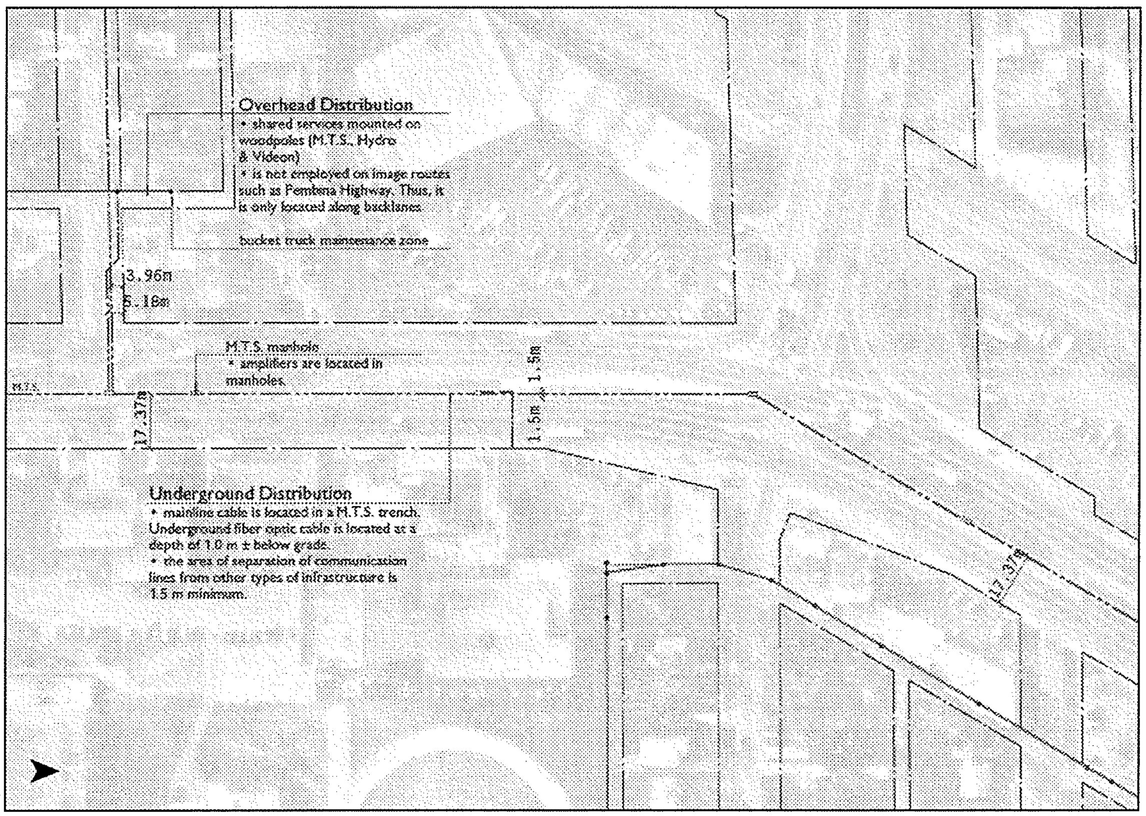


4.38 Overhead distribution.



4.39

4.39 Existing cable utilities along portion of Pembina Highway.

Design Response

Due to similar methods of distribution, the design response opportunities for cable infrastructure are the same as previously identified in the communications section (see page 37). ■

electricity

The infrastructure of Hydro serves to provide the distribution of electricity. More than 96% of the electricity generated in the province of Manitoba is generated by flowing water, which is called *hydroelectricity*. The remainder is generated by coal, wood, gasoline, diesel fuel, photovoltaics, wind energy, and natural gas. Manitoba Hydro, the provincial Crown owned utility, and Winnipeg Hydro, the city-owned utility, provide electricity to Manitobans. Their electrical generation and transmission systems are interconnected and operate as a single integrated system.

The transmission and distribution of electricity begin at the generating stations located along the Nelson River in northern Manitoba. From these stations, a high voltage transmission line system carries electricity over a distance of about 900 kilometres to terminal stations where large transformers convert the high voltages to low voltages. Sub-transmission lines later feed the electricity into a distribution system where, at various stages, transformers lower the voltages for distribution within the city.

Components & Location

Aluminum or copper cable, with crosslink polyethylene insulation, is the primary component. This system may be distributed in either two ways within the ROW – *overhead* or *underground* (figure 4.42).

Overhead distribution:

▸ **Wood poles** (figure 4.40) carry the majority of distribution throughout the city, distributing 66 kV, 33 kV or 24 kV. Poles are typically spaced at 30.0 m on centre and have a height of 13.7 m and 1.5 m deep with the primary cable positioned at 12.2 m above grade. Taller poles are at a height of 22.9 m but are rare. Poles are not used along main routes designated as an *image route* by the City of Winnipeg, such as Pembina Highway. As a result, wood-poles are located in the back lanes.

▸ **Transformers** located on the pole, lower voltage to serviceable levels of 120/240 volts for residential use and 1020/208 volts and 347/600 volts for business use. In addition, *distribution centres*, which contain switches and fuses, are located on wood poles in metal boxes. Switches isolate sections and fuses act as circuit breakers for the system.

▸ **Street lights** (figure 4.41)

Underground distribution:

▸ **Manholes and concrete ducts** may contain up to 12-15 pipes. However, in some areas, a trench may exist instead of a concrete duct. This trench typically consists of direct buried cable with or without a pipe in sand with a plank above and warning tape. MTS, Videon and Hydro may share a trench or conduit to reduce costs. The ideal depth to locate Hydro cable is 1.0 m. However, cable may be placed as low as 3.0 m to avoid other infrastructure. This depth is meant to prevent compression damage by allow pressure spread from heavy vehicles such as semi-trailers. Distribution centres are located in the manholes.

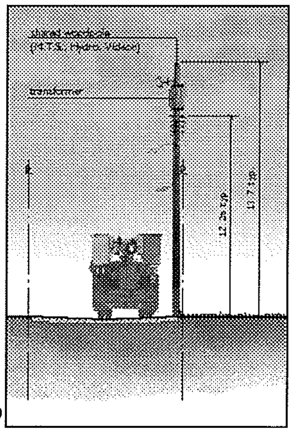
▸ **Transformers** are located on the ground where they are placed in unobtrusive location, such as the corner of a park or business parking lot. The size of a transformer is approximately 2 m tall by 2 x 2.4 m wide and 2 m deep.

Maintenance

▸ Operations staff install, maintain, and repair a variety of overhead and underground distribution transformers that can be subjected to overloads, causing transformer failure.

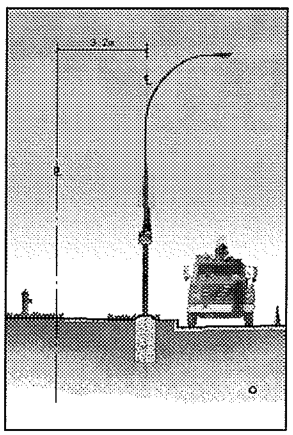
▸ Overhead systems require annual maintenance and inspections. Bucket trucks and ladders access are utilized for gaining access to overhead services. Typical services include ground rod testing and hardware tightening. Preventive maintenance services are also carried out to ensure the maximum life of wood poles.

▸ Street lighting is serviced regularly. Some of these services include the replacement of defective bulbs or luminaries and the



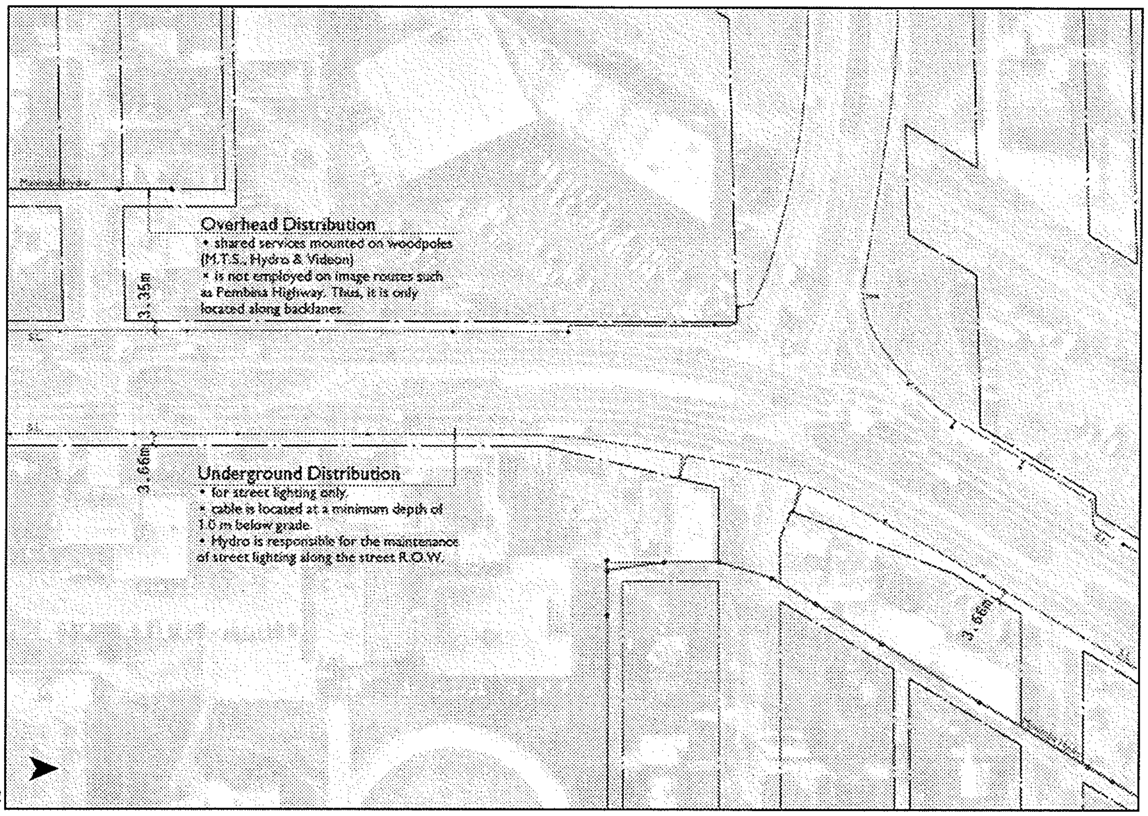
4.40

4.40 Overhead distribution.



4.41

4.41 Underground distribution – street lighting.



4.42

4.42 Existing electric utilities along portion of Pembina Highway.

replacement of damaged standards and street light bases.

▸ Underground Systems undergo annual inspections at manholes. Equipment such as connections, elbows, stress cones, and switchgear are regularly inspected, both visually and with infrared technology, to ensure the integrity of the system.

Lifecycle

The approximate lifecycle of underground and overhead services is 40 years. However, underground services generally have a longer lifecycle.

Problems

▸ Digging can damage or cut cables.

▸ Vehicles coming in contact with poles can cause damage.

▸ Trees can damage overhead and underground services.

▸ Because underground distribution is largely out of sight, problems are not as readily detected as they are in overhead systems. Undetected corrosion, heating and oil leaks greatly shorten the life of the plant, increasing operating costs and production losses. When a new trench is built, cable is removed from the old trench and abandoned.

▸ Underground services are considered to "look better" than overhead services. However, overhead services cost one-tenth that of underground distribution.

Design Response

Due to similar methods of distribution, the design response opportunities for electrical infrastructure are the same as previously identified in the communications section (see page 37). ■

gas

The infrastructure of Centra Gas distributes natural gas. The Company provides service to approximately 230,000 customers in more than 90 locations throughout Manitoba, delivering natural gas through a system of more than 5,300 kilometres of transmission mains and distribution pipelines.

The distribution of natural gas begins at refineries located in Alberta, where four large pipes, measuring as much as 1,070 mm in diameter, conduct the gas to Manitoba at a pressure of roughly 700-800 psi. The main pipelines are tapped near the city, where pressure is reduced to about 150 psi at a regulator station. Since natural gas is odourless, an odorant is injected into the gas at a regulator station as a safety precaution. The gas is regulated over various distances. By the time the gas distributed for home use, it is being distributed through a 13 mm pipe at a pressure of 40-50 psi.

Component & Location

▸ **Pipe (steel or plastic):** 95% of installation is flexible polyethylene pipe. Pipe size can range from 508-1016 mm within the street right-of-way. The pipe is placed at a minimum depth of 760 mm. The standard location of gas lines within a major arterial street ROW places it under the north or west boulevard, however, this standard does not apply to Pembina Highway (figure 4.45).

Maintenance

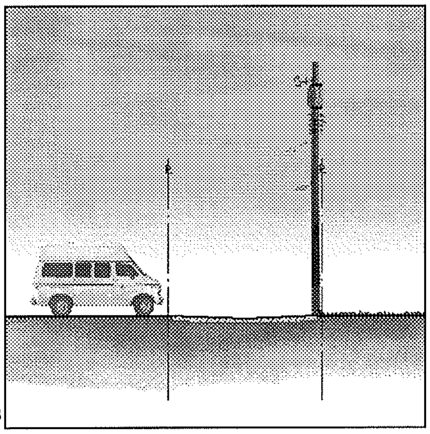
There are relatively few maintenance requirements for this system of infrastructure. Most commonly, broken pipes are caused by third party excavations (figures 4.43-44). When broken pipes are repaired, a trench is excavated to the depth of the pipe – usually 760 mm, at 0.75 m wide by 5.0 m long. The plastic pipe is then squeezed-off to stop the flow of gas. The damaged pipe is then removed and replaced.

Lifecycle

▸ Plastic pipe **40-50 years**
▸ Steel pipe **20-30 years**

Problems

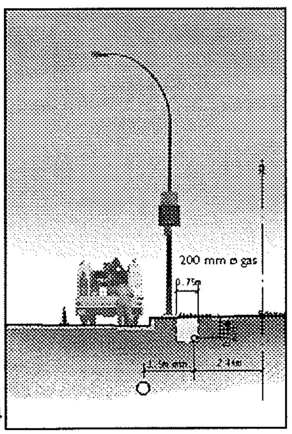
▸ Digging by third parties damage pipe.
▸ A rare condition is where water that entered a pipe during installation freezes and plugs a pipe.
▸ The lacustrine clay soil in Winnipeg is highly plastic, which is susceptable to volumetric changes as the result of changes in soil moisture and temperature that lead to swelling and shrinkage. The soil is aggressivley corrosive, chemically attacking many types of construction materials and infrastructure.



43

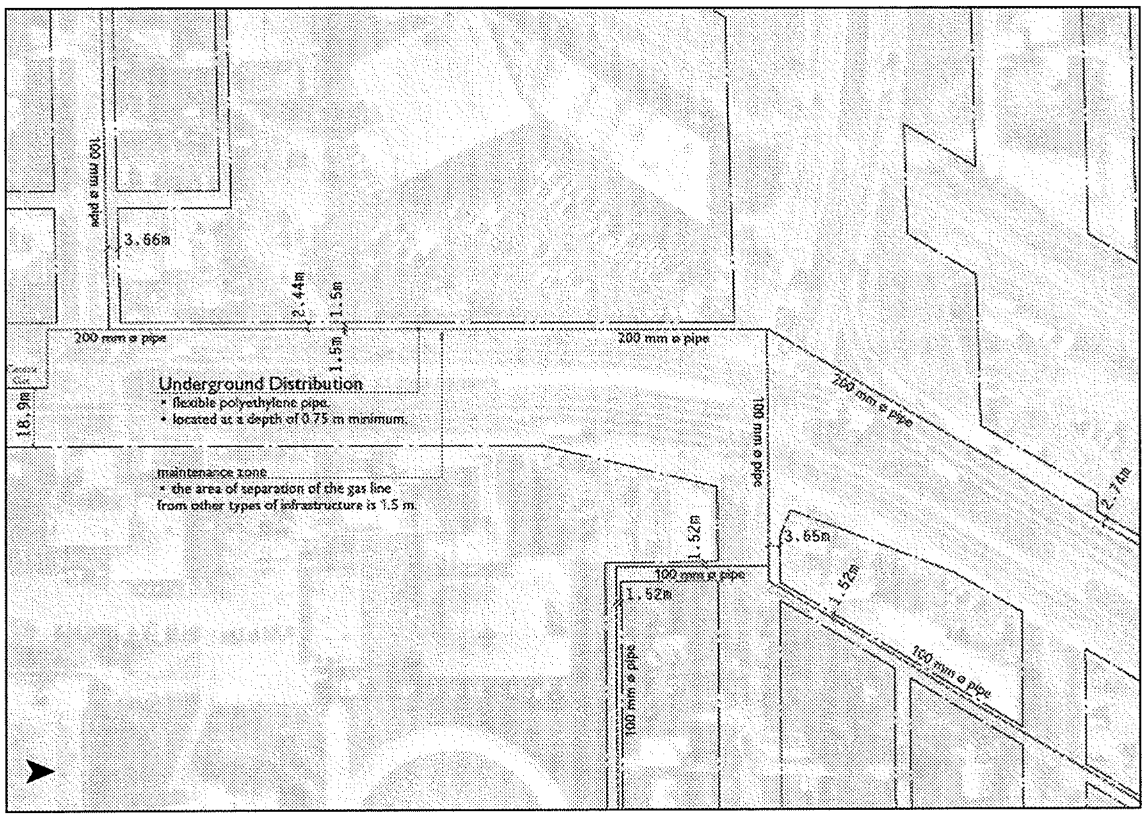
4.43 Inspector's van for locating gas utilities.

4.44 Maintenance crews attend gas line.



4.44

4.45 Existing gas utilities along portion of Pembina Highway.



Design Response
An analysis of gas infrastructure within the ROW reveals the following design opportunities:

Unit: The design response of underground infrastructure, such as gas, waste water and land drainage sewers, and water services within the ROW, must relate to the other elements of infrastructure. For example, when a trench is excavated for a gas line in proximity to a tree, there will more than likely be root damage that will have ill effects on the tree. If we intend to have healthy, mature street trees in the ROW, we must ensure that the maintenance of underground structures will not interfere with this root system. Therefore, we must consider how the placement and maintenance of underground infrastructure such as gas lines affect elements, such as trees, within the ROW.

Location: The desirable location of the gas line is beneath grass boulevards. This soft landscape allows for easier removal and repair when compared to a hard surface such as paving. The costs for the reconstruction of the paved surface can add up to 50% to the original repair of the gas line. The paving removed during a repair may be in good condition as well.

On the other hand, the placement of underground infrastructure beneath paving is another option within the ROW (figure 4.46). Take into consideration that the lifecycle of a paved surface of a street or sidewalk is 25-30 years when compared to the 40 years or more of the gas pipe, as well as recent developments in pipe technology that are increasing this lifecycle significantly. This condition indicates that reconstruction of paved surfaces will occur twice before any problems occur with the gas line. A benefit to locating underground services beneath paving is that the soft landscape within the ROW offers improved growing conditions for trees and other plantings as the soil will not be required to be excavated for servicing. Remember, we can build a road in a few weeks, while a tree requires a lifetime of growing.

Visibility: We hide gas line infrastructure underground for various reasons – to ensure safety or to screen from view, to name a few. Where this utility is visible within the ROW, its elements – valves, man holes, and so on – offer visible opportunities to add delight to the street by detailing them meaningfully. Figure 4.47 is an example where gas infrastructure is celebrated in a sculptural manner. Rather than screen these elements from view with planting, they become a sculpture in the landscape that adds to the experience of the street in a positive manner. ■

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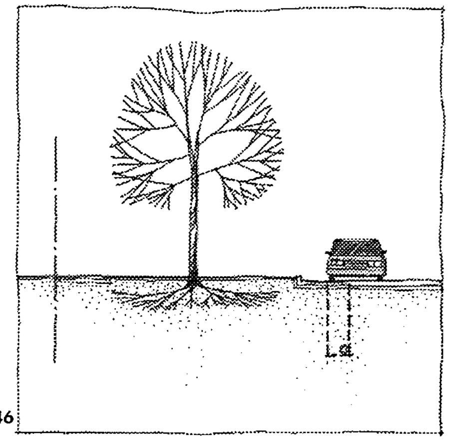


4.47


4.46 Minimizing space within the ROW.

4.47 Public art, Winnipeg.

waste water sewer & land drainage sewer

The infrastructure of sewers serves to dispose waste water and rainwater runoff from the landscape and sewer. There are approximately 1,100 kilometres of combined sewers; 1,100 kilometres of sanitary sewers; and approximately 1,000 kilometres of storm sewers in the City of Winnipeg. The sewer system replacement value is estimated at $2.9 billion (SIRP: 1998).

The infrastructure of a sewer is a gravity fed system. Gravity is the primary design consideration of the sewer system. This system is one directional in nature - flow is from the highest point to the lowest. The annual sewage handled by the City of Winnipeg is 111,189 million litres, while the daily sewage received is 304.6 million litres. There are two types of systems of sewer infrastructure – *combined* and *separated*:

▸ **Combined sewers:** In some areas of Winnipeg, both rainwater runoff and sanitary waste water are collected in the same sewer.

▸ **Separated sewers:** Since the 1950s, all new subdivisions have been built with separate sewer systems where waste water and runoff are collected in separate pipes. Each separate sewer is referred to as *waste water* and *land drainage* (figure 4.50).

Land drainage sewers consist of a series of catch basins which collects water. This water is removed from the catch basin through a series of lead pipes which eventually connects to a larger main pipe, where it is emptied at a retention pond or the river. Pipe sizing is determined by a 5 year storm (min) condition. The minimum velocity of water movement through the pipe is 0.9 m per second. Pumping stations speed the flow of waste water in the event of a storm to improve water flow. In the case of overflow at a retention pond or river, flatgates prevent water back-up in the system.

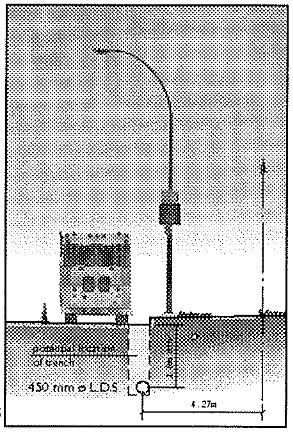
Waste water sewers work in much the same manner. Yet, rather than having the waste water drain into a retention pond or river, it is directed to a sewage treatment plant where the water is treated before being deposited into the Red River. The City of Winnipeg has three sewage treatment plants, or *water pollution control centres*, located in the north, south and west ends of the city. At the treatment plants, waste water undergo a two-stage treatment process, where the primary treatment of the water removes 90% of solids, and the secondary treatment removes 98% of suspended solids. In additon, the minimum velocity of waste water movement through the pipe is 0.6 m per second.

Components & Location

A major arterial street will have the waste water and land drainage sewers located under the median boulevard. Although this condition does not exist within the Pembina Highway ROW, the following components exist:

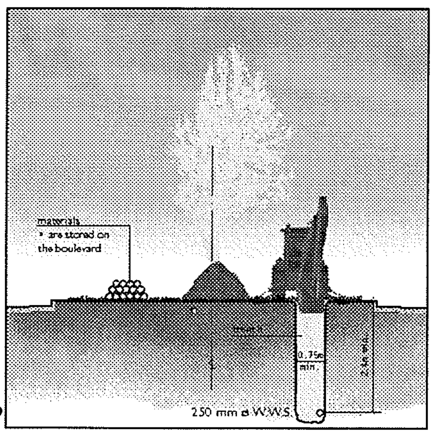
▸ **PVC or precast concrete pipes** are utilized to conduct waste water to either a treatment plant or retention pond or river, depending on the type of system – combined or separated. Waste water pipes are placed below the frost line and the depth of basement level. This condition places the waste water sewer at a minimum depth of approximately 2.4 m below grade. Land drainage sewers are not as constricted due to the fact that this system does not operate during the winter months. The typical depth of the land drainage pipe is at 1.8 m below grade.

▸ **Catchbasins:** areas where rainwater runoff is directed to be deposited into either a land drainage sewer or a combined system. Catch basins are typically located at the curb side of the street. This condition is to keep the lanes most travelled high and dry during a storm and keep the water to the parking lane. Repairs are also less likely to disrupt traffic along the curb lane rather than the middle of the street.



4.48

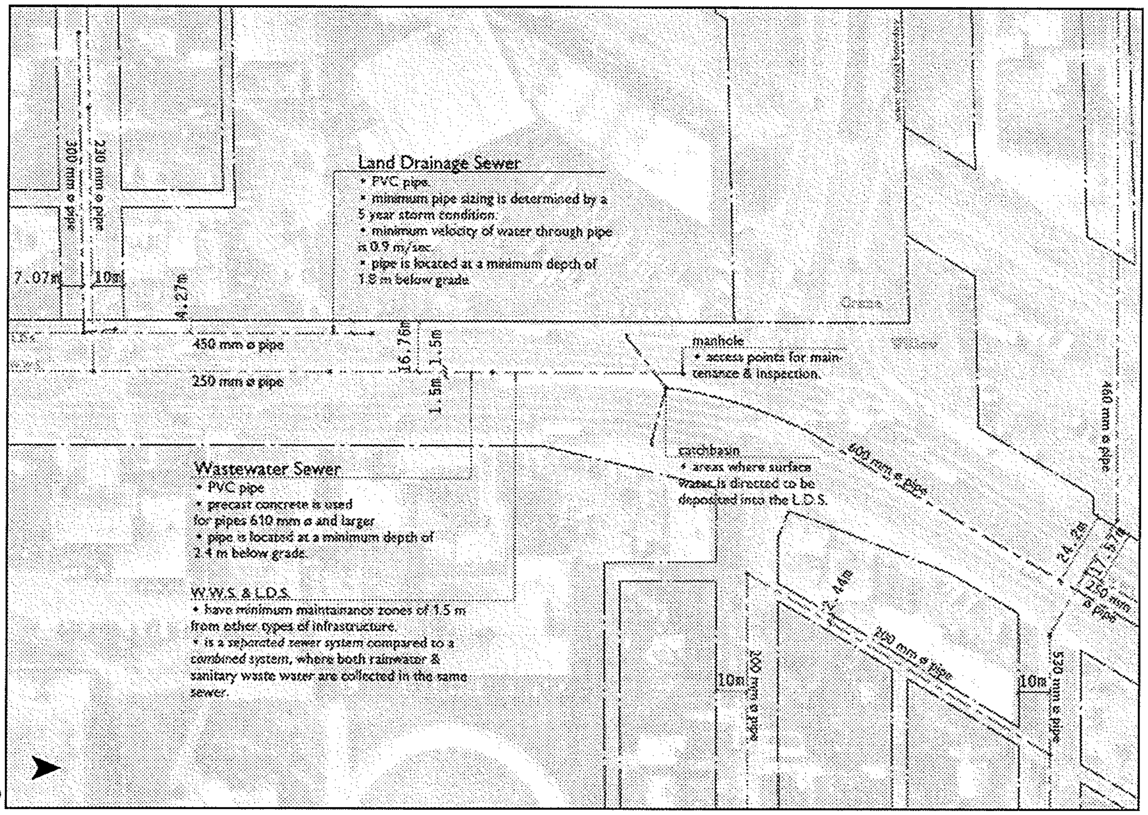
4.48 Service vehicle equiped with closed circuit television (CCTV) that is utilized for leak detection.



4.49

4.49 Work crews dig a trench using a back-hoe.

4.50 Existing waste water & land drainage sewers along portion of Pembina Highway.



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▸ **Manholes** provides an access point for maintenance and inspection.

Maintenance

A trench is required to replace or fix a sewer pipe. This space is needed to accommodate the exposed pipe and allow work crews room to assess and repair any damage (figure 4.49 & 51). Before the trench is excavated, a digital camera is sent through the pipe to find and assist in assessing the damage (figure 4.48). This process begins once back-up and flooding occurs within this system. Other rehabilitative measures include chemical grouting, structural coating, sliplining, inversion lining and folded liners.

Lifecycle

The intended lifecycle of the sewer system is designed for a minimum life of 50 years. However, this time frame varies with specific materials – for example – the steel pipes used in the 1970s and early 1980s turned out to have a lifecycle of 10 years.

Problems

▸ Since the sewer system is located underground away from visual inspection, inflow and infiltration into the sewer system is not detected until a problem such as back-up or flooding has already occurred.
▸ When it rains, the combined sewer system cannot carry all the rainwater and waste water to the treatment plant. In this situation, much of the rainwater and waste water mixture overflows into the Red or Assiniboine rivers, which is referred to as a *Combined Sewer Overflow* (CSO). A CSO affects river quality: fish habitat is damaged by the breakdown of human waste, reducing oxygen levels; bacteria from human waste can cause flu-like illnesses and skin or eye infections in some people who swim or waterski in the river.

Design Response

An analysis of waste water and land drainage sewers reveals common design opportunities as well as a unique one:

Unit: As previously described, the design of gas, waste water and land drainage sewer, and water infrastructure must consider their relationship to other elements within the ROW.

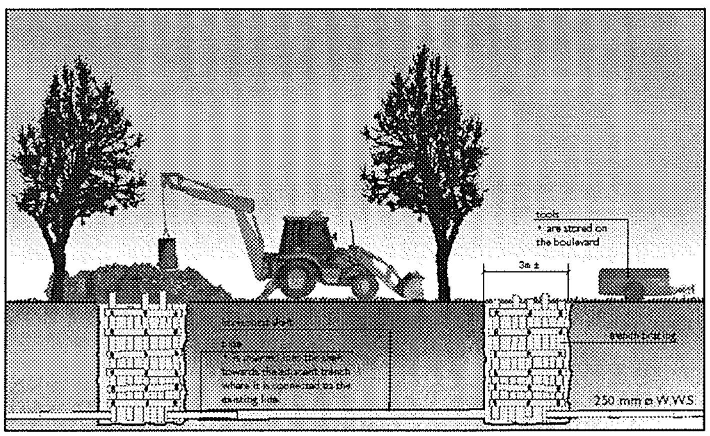
Location: As with gas line infrastructure, the desirable location of the sewer system is beneath grass boulevards. The considerations outlined for locating gas line infrastructure applies when locating waste water and land drainage sewers within the ROW. One specific consideration for locating waste water and land drainage sewers is that they are placed at a lower depth than gas line. Any trench excavated to gain access to sewer pipes will, therefore, be of greater depth, requiring more storage space than that for the gas line.

Visibility: As previously described, the design of gas, waste water and land drainage sewers, and water infrastructure can be detailed in a meaningful manner. Figure 4.52 is an example of a catch basin that is detailed to add not only delight to the street, but offers a sense of meaning – its symbolic fish shape is to remind people of the consequences of pouring motor oil or other chemicals down storm drains.

In addition to detailing visible elements of the sewer system, there exists the opportunity to rethink the land drainage sewer system into a visible system. This will entail replacing or combining the sewer pipe of the subterranean level with a biofiltration swale, or *bioswale*, located on the surface (figure 4.53). Bioswales are open channels possessing a dense cover of grasses and other herbaceous plants through which runoff is directed during storm events. Above-ground plant parts – stems, leaves & stolons – retard flow and thereby encourage particulates and their associated pollutants to settle. The pollutants are then incorporated into the soil where they may be inmmobilized and/or decomposed (Center for Urban Water Resource Management: 1998).

Although the bioswale will require greater spatial requirements than a pipe, this new system will provide the following benefits:

▸ This ecological approach to land drainage will reduce pollutants through natural filtering.
▸ A bioswale will reduce peak flows by slowing runoff. This condition will reduce the cumulative problems on the present system – downstream flooding, often accompanied by diminishing ground water supplies, to name a few (American Society of Civil Engineers: 1974).
▸ Grassy swales cost approximately one-tenth that of typical land drainage sewers (LATIS: 1998). If the swale is a hybrid system with overflow drains, then there maybe an increase in the cost of the swale.
▸ Provides habitat for a variety of small animals.
▸ Adds to the delight of the street by creating visual interest and focus.
▸ This visual tool serves to educate the public on the natural process of water and the effects of the urban environment on rainwater. ■



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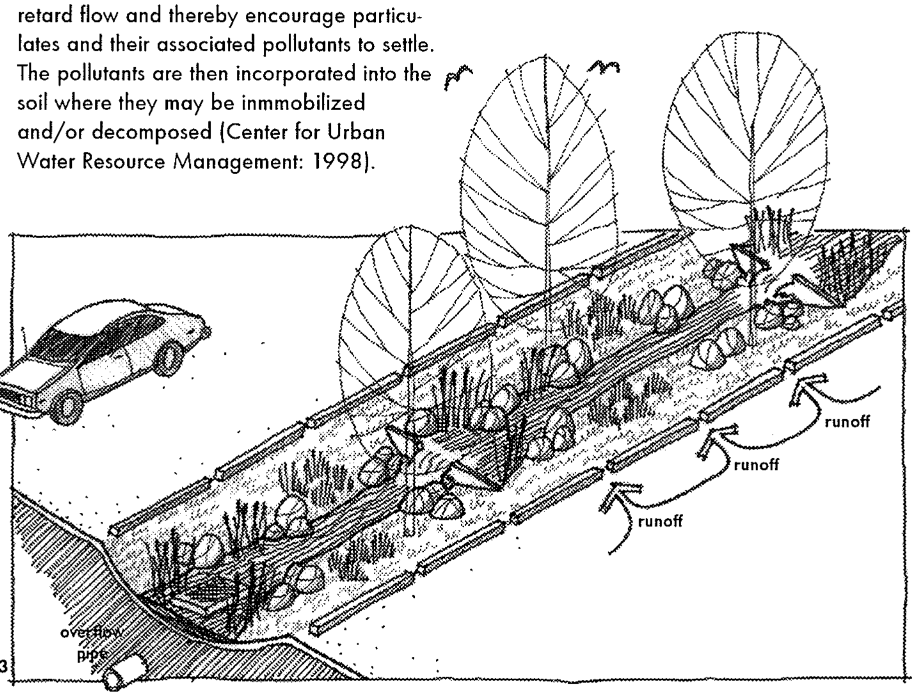

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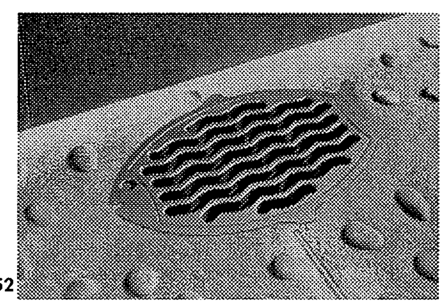

4.52

4.51 Cross-section of the installation of underground pipes through a series of trenches.

4.52 Fish drain.

4.53 Bioswale located in median boulevard.

water

Water infrastructure serves to ensure an uninterrupted supply of potable water. There are approximately 174.5 kilometres of aqueduct, 16.8 kilometres of feedermain, 2,381.8 kilometres of watermains and 18,359 hydrants in the City of Winnipeg. The replacement value of the watermains is approximately $1 billion (SIRP: 1998). The Local Sewer and Water Division of the Water and Waste Department of the City of Winnipeg is responsible for the operation and maintenance of water infrastructure.

The annual water pumped by the City of Winnipeg is 95,337 million litres, while the average daily water pumped is 261.2 million litres. The maximum hour water pumped by the City of Winnipeg is 371 million litres per day. For Winnipeg, the distribution of water begins 156 kilometres away at Shoal Lake. Here water is fed into a gravity fed aqueduct at an intake station. Once the water reaches the city, it is emptied into the Deacon reservoir. Once in the reservoir, the water is distributed through feedermains to various reservoirs for water storage during peak periods of water use. Pumping stations pump the water at 75 psi through the city's network of watermains for distribution to individual homes and businesses.

Location & Placement
The location of water services within a major arterial street is under the south or east sidewalk (figure 4.55). The distance of the water line from the property line is generally 4.0 m, which places it approximately 0.5 m from the street curb. Water pipes must be placed below the frost line and the depth of basement level. This condition places the water lines at a depth of approximately 2.4-3.0 m below grade. Water infrastructure includes the following components within the ROW:

- **Feedermains** 610 mm concrete pipe for distribution from the Deacon reservoir to the pumping stations.
- **Watermains:**
  - 150 mm PVC pipe for home distribution.
  - 200-250 mm PVC pipe for commercial distribution.
  - 250-300 mm PVC pipe for industrial distribution.
- **Hydrants** are placed approximately one every 91.0 m.

Maintenance
A trench is required to replace or fix a water line (figure 4.54). This trench is needed to accommodate the exposed pipe and allow work crews room to assess and repair any damage. Before a trench is dug to fix a watermain, leak detection equipment is employed in order to determine the location of a break.

Hydrants are tested every fall for preparation for winter conditions. They require repainting and components such as seals need to be accessed and replaced if necessary.

Lifecycle
- Waterline **50 years**

Problems
- Third party digging can damage pipes.
- Vehicles, most likely snow ploughs, coming into contact with hydrants can cause damage.
- Cathodic protection is required for older ductal iron pipes.
- Waterlines must be placed below the frost line to prevent freezing within pipes.
- Repairs are difficult in colder weather for work crews.

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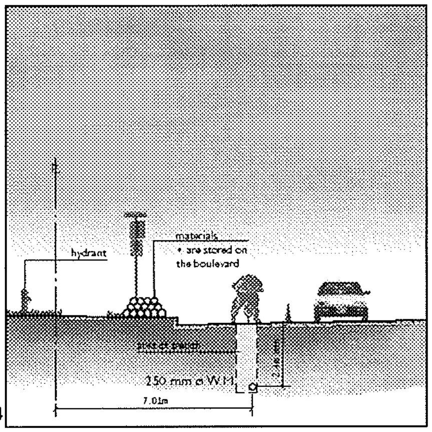
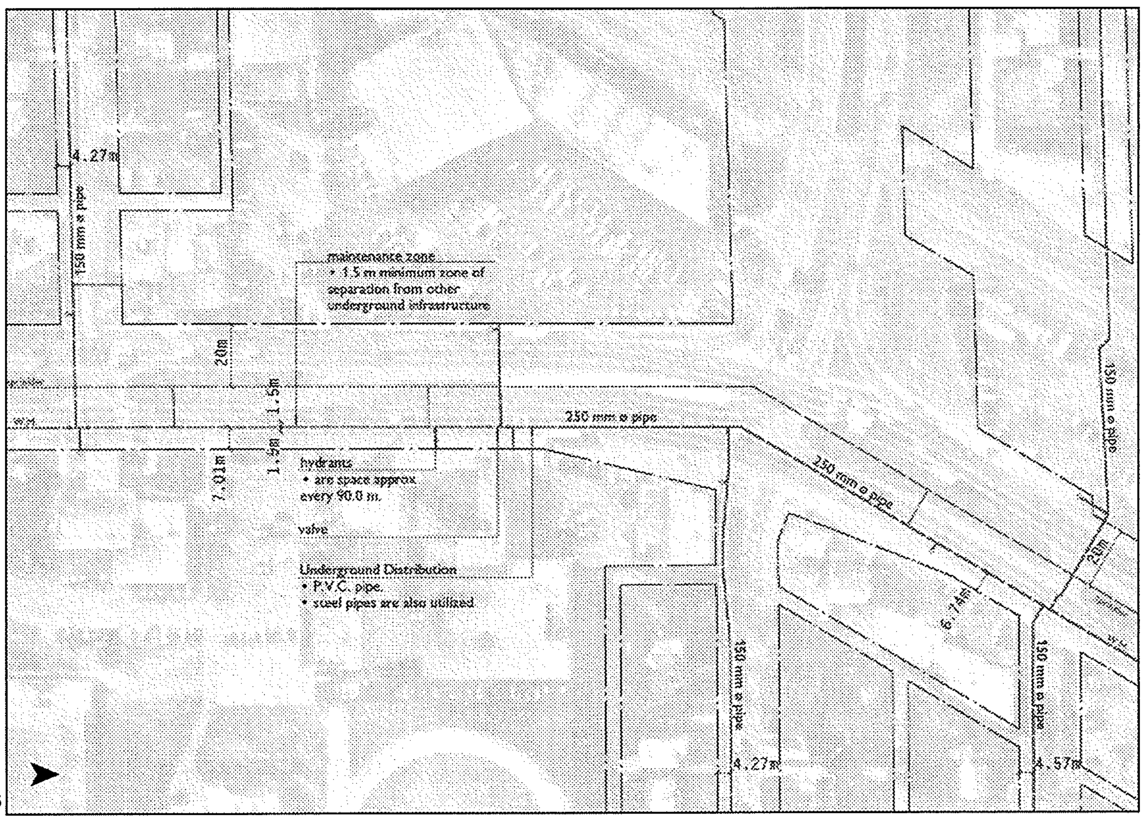


4.54 City worker cuts the existing paving with a jack-hammer.

4.55 Existing water lines along portion of Pembina Highway.

4.55


Design Response

Due to similar methods of distribution, the design response opportunities for water utilities are the same as previously identified in the waste water and land drainage sewer section (see page 45). ■

street trees

Street trees are planted along city boulevards within the ROW. In general, only one tree species will be allowed for planting on any one street The City of Winnipeg has an inventory of approximately 185,000 street trees (figure 4.56).

Location

Trees are typically planted in a straight line at equal intervals, which is determined by their ultimate size:

- Large size trees **13-16 m apart**
- Medium size trees **10-13 m apart**
- Small size trees **7-10 m apart**

Minimum planting distances from:

- Street intersections **6 m**
- Light standards **3 m**
- Private approaches **3 m**
- Hydrants **3 m**
- Hydro poles **3 m**
- Manholes **3 m**

Maintenance

- Tree planting (figure 4.57)
- Pruning
- Removal
- Clean-up
- Disease control

Equipment

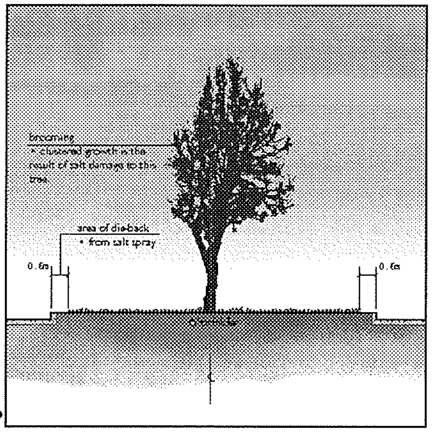
- Bucket & pick-up trucks
- Ladders
- Chippers

Lifecycle

- Natural **100 years or more**
- Urban **7-10 years**
- Suburban **20-30 years**

Problems

- The highest percentage of losses of street trees occurs during the first growing season after planting. This condition is attributed to the lack of appropriate space designated for a tree within the ROW and the present planting detail (figure 4.58). Other reasons for the shortened lifecycle of street trees are:
- Vehicle collision into tree.
- Snow-plough damage.
- Vandalism.
- Disease within monoculture areas.
- Salt damage from vehicles and winter roads.
- Root disturbance due to construction.
- Damage caused to sidewalks by tree roots.
- Roots from trees growing near or over top of sewer lines do not actively penetrate sewer pipes and cause blockages. However, roots can gain entry through previously cracked portions of a sewer pipe that will cause problems.



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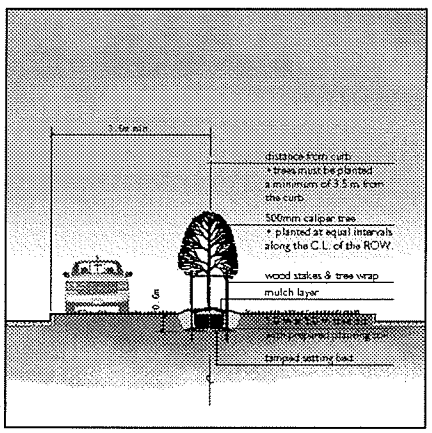

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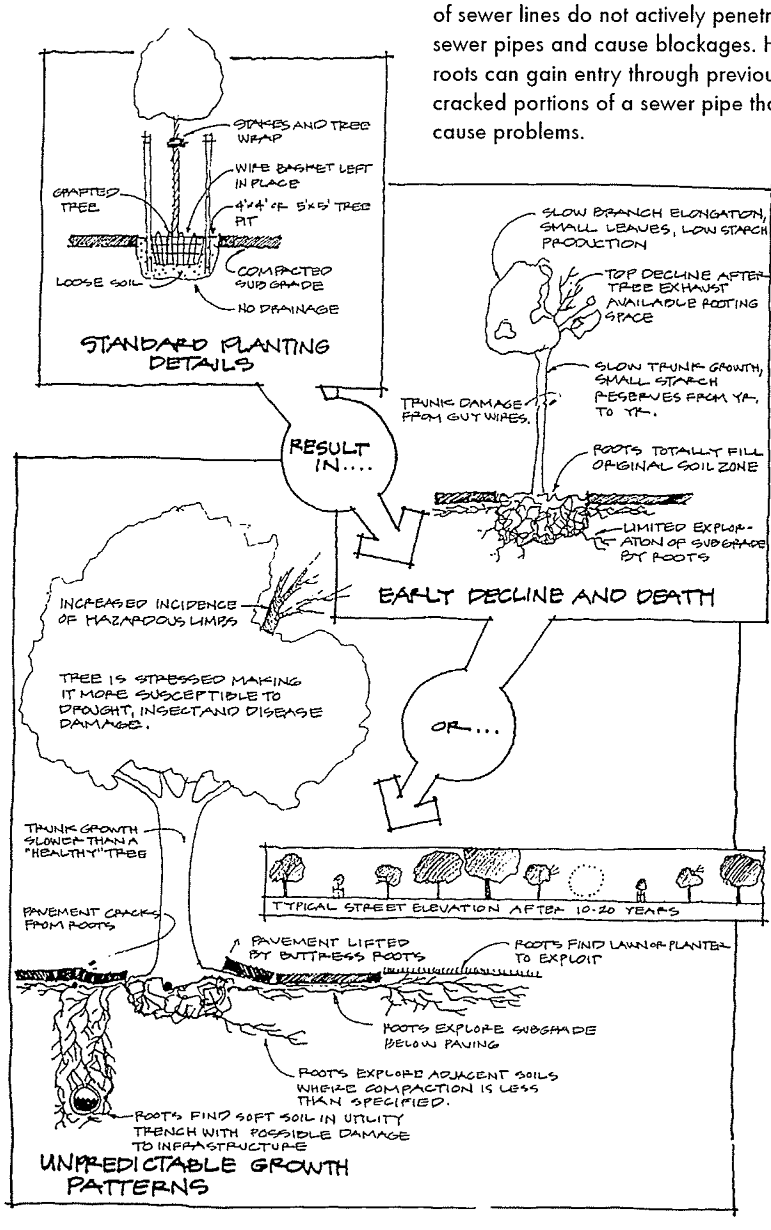
4.56 Existing tree condition along Pembina Highway.

4.57 Standard planting detail and maintenance vehicle.



4.58

4.58 Inner-city tree problems, James Urban.

Design Response

Trees must compete for space within the ROW with paving and utilities. Once we establish more ideal planting conditions for trees, we will have healthy, mature trees that will provide a variety of benefits. A shift in maintenance will occur – from keeping the tree alive to promoting tree resilience. To achieve this goal, we must consider:

Human Comfort: Trees affect the micro climate for the pedestrian by making the urban environment more friendly, providing buffer zones from traffic and producing shade from the sun and shelter from the wind (figure 4.59). Strategic tree placements reduce glare, noise and the harsh effects of precipitation as well.

Environmental Factors: Trees help to reduce carbon dioxide and increase oxygen. Trees assist in reducing wind speed, dusts and pollutants. They also control soil erosion by minimizing the effects of rain, river flow and winds. Perhaps most significantly they contribute to the habitats necessary for small animals and birds to thrive.

Spatial Requirements: The spatial requirements of a tree must be determined before planting, just as a parking stall has minimum design standards (figure 4.60). James Urban, the authority on urban trees in the United States, has established a the following set of design principles which provide for the biological requirements of trees (figures 4.61-62) (James Urban: 1998):

Volume: design with sufficient volumes of usable soil to support the area of crown desired at maturity. Ideally, these volumes must be radial rather than linear.
Accessibility: design the soil volume to be accessible to air, from which the soil absorbs water and oxygen. In good soil, only the top 0.75 m - 1.0 m are considered usable for this process.
Protection: design planting details that protect the tree and soil from damage, such as compaction.
Interconnection: design soil volumes to be interconnected from tree to tree and from other planted areas.
Symmetry: If symmetrical growth of trees is a design goal, design for symmetry of resources – soil, light, air, water, nutrients and drainage.
Growth: design to accommodate long-term growth of roots and crown, trunk flare and trunk enlargement.
Spacing: design trunk spacing and geometry to allow for long-term growth and management, including removal, thinning and replacement of the strand.
Drainage: devise planting soils with surface slopes of at least five percent and locate trees where there is adequate drainage. ■

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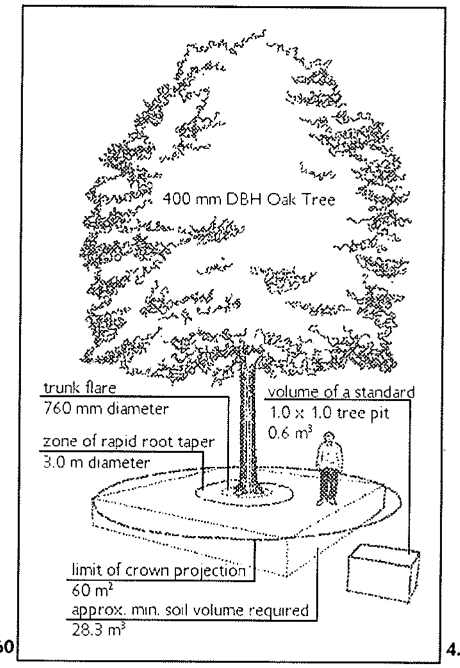

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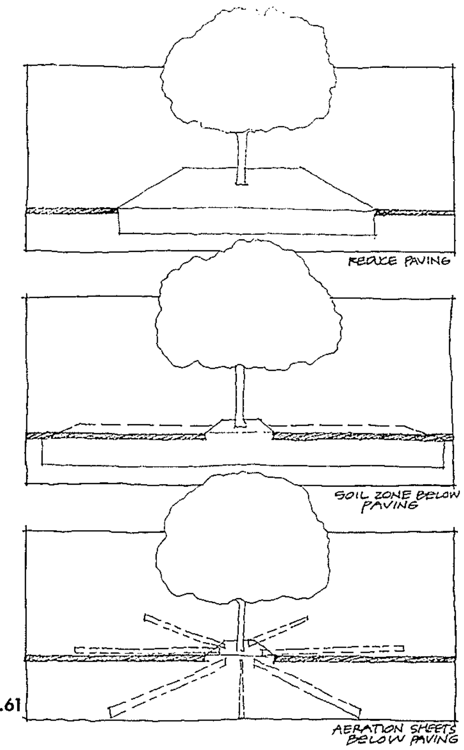

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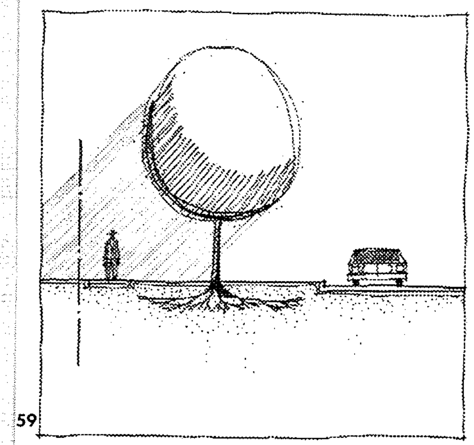
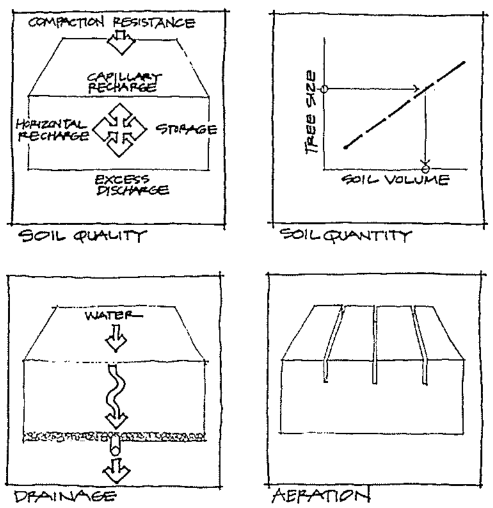


4.59 Mature trees improve pedestrian comfort.

4.60 Spatial requirements of a tree, James Urban.

4.61 Soil based solutions, James Urban.

4.62 Soil details, James Urban.

4.62


street signs

There are approximately 200,000 traffic signs in the City of Winnipeg. The design and placement of signs involve consideration of visual field, scale of letters, proportion of letters, and tonal contrast between letters and background. The *Uniform Traffic Control Manual* outlines the five basic requirements a sign must have:

- Fulfil a need.
- Command attention.
- Convey a clear, simple meaning.
- Command respect of road users.
- Provide adequate time for response.

Signs are categorized into three basic types:

▸ **Regulatory Signs** (figure 4.64) inform users of traffic laws and regulations governing movement, parking, speeds, to name a few. and indicate rules that would otherwise not be apparent, such as NO PARKING or BICYCLES ONLY. These signs are black and white in colour.

▸ **Advisory Signs** (figure 4.65) call attention to potentially hazardous conditions. These signs are typically placed sufficiently in advance of the hazard to allow for responsive action. Examples include MEN WORKING, PAVEMENT ENDS and SCHOOL CROSSING to name a few. These warning signs are yellow, while temporary advisory signs are orange in colour.

▸ **Guide Signs** (figure 4.66) provide roadside information to orient and assist users geographically. Examples include directional plates with a variety of arrow designs and route lane panels. These signs are either green or brown in colour.

Location

- Street signs are generally mounted on 2" ø steel poles or are attached on street light poles.
- Signs erected at the roadside are mounted at a height that responds to the user's field of vision:
- **Motorists:** the lower edge of the sign is at 2.1 m above grade.
- **Cyclists:** signs are mounted 1.2 - 1.5 m above grade.
- **Pedestrians:** signs are located at a height of 1.35 m above grade.

Maintenance

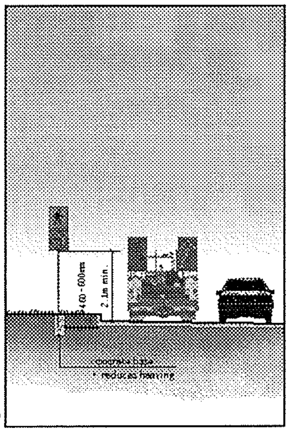
Signs may need to be repaired or replaced due to age, vandalism and vehicle contact, such as a snow plough. A pick-up truck is utilized for delivering materials and tools to maintenance and installation sites (figure 4.63).

Lifecycle

- 7-12 years

Problems

- Vehicles coming in contact with poles can cause damage.
- Snowploughs can damage signs.
- The sun fades the sign.
- Vandalism.



4.63

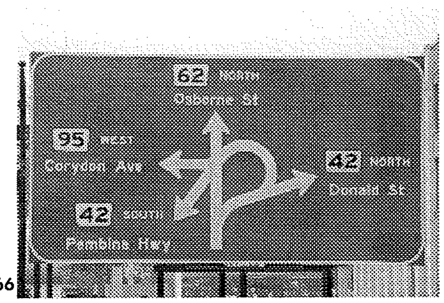
4.63 Work crews install a street sign.

4.64 Regulatory sign.

4.65 Advisory sign.

4.66 Guide sign.

4.64



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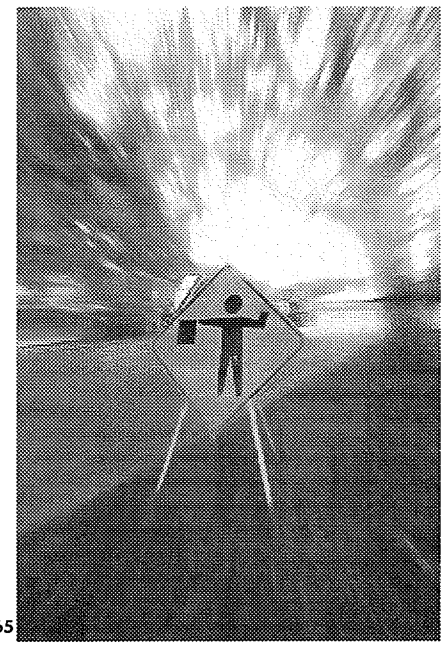

4.65

Design Response
After a review of street sign infrastructure, it becomes evident that its design and placement are governed by strict guidelines. However, the opportunity exists to rethink sign infrastructure so that it is better integrated with the street:

Permanency: Attaching the sign to a permanent pole such as a light standard or bollard (figure) is an approach that reduces the amount of metal within the ROW.

Delight: As well as making signs more permanent, in some instances we may be able to make signs more engaging to people through meaningful design details. An example includes a former detail that the City of Winnipeg applied to sidewalks in the 1930s, where the street name was embedded into the sidewalk at intersections (figure 4.68). This type of detailing provides a layer of signage at the pedestrian scale that adds to the sense of delight for the pedestrian. ■


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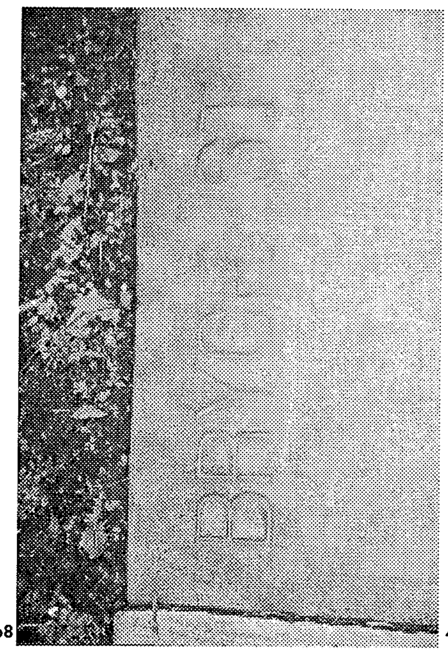
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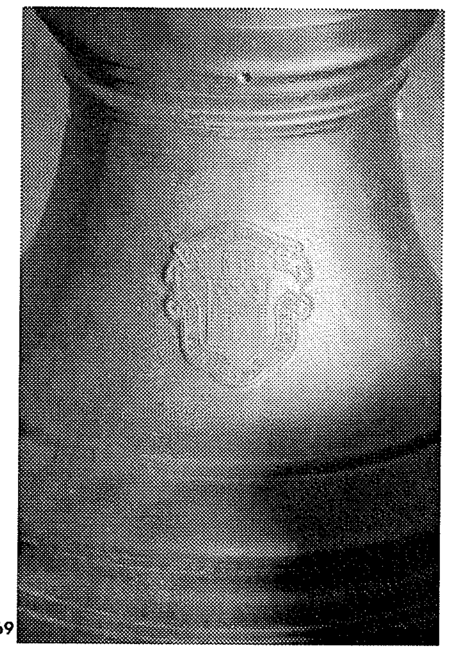

4.69

4.67 Sign attached to bollard, Winnipeg.

4.68 Street name pressed into concrete sidewalk, Winnipeg.

4.69 City of Winnipeg crest embossed on the base of a street lamp.

snow removal & ice control

The goals of the Snow Clearing and Ice Control Program are to maintain the City of Winnipeg's roadways and sidewalks so as to:

▸ Reduce the hazards of icy conditions to motorists and pedestrians;
▸ Minimize economic losses to the community and industry resulting from unsatisfactory winter driving conditions;
▸ Facilitate the handling of emergencies by Police, Fire and Ambulance services during the winter.

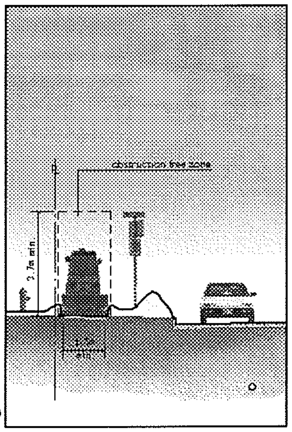
A fleet of motor graters, front-end loaders, truck ploughs, spreaders and sidewalk ploughs clears and maintains city streets. This fleet clears the city's system of streets and sidewalks according to three priority categories established in the Snow Clearing and Ice Control Program. Major Arterial streets, such as Pembina Highway, are classified as Priority I Streets (PI) (figure 4.72):

▸ Maintained to bare pavement over the full pavement width.
▸ Ploughed on a continuous basis until completed and generally performed during the night to minimize the problems associated with traffic and parked vehicles.
▸ Excessive ice or snow build-up along gutters and medians or between traffic wheelpaths is removed.
▸ **Sidewalks** along PI streets, excluding the downtown, are normally maintained to a compacted snow surface (figure 4.70).
▸ **Backlanes** are usually given an accelerated priority for ploughing for reasons of accessibility and refuse collection. Alleys are maintained to a compacted snow surface using rubber tired front-end loaders.

Maintenance
The following maintenance is performed to ploughed streets at various times throughout the winter months as required:

▸ **Salt** is effective for the melting and removal of ice and snow accumulations on the pavement only when ambient temperatures are above -7°C. Depending on the weather conditions prior to the snowfall, a single application will melt three to six centimetres of fresh snow. Salt is applied along PI streets in short burst applications called *spotting* or applied continuously to melt freshly fallen snow (figure 4.71).
▸ **Treated Sand** is used to maintain PI streets. Salt is added to the sand (5% by weight) to enhance its performance by keeping the sand fluid and workable, as well as making the sand sticky.
▸ **Removal of High Piles** occur at bus stops, crosswalks, lane entrances and intersections to improve the line of sight for motorists and pedestrians. Excess snow is either relocated within an adjacent boulevard storage area or loaded and hauled to a snow storage site.
▸ **Removal of Windrows** or *snowbanks* occur when there is a lack of adequate storage along boulevards. When removed, windrows generally exceed the height of approximately 1.5 m.

Problems
▸ The process of windrow removal is hampered by the addition of having to remove snow from between sidewalk obstacles such as street furniture or street trees. The snow is ploughed out from between trees or street furniture through the use of smaller equipment. Next, the snow is placed into the adjacent traffic lane, where it is blown into a dump-truck which is utilizing the second most traffic lane. Therefore, two traffic lanes are required where there are obstacles for windrow removal, rather than the desired one lane.
▸ Snow storage capacity along boulevards may be inadequate for the entire winter. High piles of snow may block motorist or pedestrian visibility, as well as pedestrian access.
▸ Overhead clearance for equipment may be obstructed, by canopies or tree branches, to name a few examples. Thus, the minimum clearance required by snow ploughing equipment is 5.0 m from grade and 3.5 m for sidewalk ploughs.



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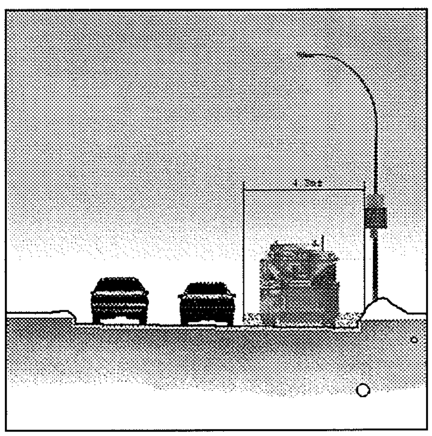

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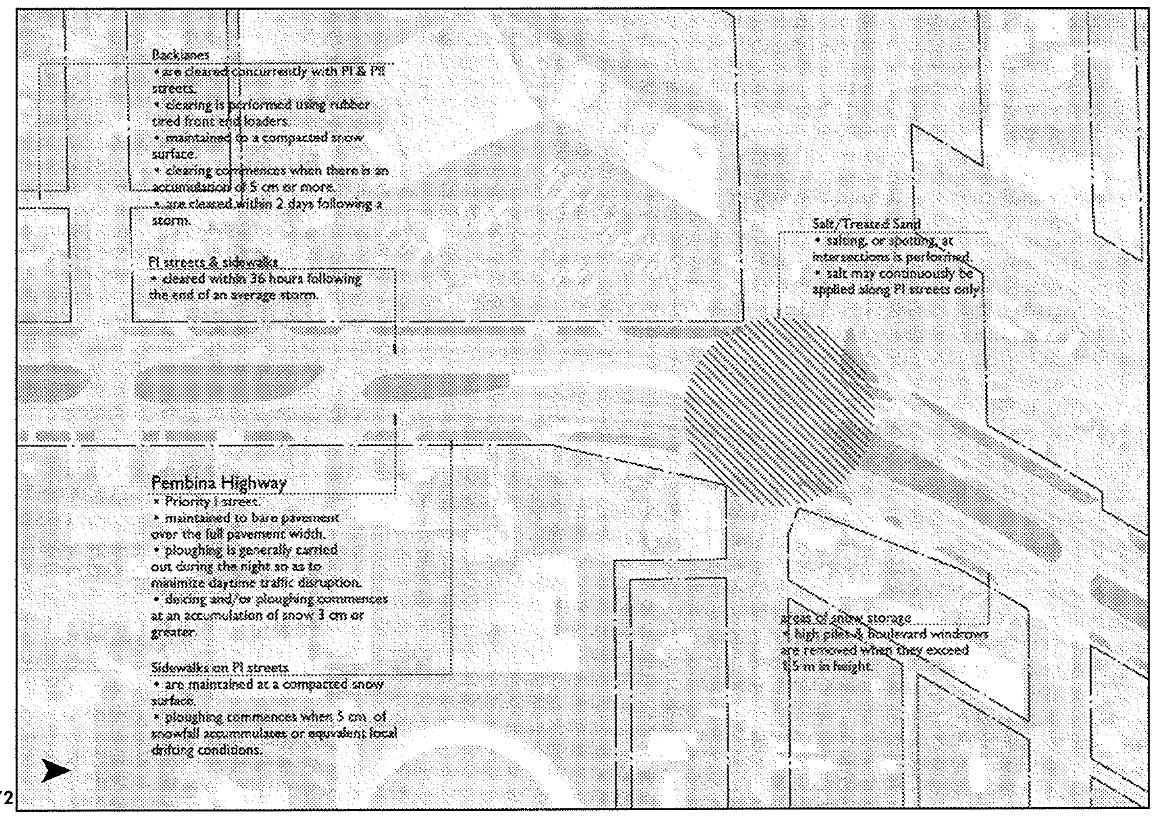
4.71 Obstruction free zone.

4.70 The area of spray from a sander is 4.3 m ±.



4.72

4.72 Existing snow storage along portion of Pembina Highway.

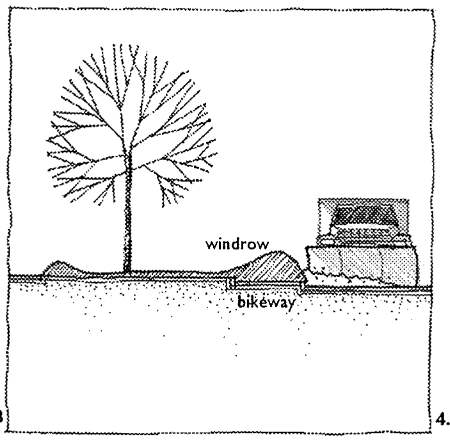
▸ Ploughs damage curbs, scrape pavements, and remove trees and signs.

Design Response

Winnipeg receives an average of 123 cm of snowfall per year. The maintenance of snow removal and ice control of city streets has a significant impact on materials, placement of utilities and street furnitiure, and street trees. Upon a review of the problems associated with snow removal and ice control, there are a number of opportunities to rethink this system of infrastructure:

Snow Storage: Inadequate snow storage requires the removal of windrows. As previously described, the ideal condition for the removal of windrows from sidewalks is to keep these areas free of clutter: benches, sidewalks, planters and street lamps. Yet, it is this so called clutter that makes our sidewalks comfortable to us. There is an opportunity to reconcile these opposing views by designing for adequate snow storage. Figures 4.73 and 74 illustrate how these designed areas of snow storage will serve other functions – as a bicycle path and as an area to locate underground infrastructure. During winters of high snowfall accumulation, where the removal of windrows are necessary, the storage areas are free of clutter as well.

Alternatives to Salt Use: The use of salts to control ice is damaging to the environment. For example, trees often exhibit stress as a result of high salt deposits in adjacent soils. Despite the cheapness and effectiveness of salt use, it has been estimated that the real cost of using salt, taking into account repairs to roads and bridges, vehicle corrosion, water pollution and damage to vegetation, is ten to fifteen times its purchase price (Dunn & Schenk: 1979, Murray & Ernst: 1976). Therefore, there is an opportunity to employ alternatives to salt that have a greater purchase price but are less environmentally damaging. Several alternatives to salt have been outlined in the study: *Effects of Salt Use on the Urban Environment* (Cuthbert, Cuthbert, Mintenko, Philipation & Stow: 1996). These alternatives include abrasives, abrasive mixtures, and chemical, inorganic and organic de-icing agents. Materials that will reduce the effects of salt damage are also described in this study. ■



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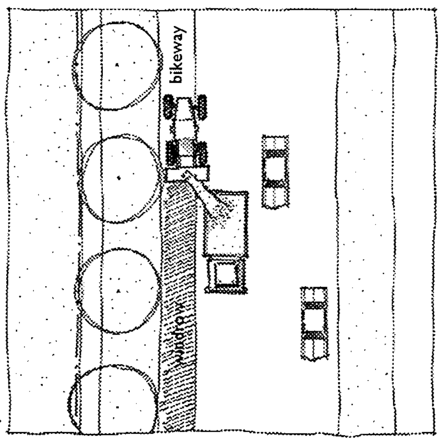


4.74

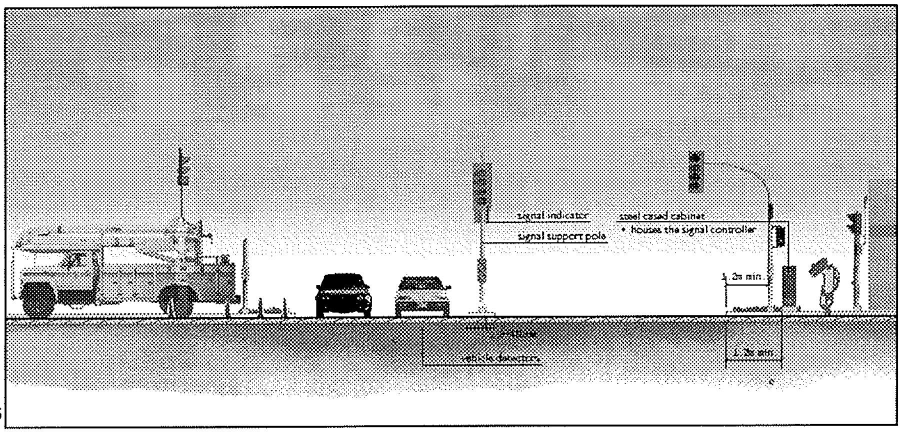
4.73 Snow storage.

4.74 Snow removal.

traffic signals

The infrastructure of traffic signals serves to provide advice and direction to motorists. There are about 590 signal control lights in the City of Winnipeg. The Public Works department is responsible for the design, service and installation of traffic signals and related electric control signals, such as pedestrian corridors, reversible lane signals, flashers, railway crossings and other miscellaneous warning signals.

There are two types of traffic signal control: *local* and *central*. *Local control* is achieved using one or more controllers to operate the traffic signals at an isolated intersection or a series of adjacent signals. *Central control* is accomplished by operation a controller or controllers from a centrally located source.



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Each of these control methods can operate signals as fixed-time, semi-actuated, or fully actuated.

Components

The components of traffic signal infrastructure are tied into an underground network of cable that is housed in plastic pipe. A typical intersection containing traffic control signals will contain (figure 4.76):

▸ **Signal support poles**: 8 poles minimum.

▸ **Signal indicators:** consist of red, yellow, green, and possibly directional arrow indications. Pedestrian signals and illuminated signs are other examples of signal indications.

▸ **Steel-cased cabinets** that house a signal controller. These cabinets need to be sturdy enough to offer protection from vandalism, weathering and impact. Cabinets are typically mounted near the intersection adjacent to the signal support poles. There are two types of controller hardware employed by the City of Winnipeg:

▸ **Electromechanical**, or a *pretimed controller*, is a device that consists of moving parts to open and close electrical contacts to change signal phases.

▸ **Microprocessor-based**, or an *actuated controller*, is designed to functional specifications developed by the National Electrical Manufacturers Association (NEMA), which serves to provide uniformity in traffic control equipment. The model of this type of controller that the city of Winnipeg uses for traffic signal control is the Type 170, which is able to be loaded with programs for various applications.

▸ **Vehicle detectors** are located at a depth of 150 mm to 460 mm in the pavement surface of a roadway. The presence of the vehicle is detected by the disruption caused in an induced or natural magnetic field by the vehicle. Detectors are utilized in roughly three-quarters of the traffic controlled intersections in the City of Winnipeg.

Location

The following practices are employed with regard to the placement of traffic signal poles and pedestals:

▸ All traffic sign poles and pedestals must be place a minimum distance of 1.2 m from the curb face.

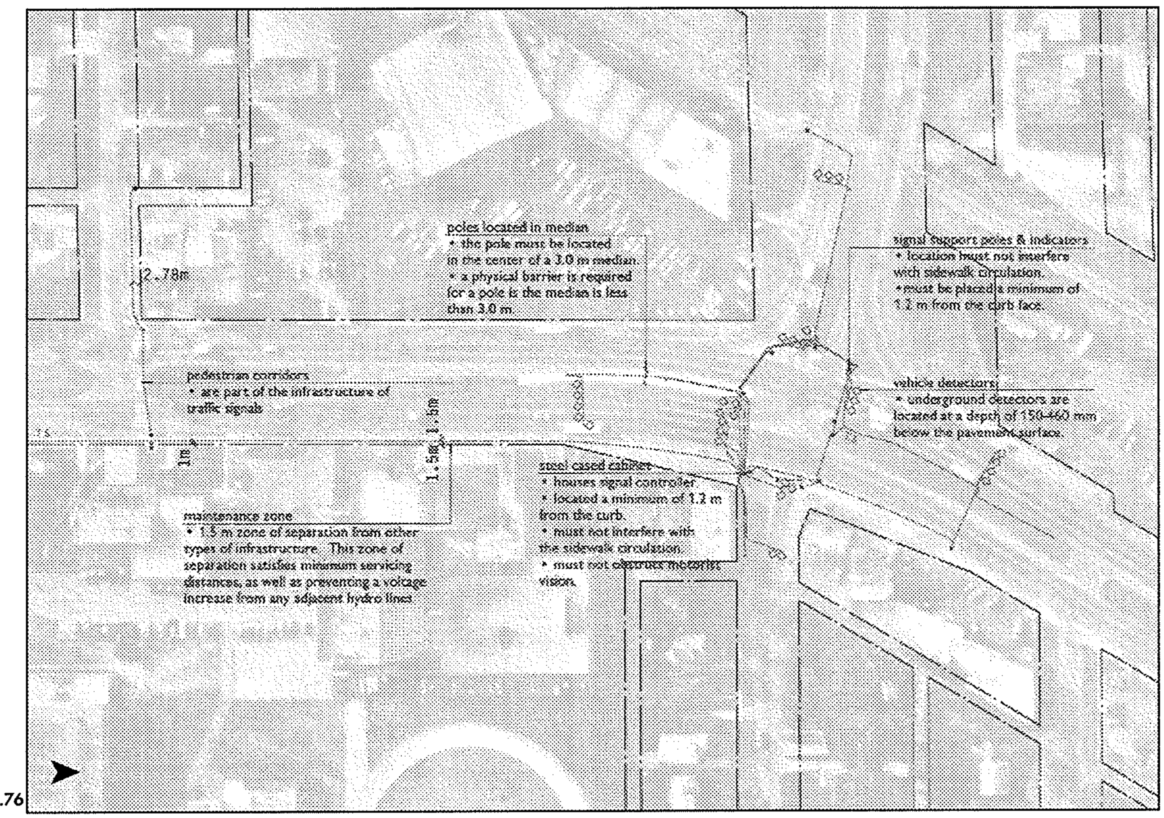
▸ Poles and pedestals must not be placed in sidewalks unless there is at least 1.2 m of sidewalk remaining on at least one side of the pole or pedestal.

▸ Poles and pedestals must not interfere with wheelchair ramps.

▸ Poles in roadway medians are acceptable provided that the median is at least 3.0 m wide. If the median is equipped with a *New Jersey barrier*, the signal pole may be

4.75 Work crews prepare to repair a damaged light standard.

4.76 Existing traffic signal infrastructure along portion of Pembina Highway.



4.76

placed in any width median, provided the pole and foundation are protected by the barrier.

The following practices are employed with regard to the placement of control equipment cabinets:

- Cabinets must be placed at least 1.2 m from the nearest pavement edge or curb face.
- Cabinets must be placed so that the sidewalk will not be blocked.
- Cabinets must be placed so as not to obstruct the visibility of a driver attempting to enter the intersection when the signal is in flashing operation.

Maintenance

The equipment utilized for the maintenance of traffic signals are a bucket truck and ladders to gain access to overhead traffic control infrastructure (figure 4.75). There are two types of maintenance that require attention, preventive and corrective:

- **Preventive maintenance** is performed on an annual basis using a set of procedures to preserve the intended working condition of the traffic signal system. Periodic maintenance of components includes inspection, cleaning, replacement and record keeping.
- **Corrective maintenance**, or *emergency maintenance*, is required when equipment breaks down or malfunctions.

Lifecycle

The typical lifecycle of traffic control signal infrastructure is 30-40 years. This figure is based on failures due to corrosion of the signal support pole. However, galvanized poles are replacing the older steel poles, which tend to have a lifecycle of approximately 40-50 years. Once a signal support pole reaches an age of 25 years, the pole is monitored more closely for any signs of failure.

Problems

- 90% of all damage to traffic control infrastructure is caused by vehicle collision in the City of Winnipeg.
- High winds can damage poles.
- Third party excavations can damage underground cable.

Design Response

The examination of traffic signals led to the following:

Technology: Third party software compatibility is an emerging technology of traffic signal controllers, where the controller can simultaneously operate traffic control signals and provide other services as well. The City of Winnipeg makes use of this technology by using two controllers as weather stations. The data from one of these controllers is not only utilized locally but is sent to a data base located somewhere in Omaha, USA. Therefore, the opportunity exists to utilize this emerging technology for the creation of amenities for human use within the ROW. Weather stations located at bus stops, for instance, may be plugged into existing controllers and provide local weather information at kiosks along the sidewalks.

Location: The location of traffic signals within the ROW must take place in the early stages of the project. In doing so, we will avoid tacking-on the signals at the end of the design process which may lead to problems as figure 4.77 illustrates.

Efficiency: Spacing lights between intersections is critical in allowing uninterrupted traffic flow. Pembina Highway has developed over time with little regard to the ideal spacing of traffic signals. This condition has lead to traffic congestion along areas of the commercial strip. The ability to resolve this issue appears unrealistic as it would require moving major intersections from their present location to fit the ideal signal spacing. However, in the design of a new street, the ideal spacing and sequencing of traffic signals must be considered at the beginning of a project to avoid the inefficient layout of these devices. ■

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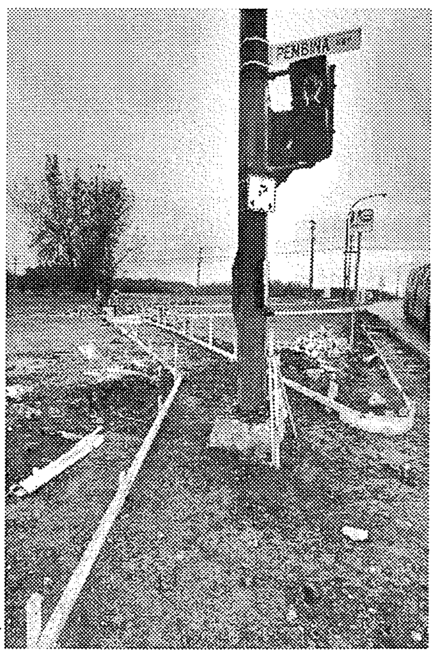


4.77 The placement of a traffic signal in the middle of the sidewalk.

public transit

Winnipeg Transit provides regular, special and emergency transit services with its fleet of diesel buses. Winnipeg Transit has an annual revenue passenger ridership of 40,000,000 people, an average weekday revenue passenger ridership of 140,000, an average Saturday revenue passenger ridership of 60,000, and an average Sunday/Holiday revenue passenger ridership of 28,500.

Components

Winnipeg transit operates its fleet of buses on city streets, primarily in the curb lane. Some lanes in the City of Winnipeg have been designated *Diamond Lanes*, which are for the sole use of Transit buses during peak periods.

The layout of the individual bus stop depends primarily upon the characteristics of the particular site (figure 4.78). However, the following components apply:

- On unpaved boulevards, a 1.0 m concrete pad walkway is provided from the sidewalk to the curb and back along the curb 7.75 m to the back door.
- Steel and glass shelters.

Location

There are three types of bus stop placements in the street ROW – nearside, farside and mid-block (figure 4.80). The type of stop chosen relies upon careful analysis of passenger/pedestrian movement, traffic flows and transit vehicle and route movement, and other site specific considerations:

- The front and rear door areas of a stop must be kept clear of trees, light standards, hydrants and other infrastructure.
- Stops are placed at intervals of approximately 200-300 m.
- Pedestrian lighting levels
- The proximity of major passenger origin and/or destination facilities.
- The proximity of usable infrastructure such as Hydro, which provides electricity for heated shelters. Winnipeg Transit will not, however, place bus stops near infrastructure that could pose a threat to passengers. An example is in the downtown area where Winnipeg Hydro has transformers located under the sidewalk. These transformers have the potential to explode: therefore, there are no bus stops located over this infrastructure.

Maintenance

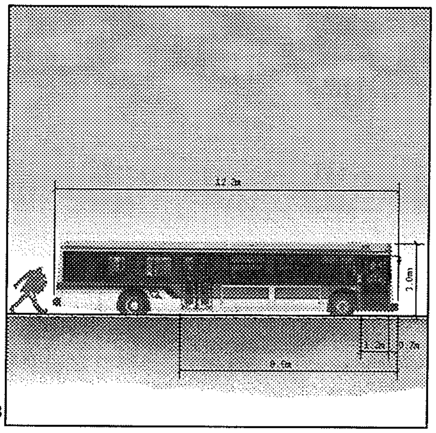
- The maintenance of bus stops is done using a van that houses equipment and supplies that are needed (figure 4.79). Equipment and supplies such as a high pressure washer and disinfectant are used for cleaning bus shelters.
- Bus stops are serviced on a weekly schedule determined by district.
- Bus shelters are serviced either once, twice or three times in a week according to route demand.

Lifecycle

- A diesel bus has the potential to have a lifecycle of 35 years or more.
- The lifecycle of transit bus stop components, such as a bus shelter or bench, is greatly influenced by vandalism and other factors. Winnipeg Transit's oldest bus shelter was approximately thirty years old. It was constructed out of wood and was highly effective in maintaining a warm temperature supplied by electric heat during the winter. However, the wood material was impossible to disinfect, which resulted in these shelters exhibiting an unpleasant aroma over time.
- The first shelters to replace these wooden ones were built in 1991 at Polo Park Shopping Centre. These shelters are constructed out of metal and glass which allow for easy cleaning and disinfecting. In addition, the kit-of-part construction allows for easy replacement of components if needed due to vandalism. The lifecycle of these metal bus shelters is yet undetermined, but could potentially last longer than the thirty year span of the wood shelters due to the durability of their materials.

Problems

- Vandalism.
- Vehicular contact with bus shelter.



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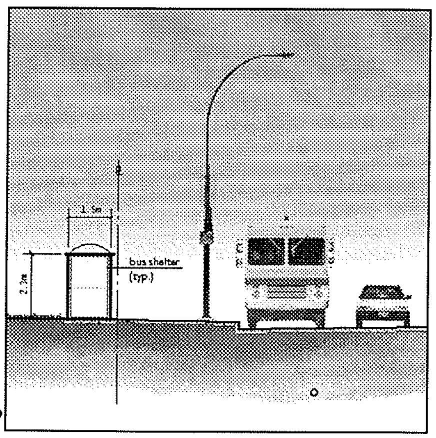
4.78 Required boulevard space for transit stops.

4.79 Typical bus shelter and maintenance vehicle, Winnipeg.



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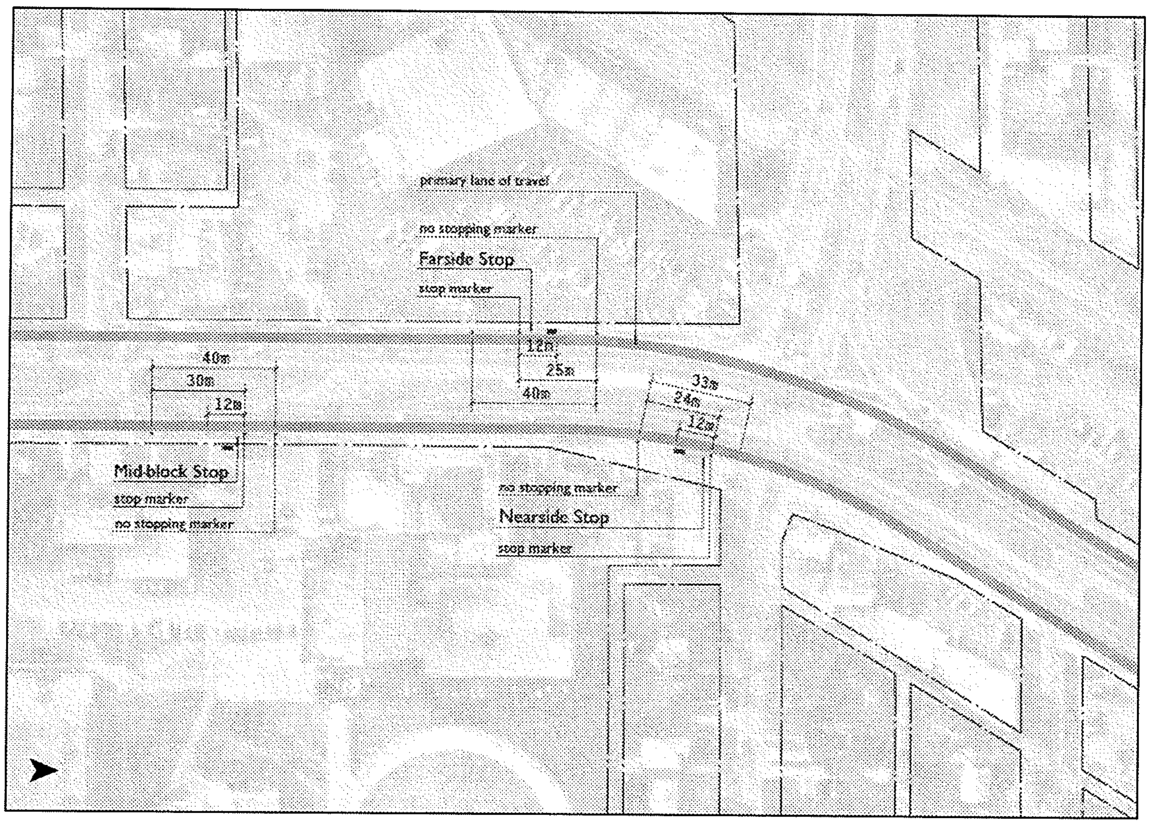
4.80 Existing bus stops types along portion of Pembina Highway.



4.80

▸ vehicular accidents.
▸ Traffic congestion.
▸ Mechanical problems with vehicles
▸ A major snow storm can essentially shut down service.
▸ The street boulevard acts as an area for snow storage through the winter. Snow affects the placement of bus stop components. Elements such as signs are placed away from the boulevard curb, near the property line, to avoid being ploughed over. In addition, snow ploughing can bury bus stops, making passenger loading and unloading difficult and unsafe. Thus, bus stops need to be cleared during ploughing of city streets.
▸ Heated shelters can cause ice, which results in slippery surfaces that are dangerous to passengers. As a result, maintenance crews sand icy areas, as well as equipping major stops with sand on site.

Design Response
When designing public transit, we must consider striking a balance between maintenance issues and human comfort, as well as better integrate the transit route and stops with the street and the neighbourhoods in which it passes through.

Balance: There is no question that transit furniture, such as benches and shelters, are highly susceptible to vandalism. Maintenance issues have overwhelmed human comfort issues as a result. The opportunity exists to strike a balance between these competing criteria and design bus stops to become more than areas to sit and catch the bus. For example, perhaps for maintenance and functional needs, bus shelters need to be constructed of glass and steel, but do benches really need to be constructed of steel? Consider using wood as a material for the bench as it has the ability to gain heat relatively quickly. Another example includes the introduction of some custom pieces to be added to the bus shelter kit-of-parts. These custom pieces could be used along a street and added to improve the shelter.

Integration: The effective integration of public transit within the ROW delivers a more efficient service to the public. Integrate transit service with the street so that it not only passes through neighbourhood, but becomes part of the neighbourhood. This is achievable by considering the design of the *transit route* and the *bus stops*:
▸ **Transit routes** along a major arterial streets such as Pembina Highway must be made more efficient by the introducing diamond lanes during peak travel times. The use of diamond lanes along Pembina Highway will greatly improve travel times, making the route more appealing to the motorized public, as well as regular ridership.
▸ **Bus stops** must truly be integrated with the street so that it works as a unit with other elements of the street. For example, consider the benefits of combining a bicycle or recreation trail with a bus stop – the trail will provide a setback for the location of trees so that they will not interfere with the loading and unloading of transit passengers. As well, by considering the benefits of a recreation trail with a high volume stop, other amenities, such as bicycle racks, built-in vending opportunities and bulletin boards, can become part of the design parameters of the stop. These amenities, combined with the benefits of a recreation trail, will not only produce a better stop but a better street. ■

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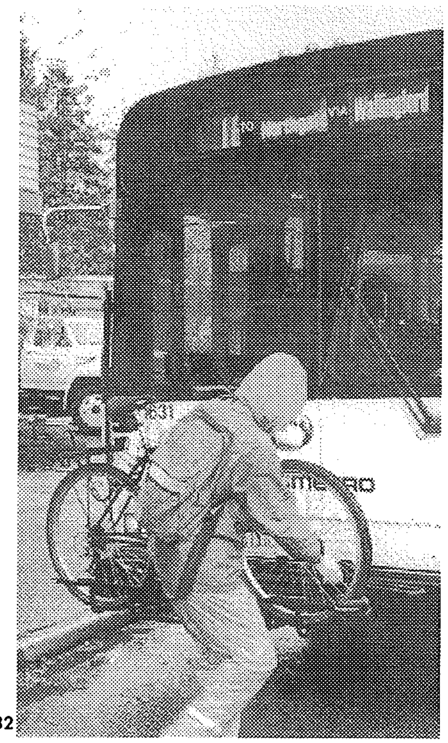

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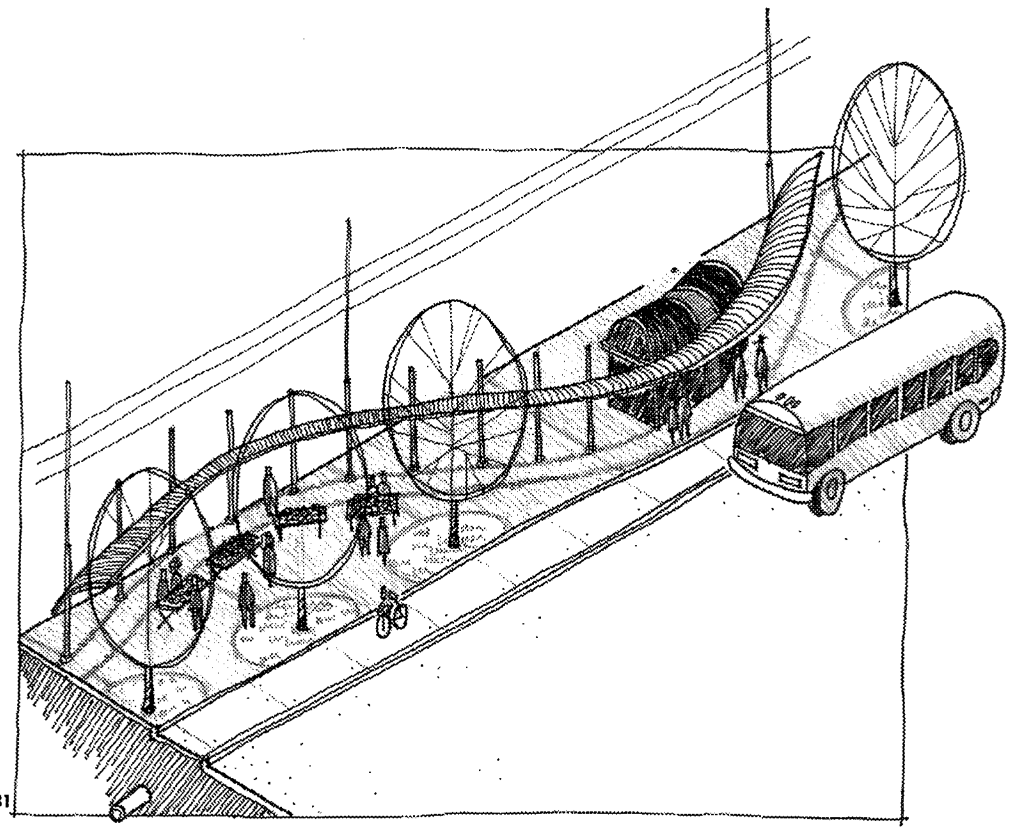
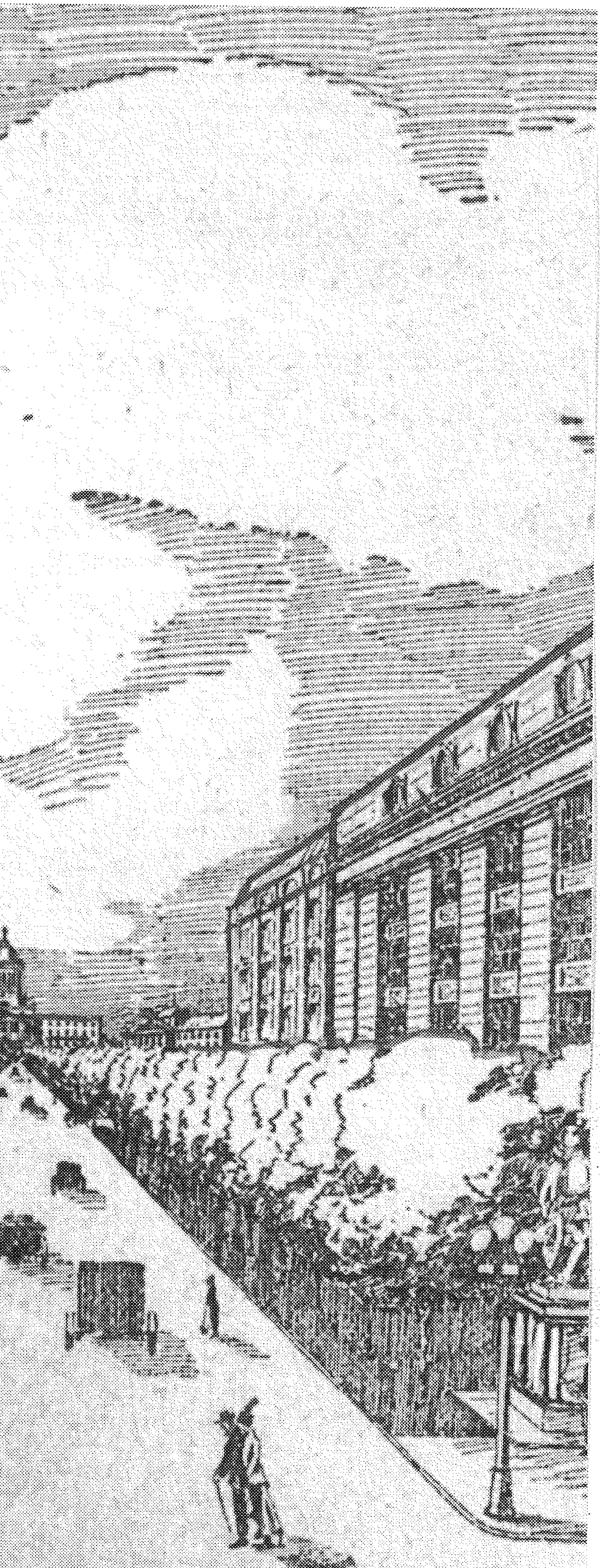
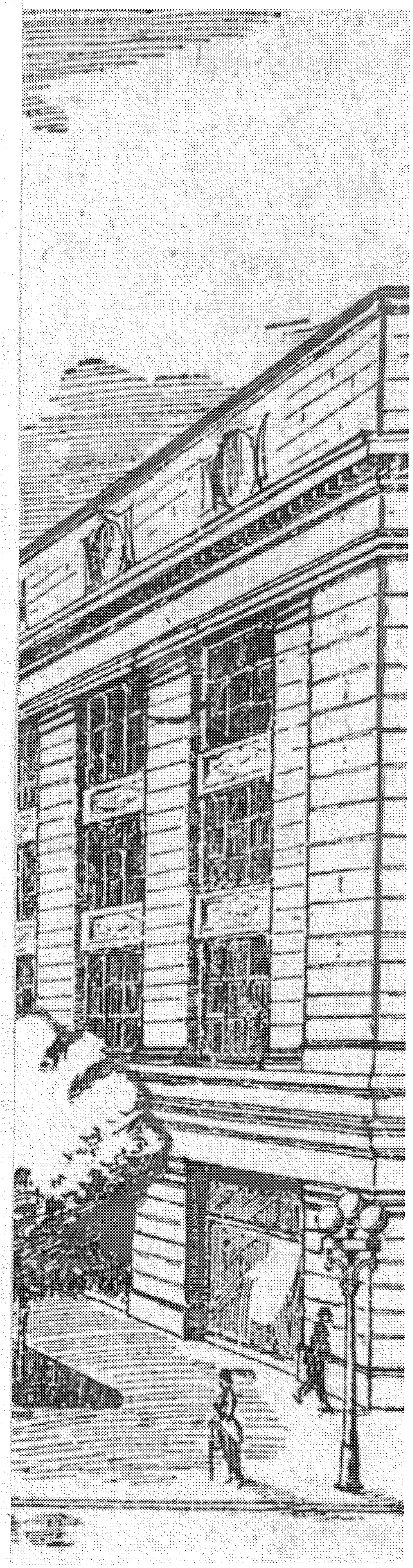


4.81 Integrate bus stop with street to produce an amenity space.

4.82 Bicycle rack on city bus, Seattle.





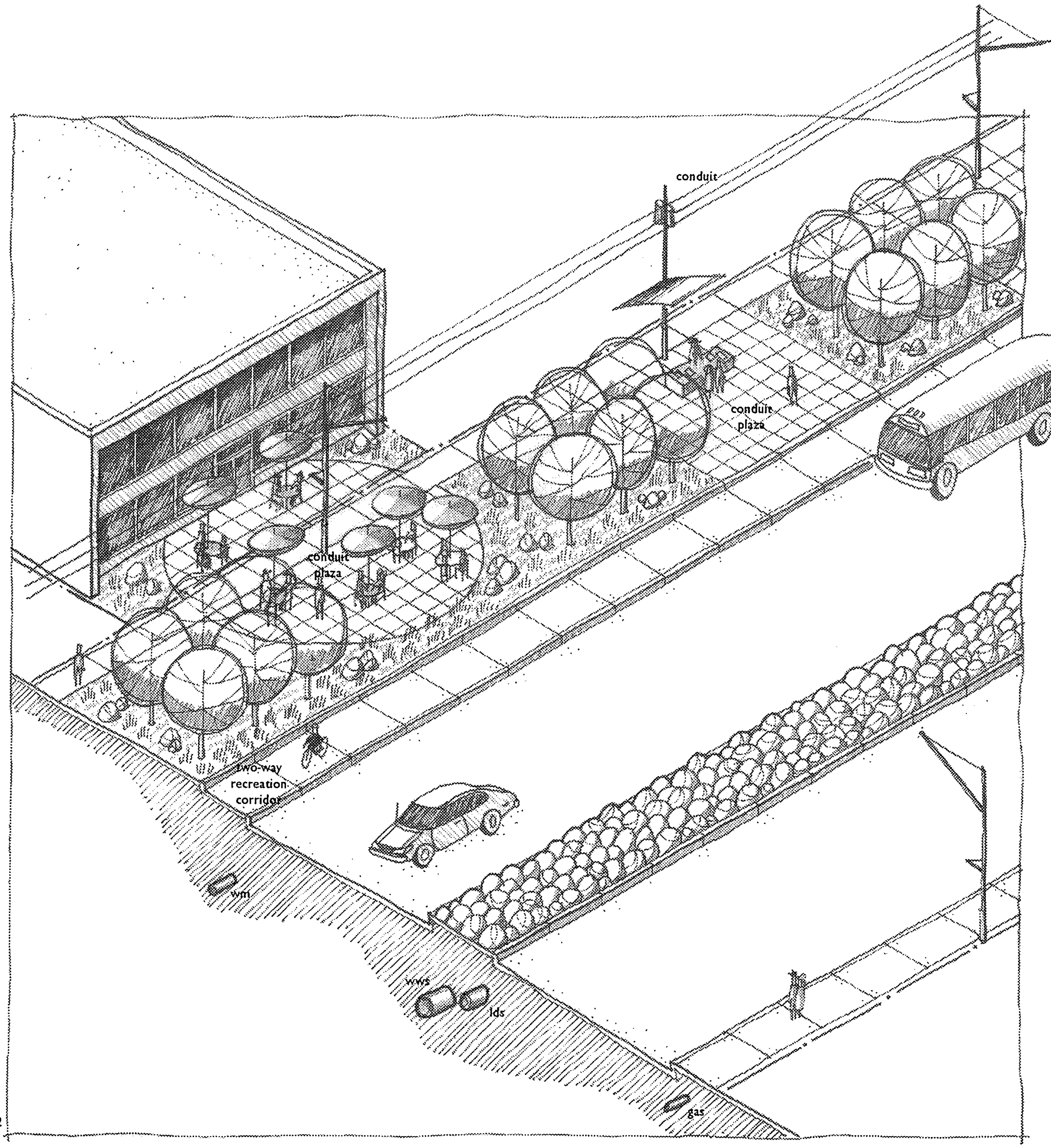
"To build or not to build"
Winnipeg Free Press

◄ **5.1** a vision of a new city street in Winnipeg, September 20, 1913.

5.0 intervention & transformation

After we examine Pembina Highway and the major arterial street, we realize that the different elements of infrastructure within the ROW must compete for very limited space. However, once these elements can work as a unit, they will greatly improve the quality of the street. Here, we will use the tools presented in the program analysis to rethink the ROW – to intervene with the existing street of Pembina Highway, and to transform the standard layout for the major arterial street – into infrastructure that is meaningful.

intervention I



5.2

5.2 Intervention I – character sketch of the conduit street.

5.3 Intervention I – proposed section of the conduit street.

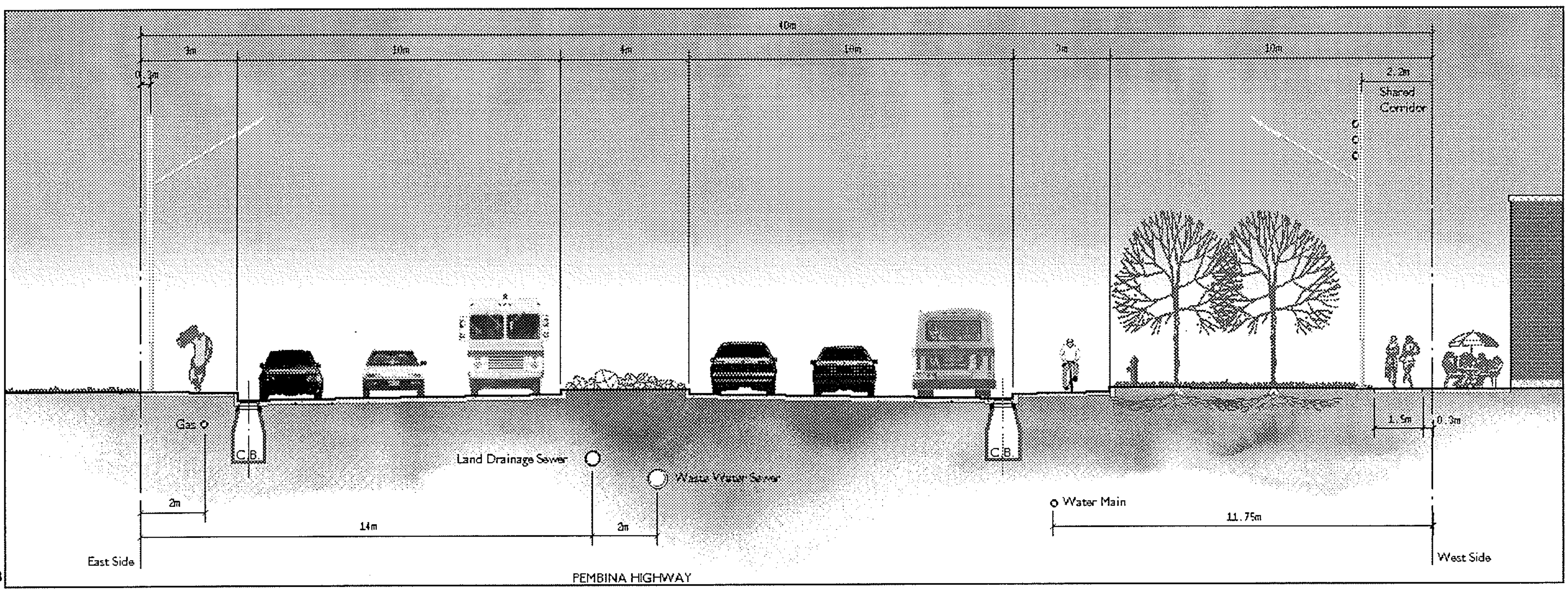
Pembina Highway

An overhead utilities corridor or conduit of electrical, communications and cable – usually regulated to backlanes or located underground – are revisioned to engage the senses and become an amenity. This conduit is located in the ROW to separate the different realms of the ROW – motorist and pedestrian. It is set-back from the street, where it is away from a potential vehicle impact, clear of being an obstacle for snow removal, while being fully accessible for maintenance. This set-back from the street functions as a two-way recreation corridor for cyclists, inline skaters and the like. Businesses along the pedestrian realm cater to the pedestrian, with sidewalk cafes, vendors and the like, while the realm of the motorist cater to the big-box development, gas stations and similar types of businesses.

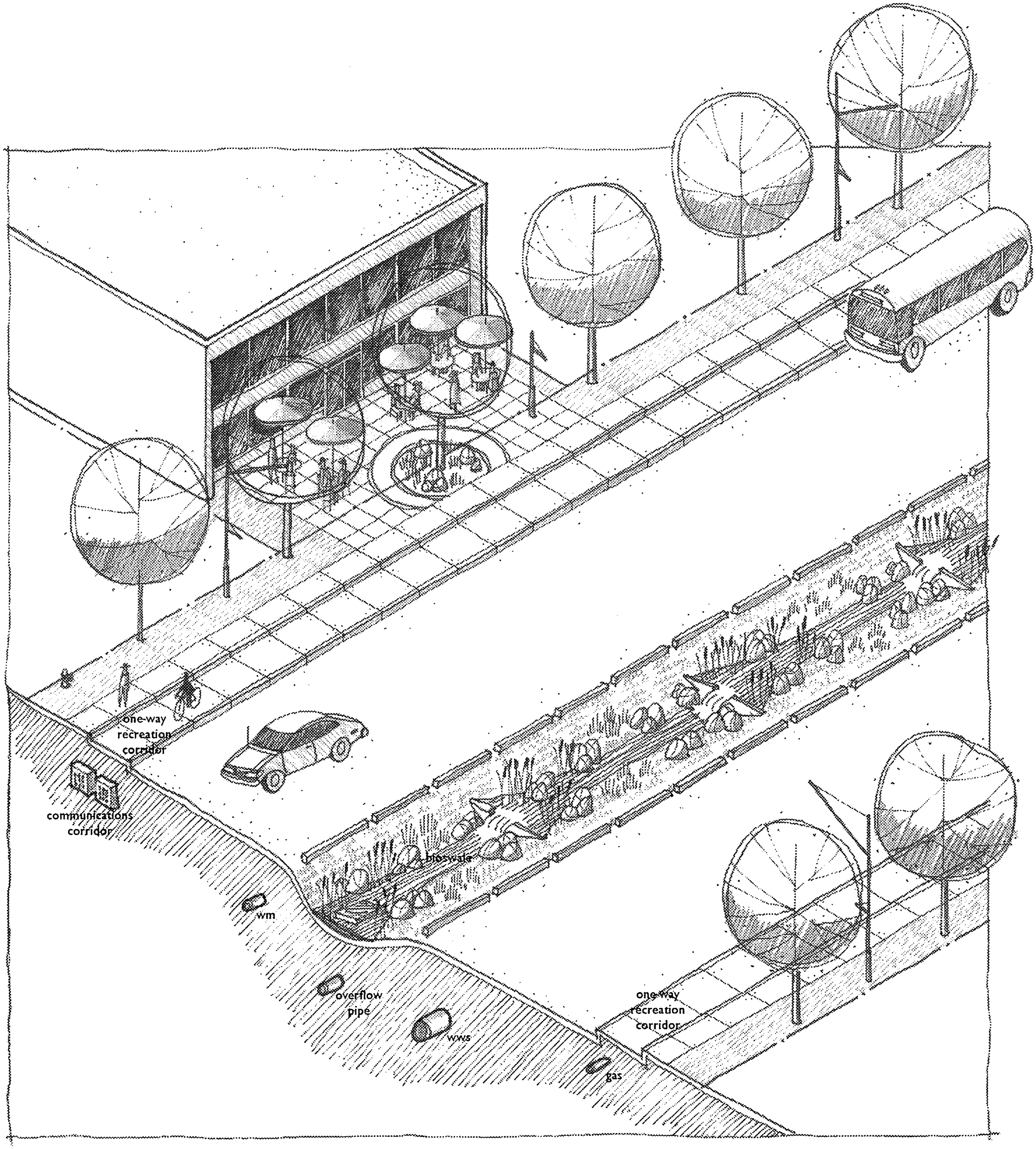
Rather than use standard woodpoles, an elegant steel structure is detailed to add visual interest and delight to the structure. Plazas radiate from the conduit poles that are equipped with plug-ins – electrical and fibre-optics – which offer public entrepreneurial opportunities. Space along the conduit can be rented for a small daily fee at the plaza location of ones choice. Along with the plug-ins will be a mix of permanent steel canopies and seasonal tent structures attached to the conduit. These additional amenities will offer shade from the sun and protection from the rain, which will contribute to a comfortable street environment. At night the conduit comes alive – impulses of light move along exposed fibre-optic cable affixed to the structure, adding to the delight and character of the street.

Alternating between the plazas of the conduit are clusters of trees. These plantings work with the setback of the recreation corridor to situate the trees away from the curb, where they are susceptible to the effects of salt spray. These clusters of trees share large soil volumes along the street which will promote healthy tree growth.

Together, the conduit and plantings create a dynamic condition along the street as patterns of human activity are divided by patches of trees which provide transition between these activities. Making an amenity out of what may be considered an eyesore will make this form of infrastructure part of our everyday lives. It will enhance the human experience of the street where people will be able to interact with it in a positive manner. ■

5.3


intervention II



5.4

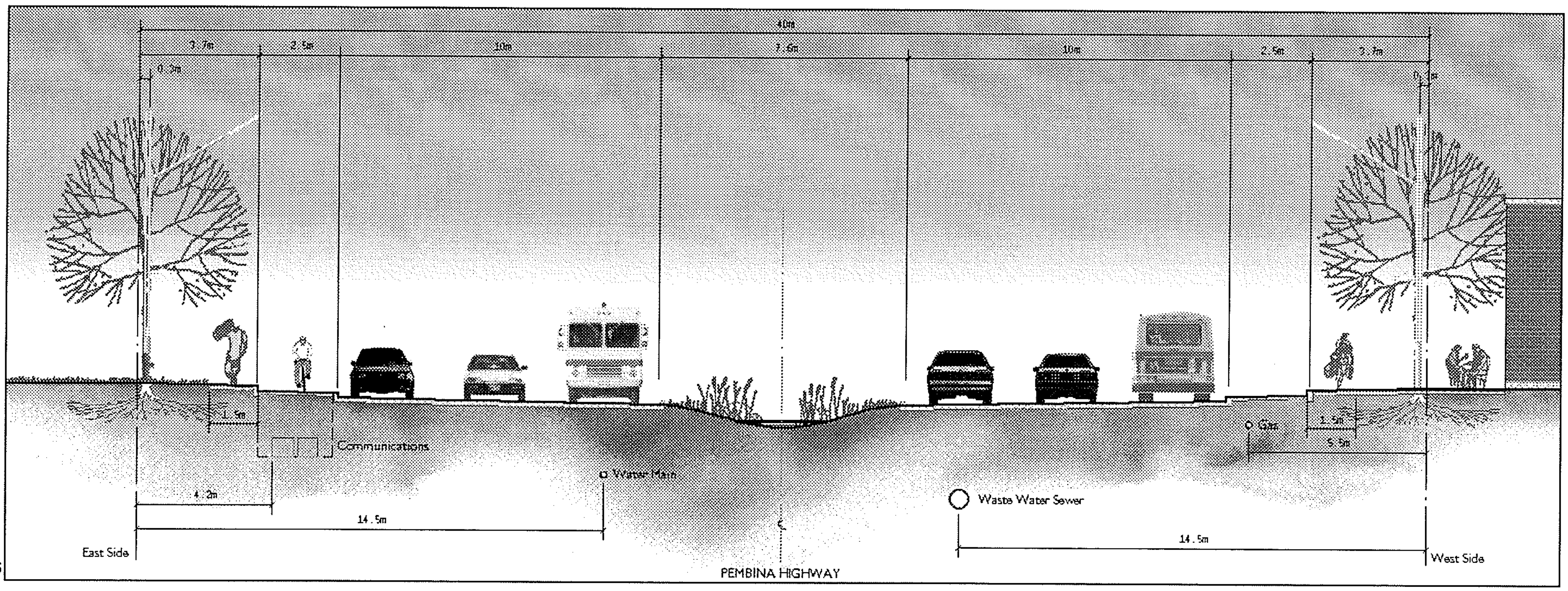
5.4 Intervention II – character sketch of the bioswale street.

5.5 Intervention II – proposed section of the bioswale street.

Pembina Highway

Intervention II improves Pembina Highway in two improtant ways. Tree lined boulevards serve to define the street, improve pedestrian comfort, and create visual interest and focus (see program analysis for details). However, in order that there be sufficient soil for the street trees to survive, they are placed so that their roots share the soil of adjacent properties. Property owners are required to meet minimum landscape requirements with a 1.2m strip of soft landscape, which provides opportunities to place trees where their roots can access more soil, and with little or no obstruction.

The tree-lined boulevards focus attention to the bioswale – the central line of axis for the street. This 7.5 m wide bioswale replaces the current 750 mm land drainage sewer pipe. Now used as an amenity, rainwater runoff is absorbed and retained on site. The bioswale becomes a living system of infrastructure that adds to the delight of the street: the sound of rushing water filtering the sound of the traffic, and the lush vegetation of the swale creating visual interest and focus. Besides adding delight to the street, this visible infrastructure becomes a tool to educate the public on the water's natural processes and the effects of urban environment on rainwater. ■



5.5

transformation

Major Arterial Street

Double tree-lined boulevards and a prairie meadow central axis transform the ROW into a greenway. Double tree-lined boulevards, designed to provide the spatial requirements for trees to grow to maturity, serve to define the street on many levels. On a micro level,these trees will define a comfortable environment for the pedestrian and the like. The closely spaced plantings offer shade in the summer and allow the sun to penetrate in the winter; they also reduce the impact of uncomfortable winds and protection from the rain. For the pedestrian, these trees will serve as a buffer from the traffic of the street, filtering noise and pollution. For the motorist and cyclist, the boulevard trees will reduce sun glare, making travel more comfortable and safe.

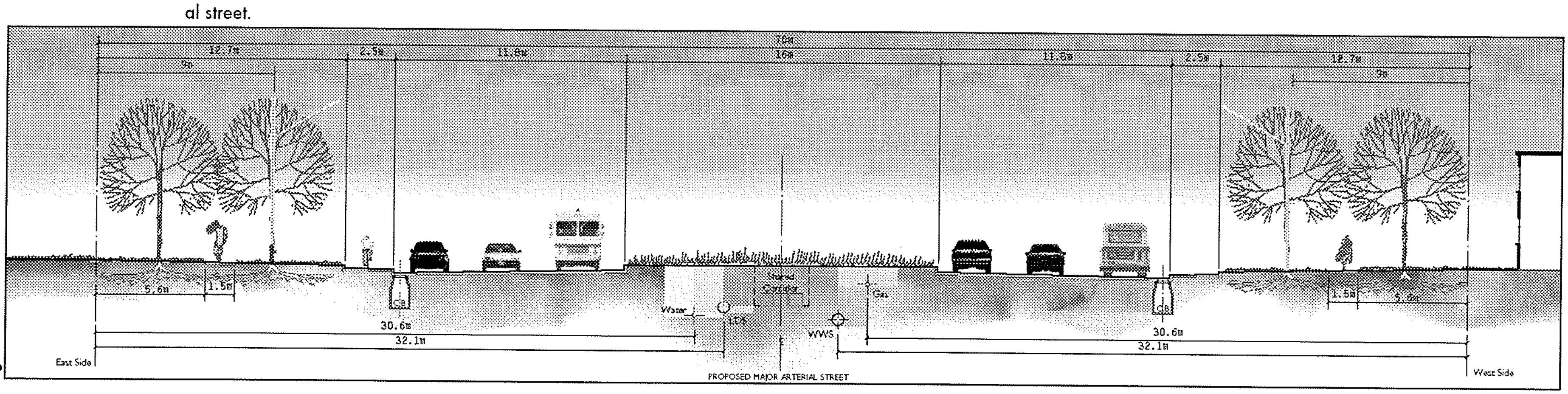
On the macro level, these planted boulevards define the neighbourhoods through which the street passes. A tree specimen will compliment each neighbourhood and provide transition between them by acting as a visual cue. More importantly, the double tree-lined boulevard, as applied to the typically undefined character of the commercial strip, creates an appealing environment that invites pedestrian interaction.

The boulevards provide the focus to the prairie meadow – the central line of axis of the street. This 16.0 m prairie meadow boulevard provides the spatial requirements for all underground utilities. When access to these services is required, the a soft landscape of the meadow is cut and then reinserted once the maintenance is complete.

Together, the double tree-lined boulevards and the prairie meadow transform the street into a comfortable greenway environment that enriches the experience of the street – joggers, pedestrians, cyclists, inline skaters, will enjoy the pathways; there will be pockets of human activity amongst the urban forest of the boulevard – cafes, markets, buskers and jugglers. The seasonal changes in colour of the trees and meadow along with their evolution over time add a dynamic level to the street as well. ■

5.6 Transformation – proposed section, major arterial street.

5.7 Transformation – character sketch of the proposed major arterial street.



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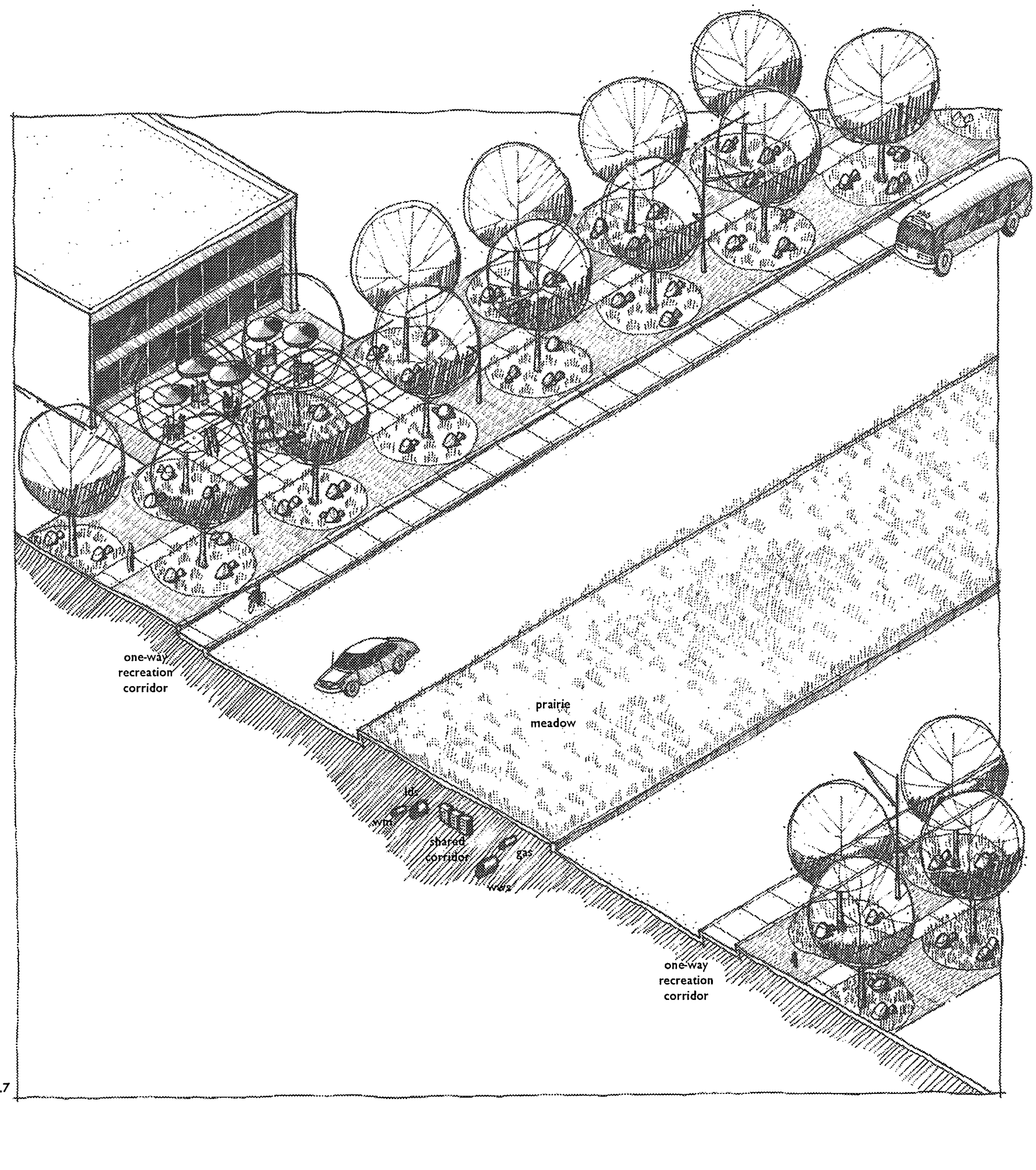
one-way
recreation
corridor
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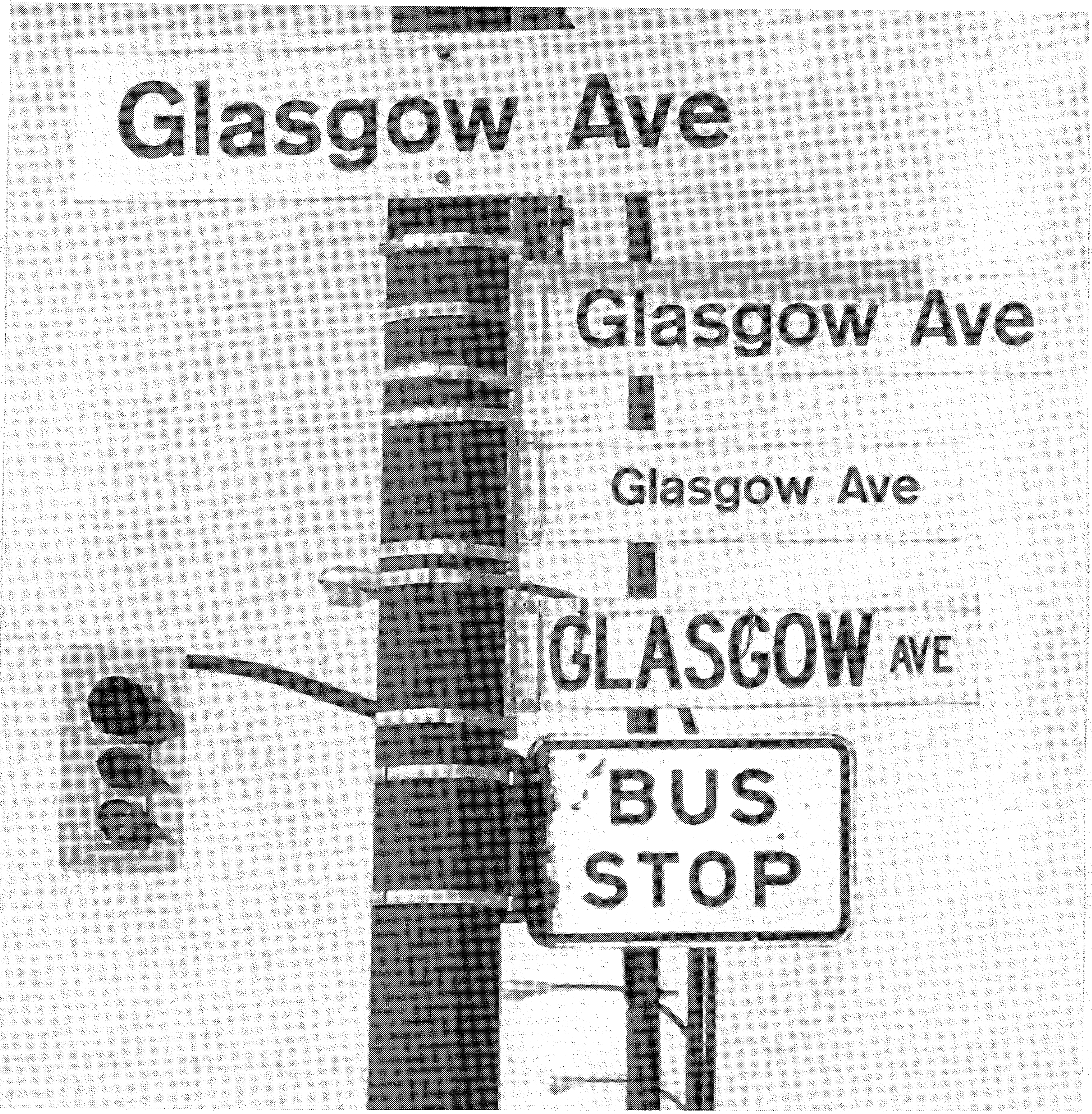
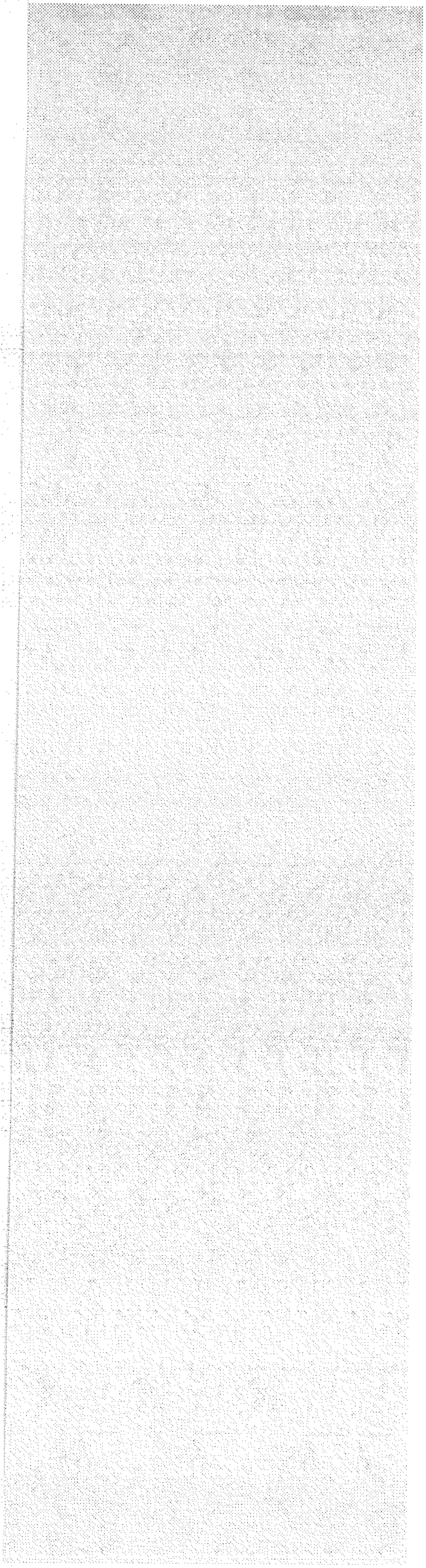
one-way
recreation
corridor

5.7

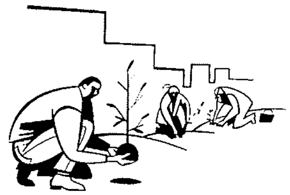

Glasgow Ave
Glasgow Ave
Glasgow Ave
GLASGOW AVE
BUS
STOP



Glasgow Avenue

◄ **6.1** testing street signs by the City of Winnipeg, March 7, 1972.

6.0



rethinking the ROW

Through this research we have examined infrastructure, looked at its potential, analyzed the infrastructure of the street, and illustrated how we can rethink the ROW in a number of different ways. Nine conclusions resulted from this research:

▸ Consider the spatial requirements of the all the infrastructure.

▸ Plant street trees where they have sufficient spatial requirements to grow.

▸ Ensure elements of infrastructure work together as a unit.

▸ Consider the ecological opportunities.

▸ Make infrastructure visible.

▸ Design infrastructure collaboratively.

▸ Avoid the tack-on approach.

▸ Invovle the community.

▸ Make infrastructure meaningful.

conclusions

Consider the spatial requirements of all the elements of infrastructure located within the ROW when designing the street.

This consideration will have an effect on the width of the ROW. It may be unrealistic to change the width of an existing ROW, but it is not impossible to increase the width of the ROW when designing a new street. The amount of space within the major arterial street is inadequate for the much of what is desired in street: tree-lined boulevards that provide a buffer for the pedestrian from the street; underground infrastructure located beneath a soft landscape for ease in maintenance; and wide traffic lanes for increased driver comfort. Placing a very rich pedestrian corridor along one side of the street and not the other illustrates the compromise of the narrow ROW width. Therefore, we must decide whether we want more out of our streets besides efficient traffic conduits.

Plant street trees where they have sufficient spatial requirements to grow.

The approach to the way trees are planted in our ROWs must change. In Winnipeg, trees are planted with the notion that they will live for only 7-10 years. This condition exists primarily because the spatial requirements of the trees have not been considered. If we want trees along our city streets, then we must reconsider how and where they are planted. The trees along Pembina Highway illustrate the effects of salt damage. Although they appear to have ample soil, the ground has been saturated with salt form the adjacent traffic lanes during the winter months. The areas surrounding the trees has also been disturbed and compacted by maintenance machinery used to service any infrastructure located along this same medium. Healthy street trees will transform our streets from traffic conduits to greenways. Only then will public access to green space improve. Trees will contribute to creating a comfortable streets that will encourage public use – places to walk, sit, run, shop and entertain.

Ensure elements of infrastructure work together as a unit.

For ROW infrastructure, working as a unit means sharing space and providing for multi-uses while respecting the spatial requirements of adjacent infrastructure. For example, the use of a recreation corridor located adjacent to the curb lane provides a safe route for the cyclist and joggers while at the same time providing a location for underground utilities, a place for snow storage during the wither months, as well as providing an unobstructed area for windrow removal and sight lines for the motorist. The value of having infrastructure working together as a unit transforms them into multi-functional elements that provide a series of benefits at little or no additional costs.

6.2 Section detail of an utility median illustrating the minimum distances required for maintenance.

6.3 Street tree, Winnipeg.

6.4 Working as a unit – sharing space.

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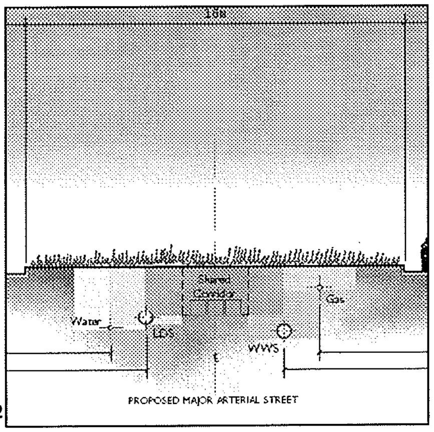

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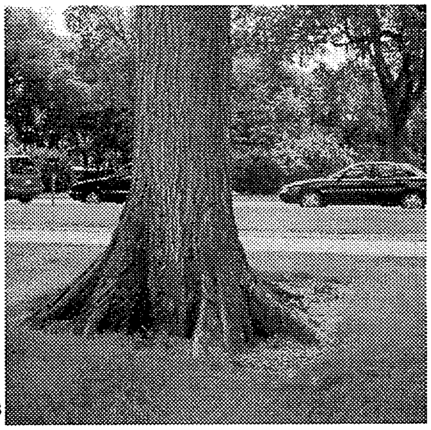

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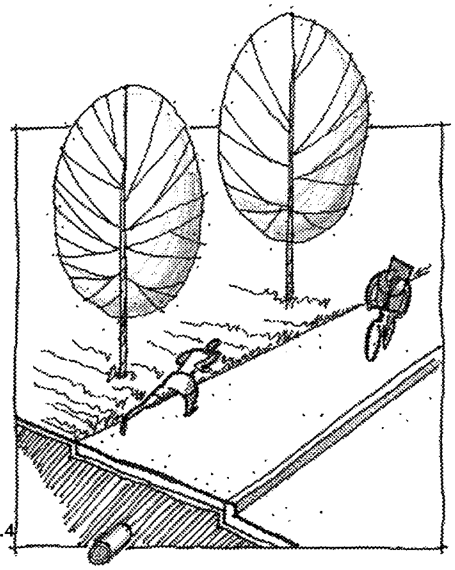

Consider the ecological opportunities when designing infrastructure.

As previously described in chapter 2.0, from an ecological standpoint, we cannot afford to continue to destroy our environments with our present one-way flow infrastructure. Ecological opportunities must be considered in the design of our infrastructure. Filtering pollutants from runoff through the use of bioswales in one such example. The value of this design approach is the regenerative benefits produced by the infrastructure. In the case of the bioswale, runoff water is filtered and used onsite – to replenish ground water and support a variety of plant life. This means of stormwater management will also become a visual tool to educate the public about the process of rain water, to name a few.

Make infrastructure visible.

Infrastructure that is visible and integrated with everyday life is meaningful. The conduit of design intervention I or the bioswale of intervention II are examples of visible infrastructure. The value of visible infrastructure is that it fulfills educational roles by revealing the public how it works as well as adding delight to the experience of the infrastructure.

Design infrastructure through the collaborative design approach.

Streets are a type of infrastructure that serve a variety roles – for the moving goods and services, providing a place to do business and serving as a place for a street festival or parade. If we consider these many functions of the street, then we must conclude that designing a ROW must be a collaborative approach. As described in chapter 3.0, the Humber Bridge in Toronto illustrates the benefits of such a design approach. A broad multidisciplinary approach to the design of infrastructure opens the door for a greater range of opportunities. By freely exchanging ideas, engineers, landscape architects, artists, architects and the like may design a street ROW that succeeds on many levels, beyond that of an efficient traffic conduit.

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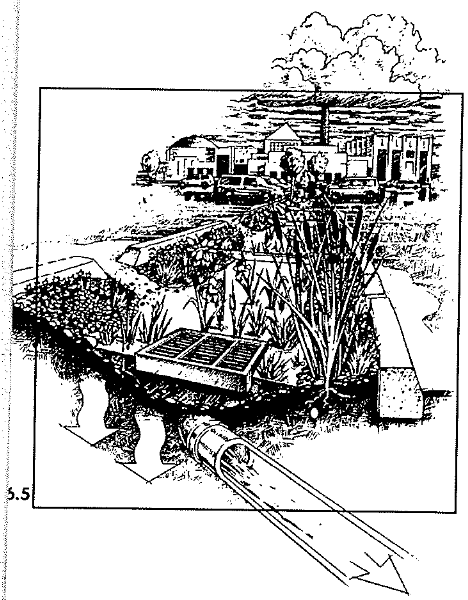

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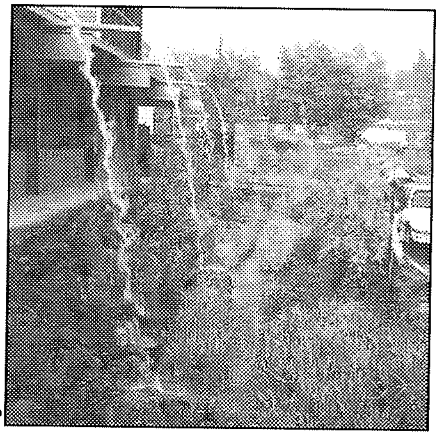

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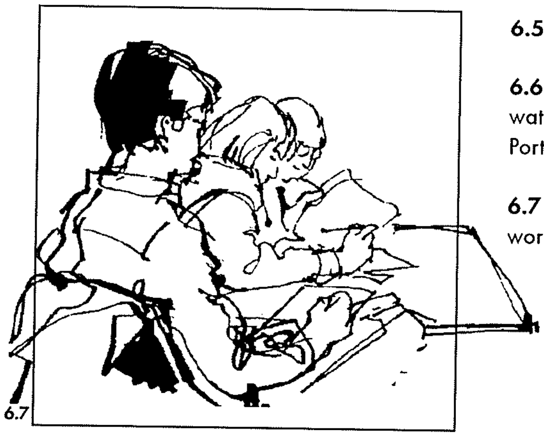


6.5 Bioswale.

6.6 Scuppers direct water into bioswale, Portland.

6.7 Professionals working together.

Avoid the tack-on approach to the design of infrastructure.

The tack-on approach, as discussed in chapter 3.0, is often applied to infrastructure projects. Metal trees of a streetscape project along a stretch of Portage Avenue in Winnipeg are an example of the tack-on approach to infrastructure. These "trees" were selected due to the short lifecycle of street trees in Winnipeg. The price tag per tree was roughly $3,800. Perhaps if the other elements of the ROW infrastructure were considered through the design process, real trees could have been planted that would survive. Design opportunities can be lost as illustrated with the metal trees.

Involve the community in the design of their infrastructure.

Infrastructure projects are often met by public resistance. This resistance is often associated with the public's negative perception about infrastructure as described in chapter 2.0. However, community involvement in the design of infrastructure will change these perceptions and increase the effectiveness and acceptance of the infrastructure project as a cultural amenity. The Main Street Norwood bridge in Winnipeg illustrates the value of having the community involved in its design; the design addresses community needs such as providing bicycle lanes, viewing areas and river access, rather than only fulfilling basic functional roles such as traffic movement.

Make infrastructure meaningful.

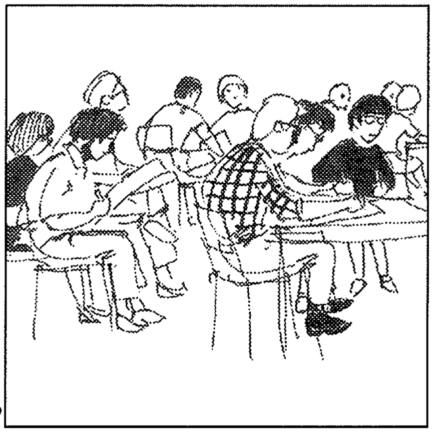
As discussed in chapter 2.0, infrastructure is generally viewed as an eyesore – something to be screened or buried from sight. However, there are opportunities to transform these "eyesores" into meaningful places. Taking a purely functional element, such as a Hydro pole, and rethinking it as an element that is interactive and supports a variety of roles, illustrates this transformation. The value of integrating infrastructure into the public realm is that it allows people begin to understand and appreciate it. While a typical infrastructure project may meet public resistance, infrastructure that is meaningful and expressive of place can become accepted sources of public pride.

6.8 Metal street tree, Winnipeg.

6.9 Community involvement at a public workshop.

6.10 Character sketch of a "Conduit" plaza.

6.8


6.9


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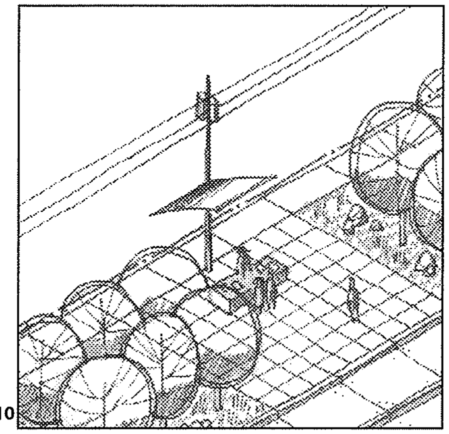

Areas for further research

The ideas presented in this study must be examined further and built upon. To illustrate, replacing a land drainage sewer with a vegetated bioswale is a complex topic that exceeds the scope of this research – maintenance issues, methods of controlling erosion in open channels, risk analysis of land drainage systems are a few of the areas that require further investigation on the topic. In addition to further research on the infrastructure presented in this study, there exists many types of public works projects – Hydro electric dams, power plants, waste water treatment plants, old and abandoned infrastructure are a few examples – that must be studied and rethought to go beyond fulfilling their basic functions. The Water Pollution Control Laboratory in Portland or the 27th Avenue Solid Waste Management Facility in Phoenix are a few of the examples that illustrate the design opportunities for our infrastructure.

An opportunity exists to rethink our infrastructure and better integrate it with our built environment making it multi-functional, interactive, and most of all, meaningful. ■

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Ken Boyd, Support Services Engineer
City of Winnipeg, Street Maintenance Division
interviewed: December 4, 1998
Roy Hartmann, P. Eng.
City of Winnipeg, Traffic Assessment Engineer
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Kas Zurek, P. Engineer
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Rob Small, Director of Operations
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Ken Ducheminsky, P. Engineer
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Terry Josephson, Water Waste System Planning Engineer
City of Winnipeg,Waste Water Division
interviewed : October 30, 1998

Chris Macey, P. Eng.
UMA, Senior Municipal Engineering Specialist
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Gerald J.Kuta, Senior Forestry Technician
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Ralph Johnson, Field Supervisor
City of Winnipeg, Traffic Service Branch
interviewed : November 17, 1998
Walter Chubey, Shop Foreman
City of Winnipeg, Traffic Service Branch
interviewed : November 18, 1998

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Bruce McPhail, P. Eng.
Manager of Streets Maintenance
The City of Winnipeg, Public Works Department
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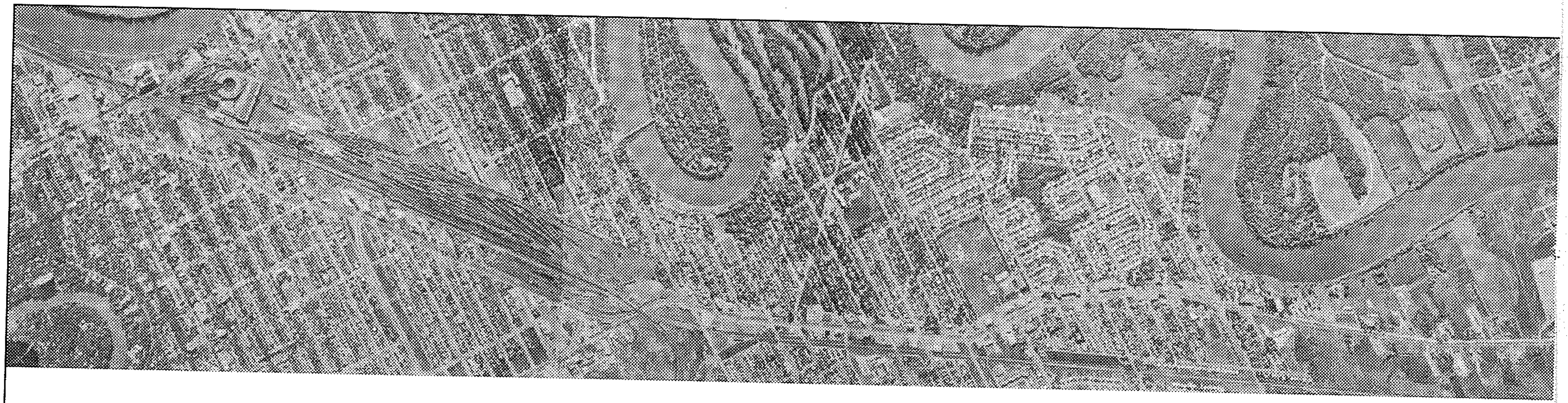
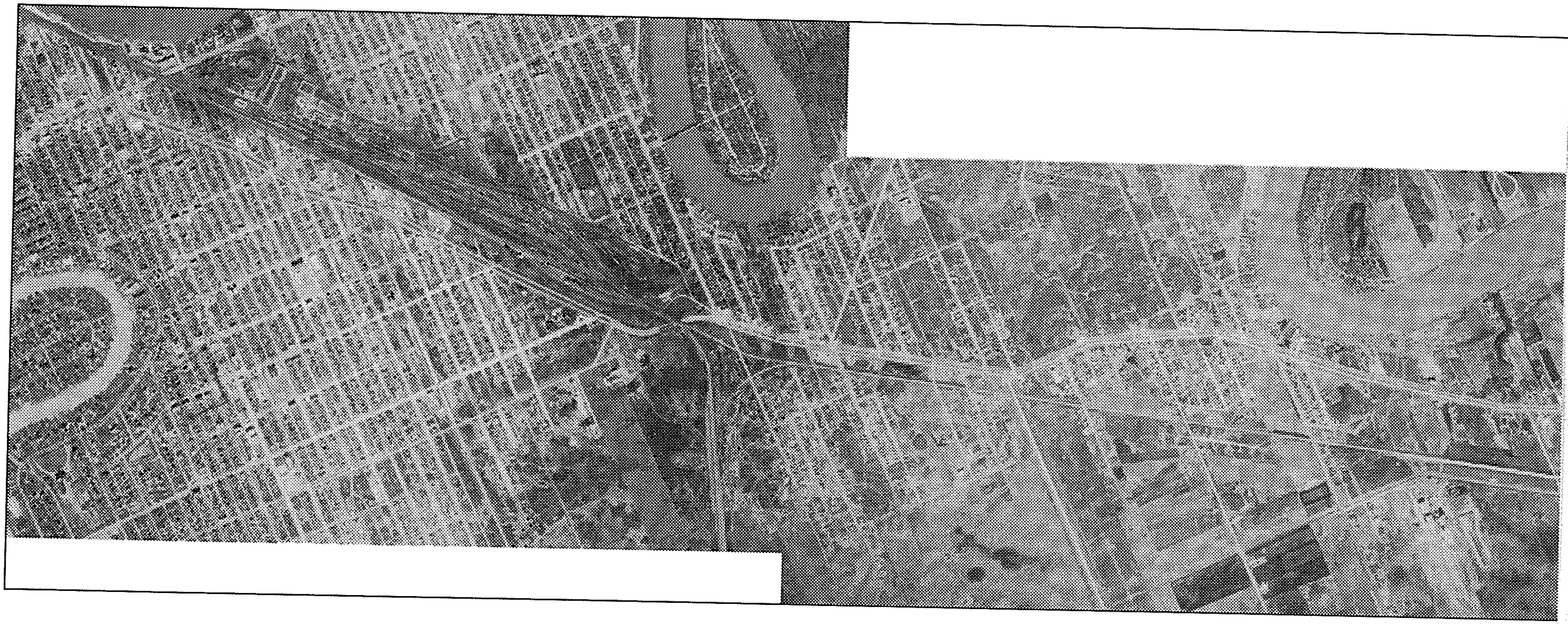
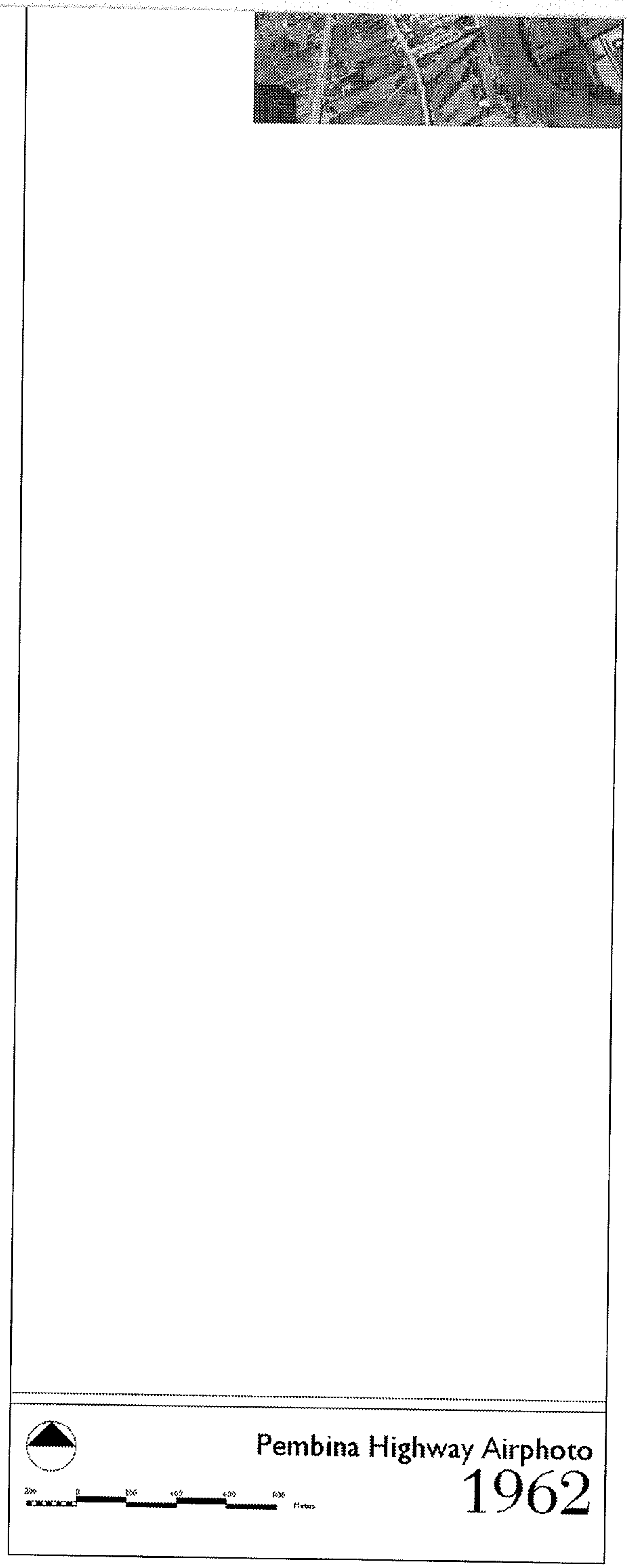
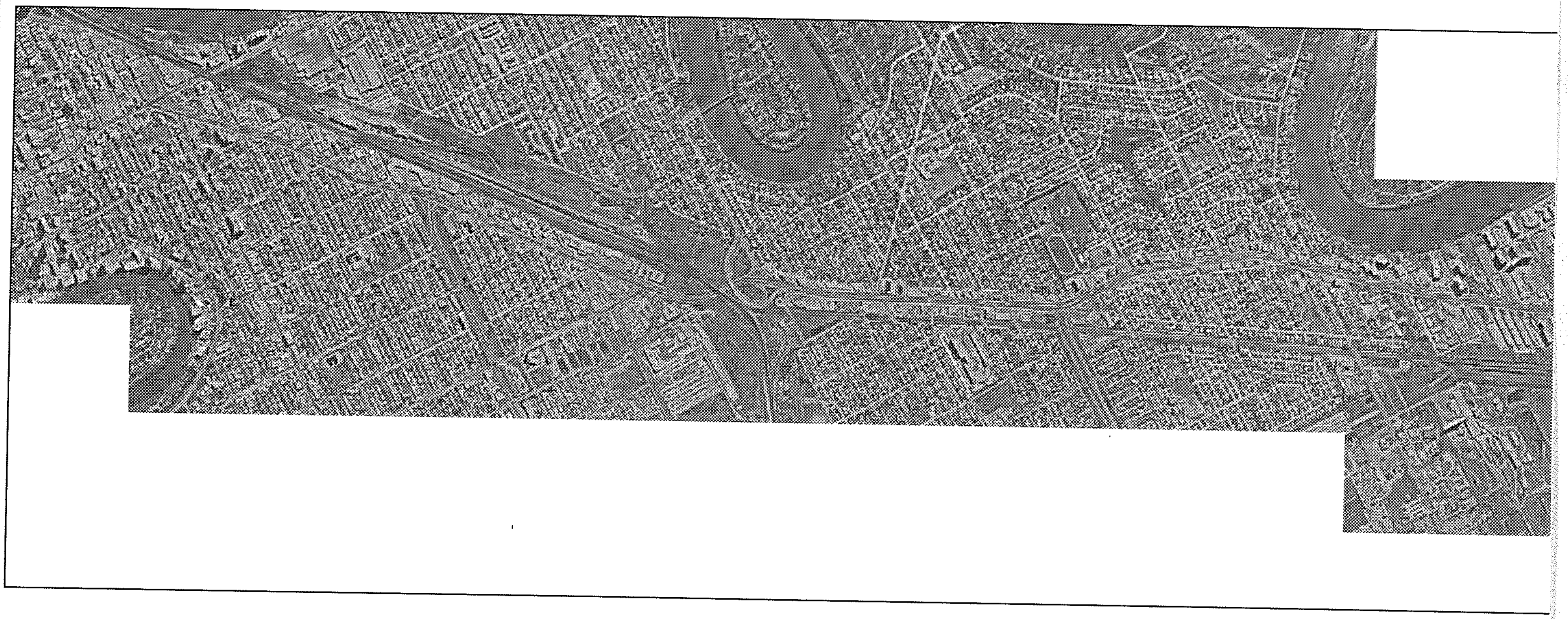
appendix A
pembina highway: airphotos

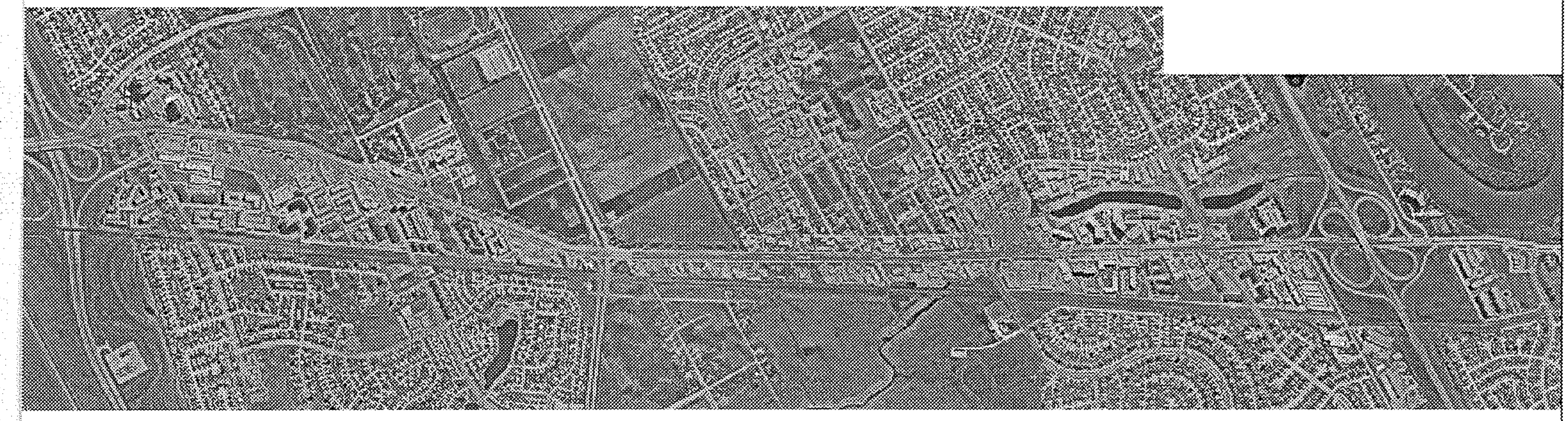





Pembina Highway Airphoto
1946
Metres


Pembina Highway Airphoto
1962
Metres

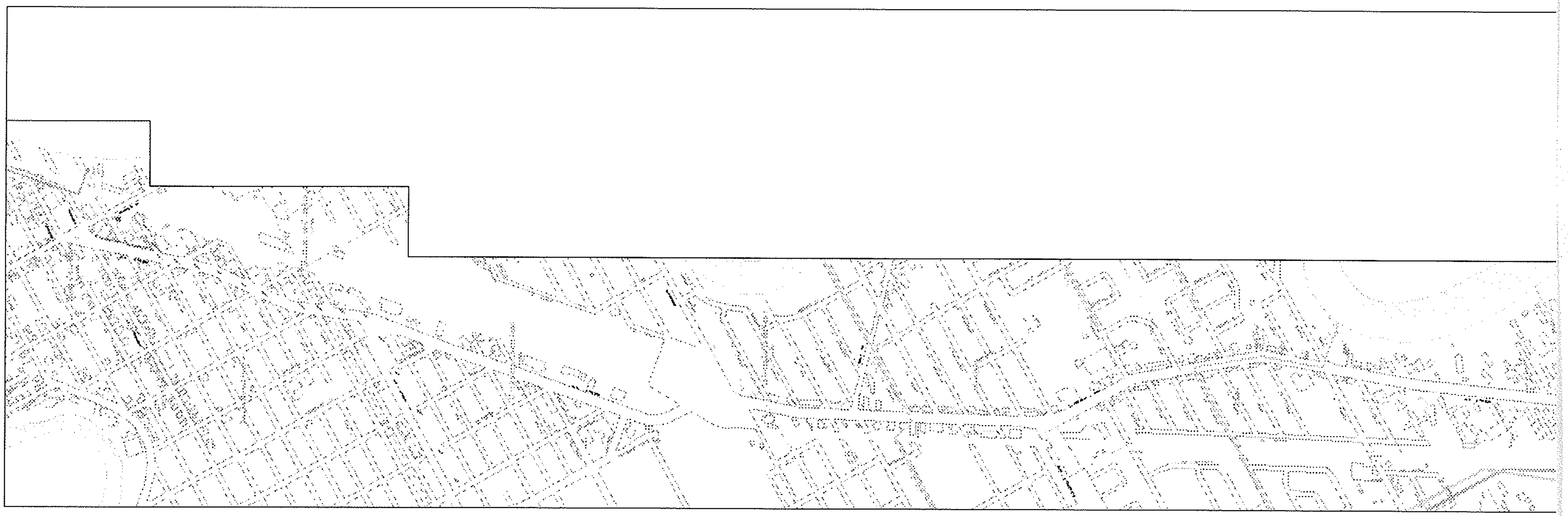


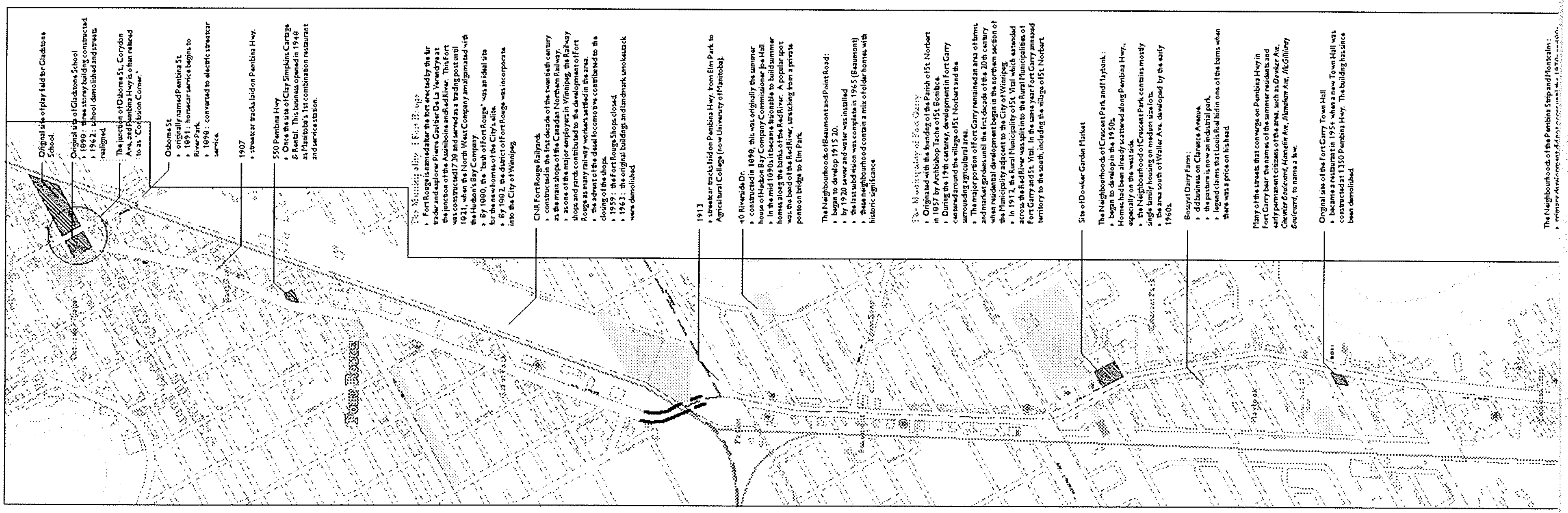


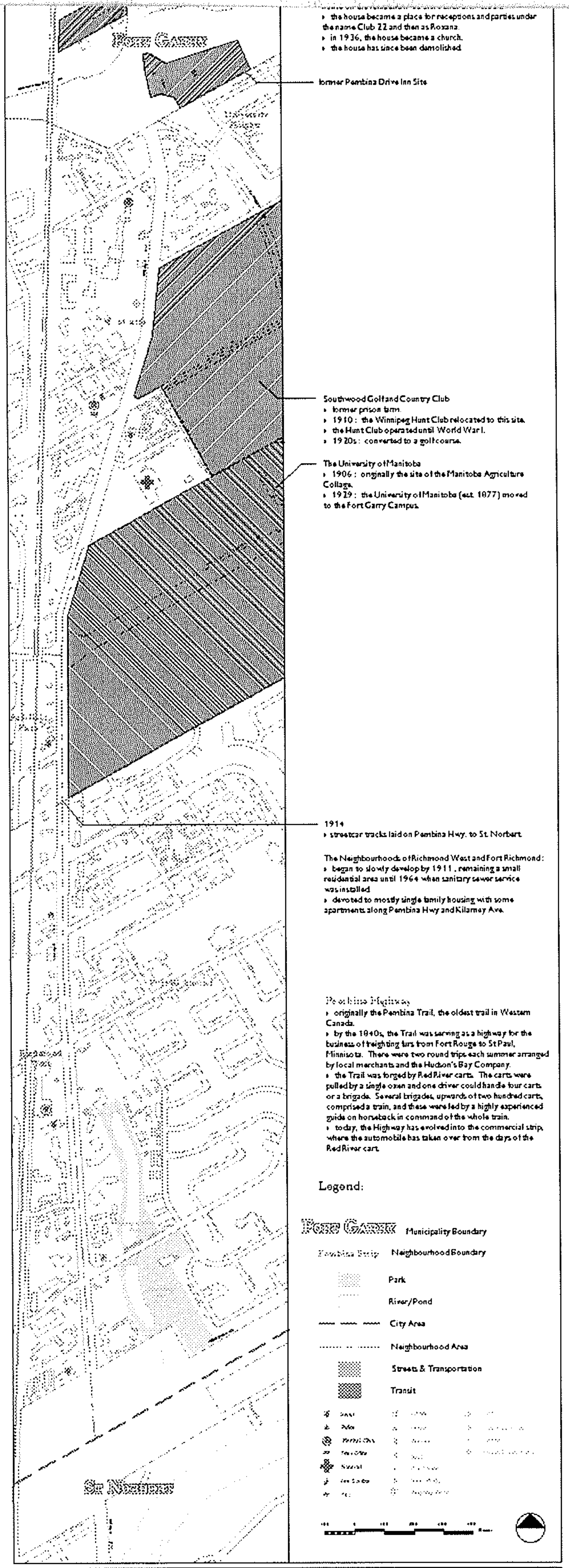
Pembina Highway Airphoto 1993

Pembina Highway Airphoto 1980

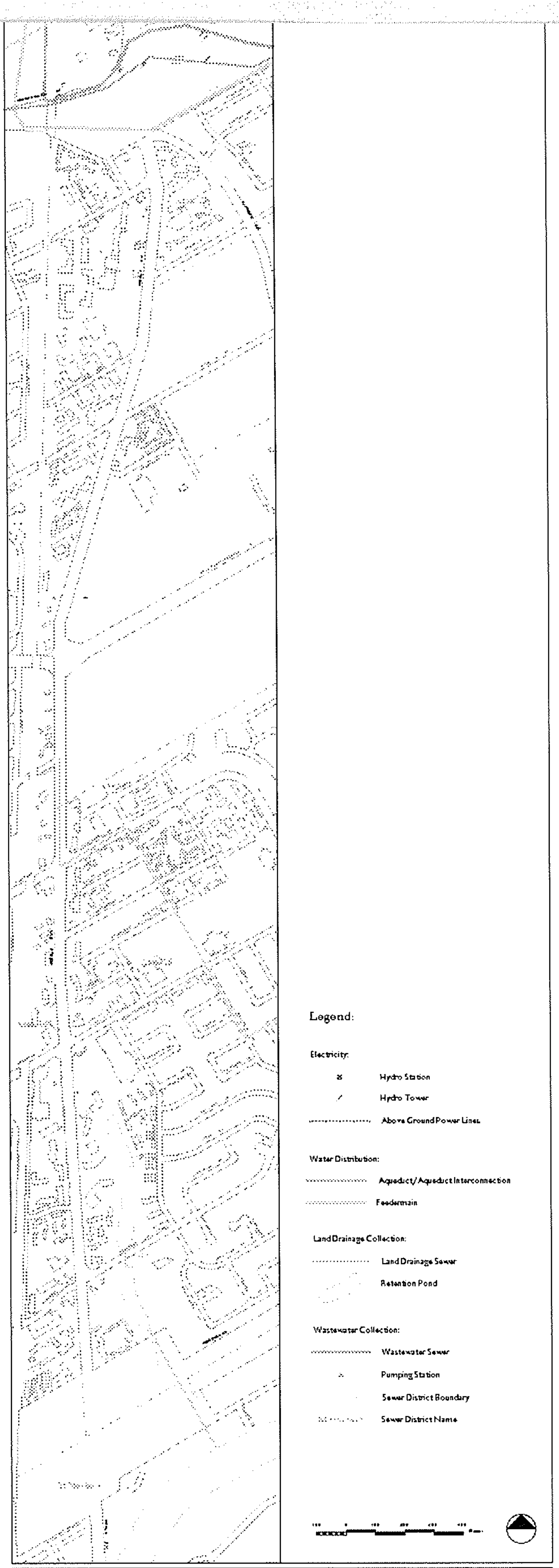
appendix B
pembina highway: site analysis



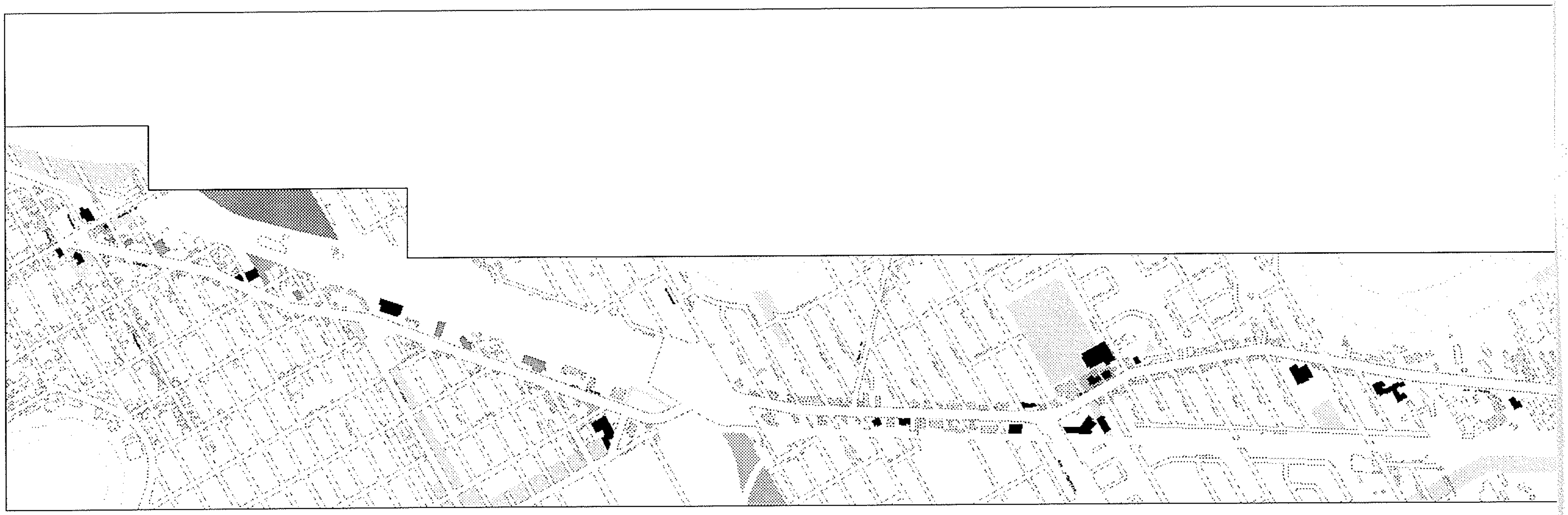


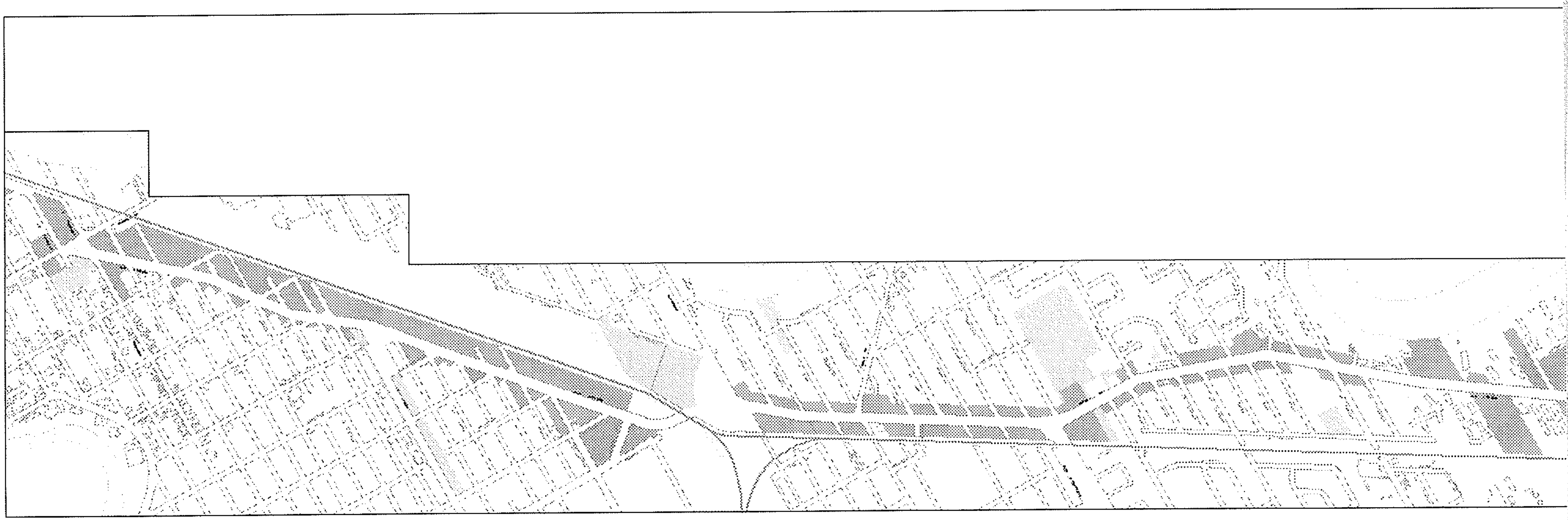


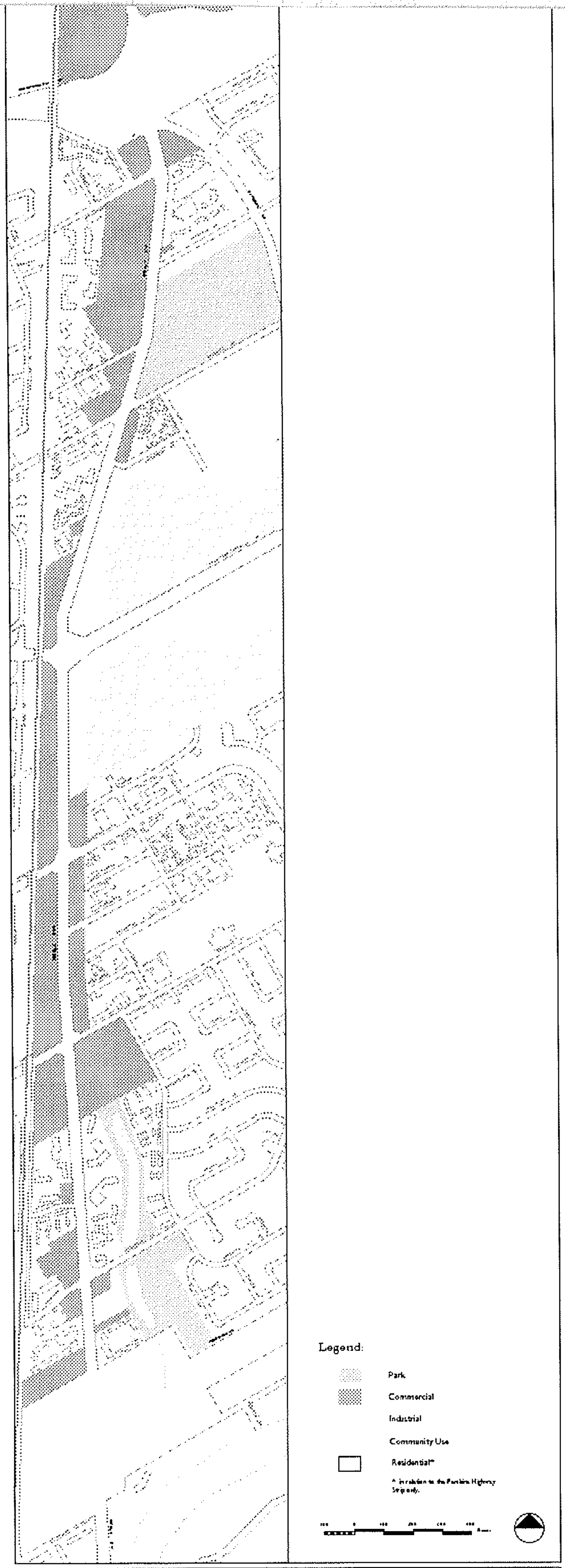
Pembina Highway Site Analysis
Neighbourhood



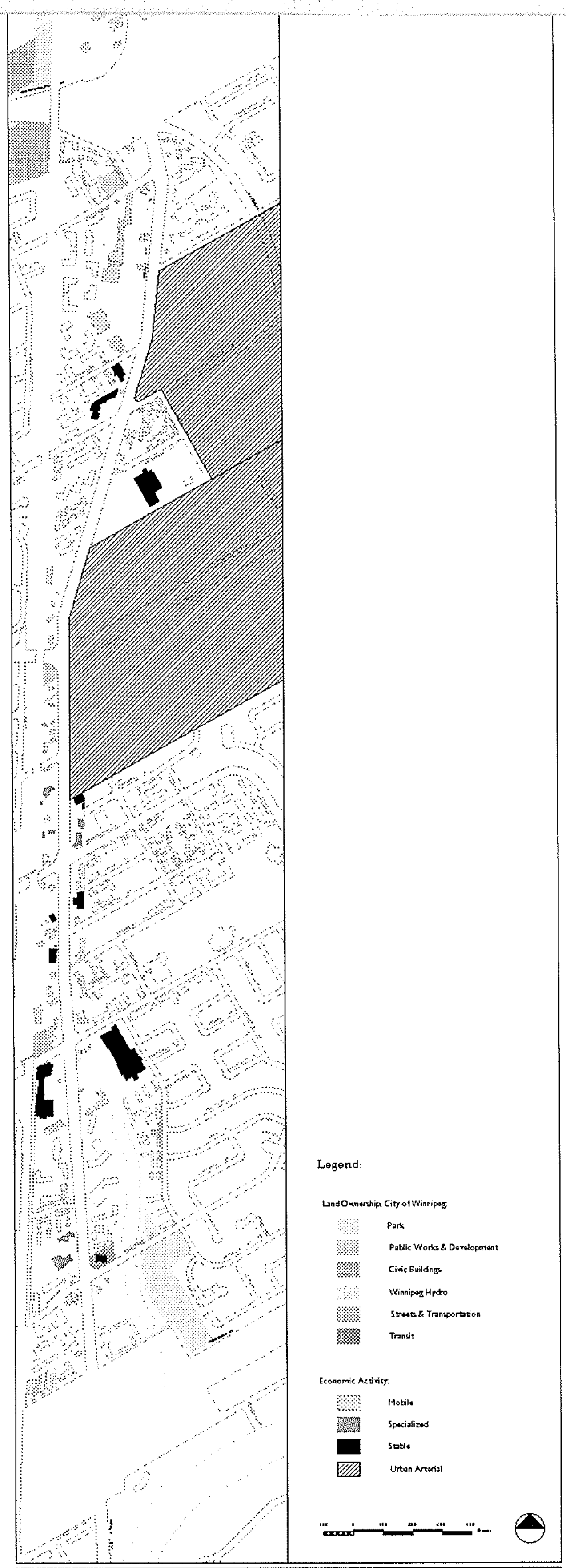
Pembina Highway Site Analysis
Infrastructure



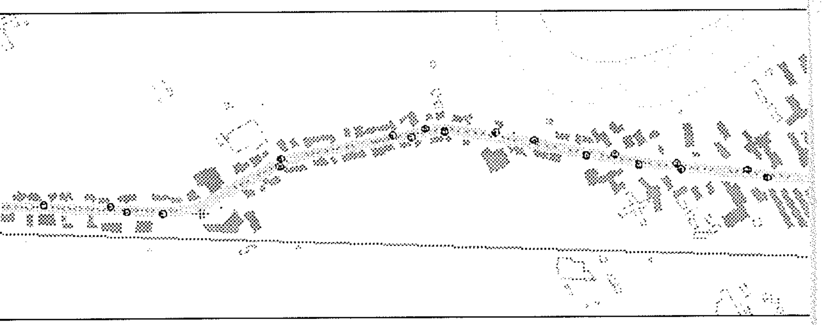


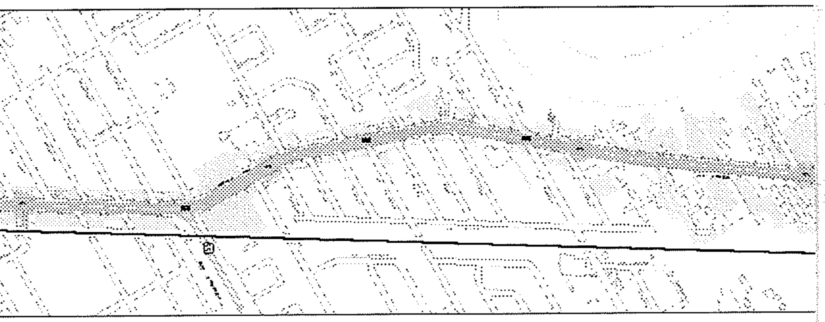


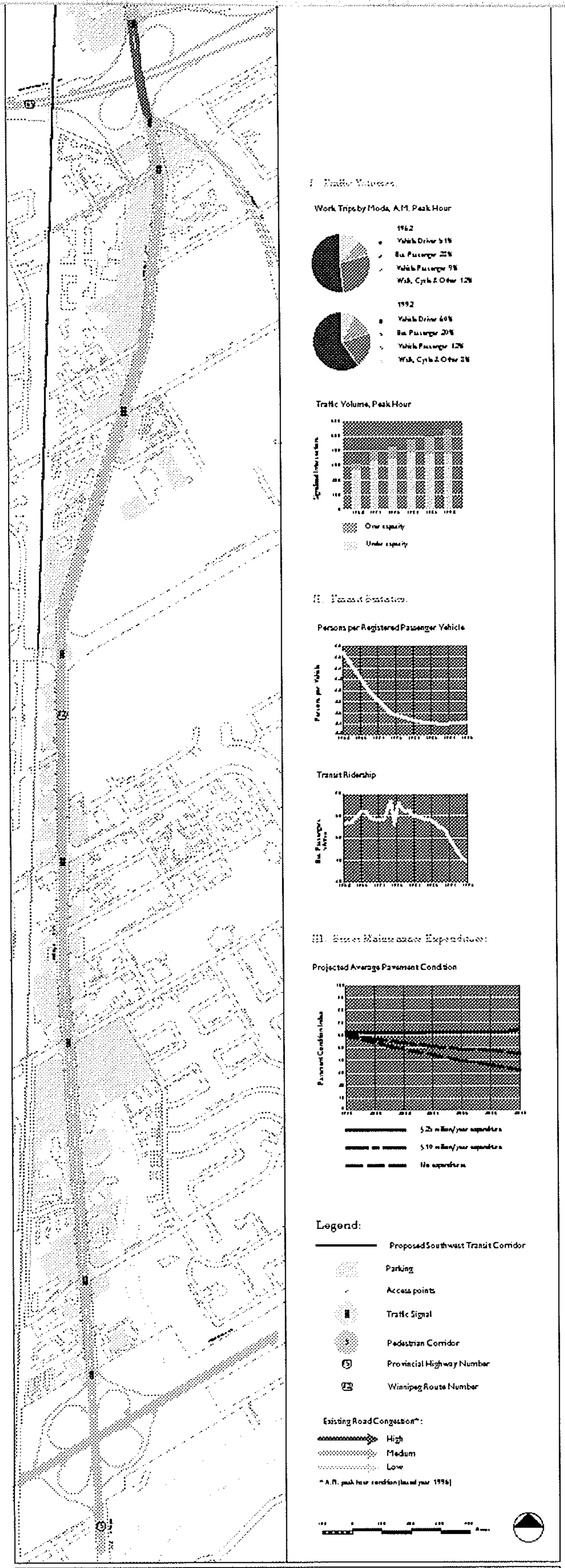
Pembina Highway Site Analysis
Land Use



Pembina Highway Site Analysis
Strip Geography



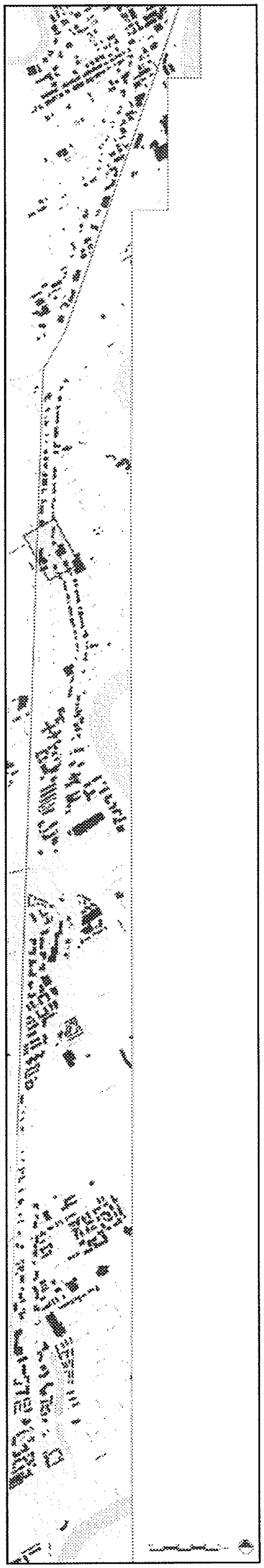


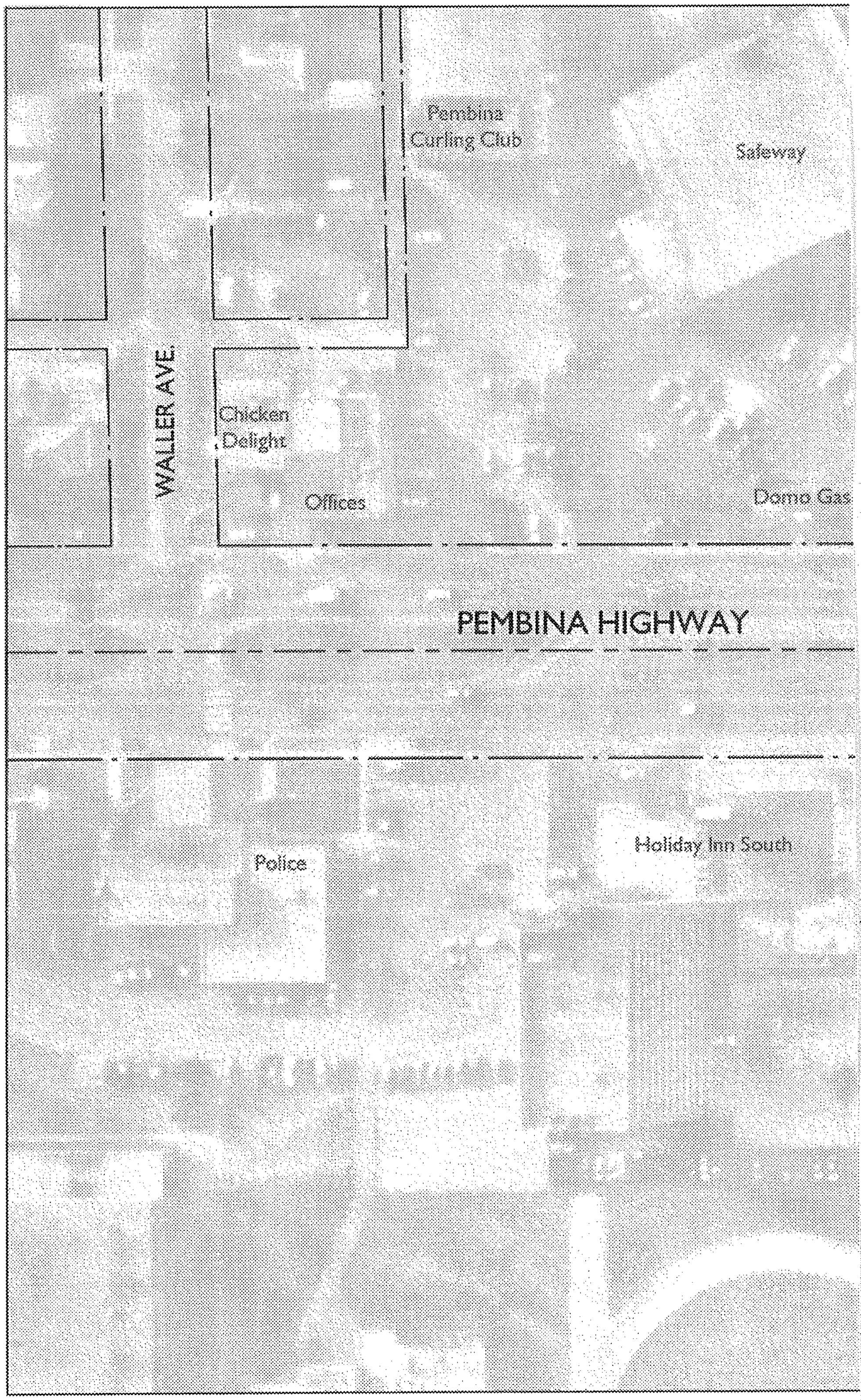


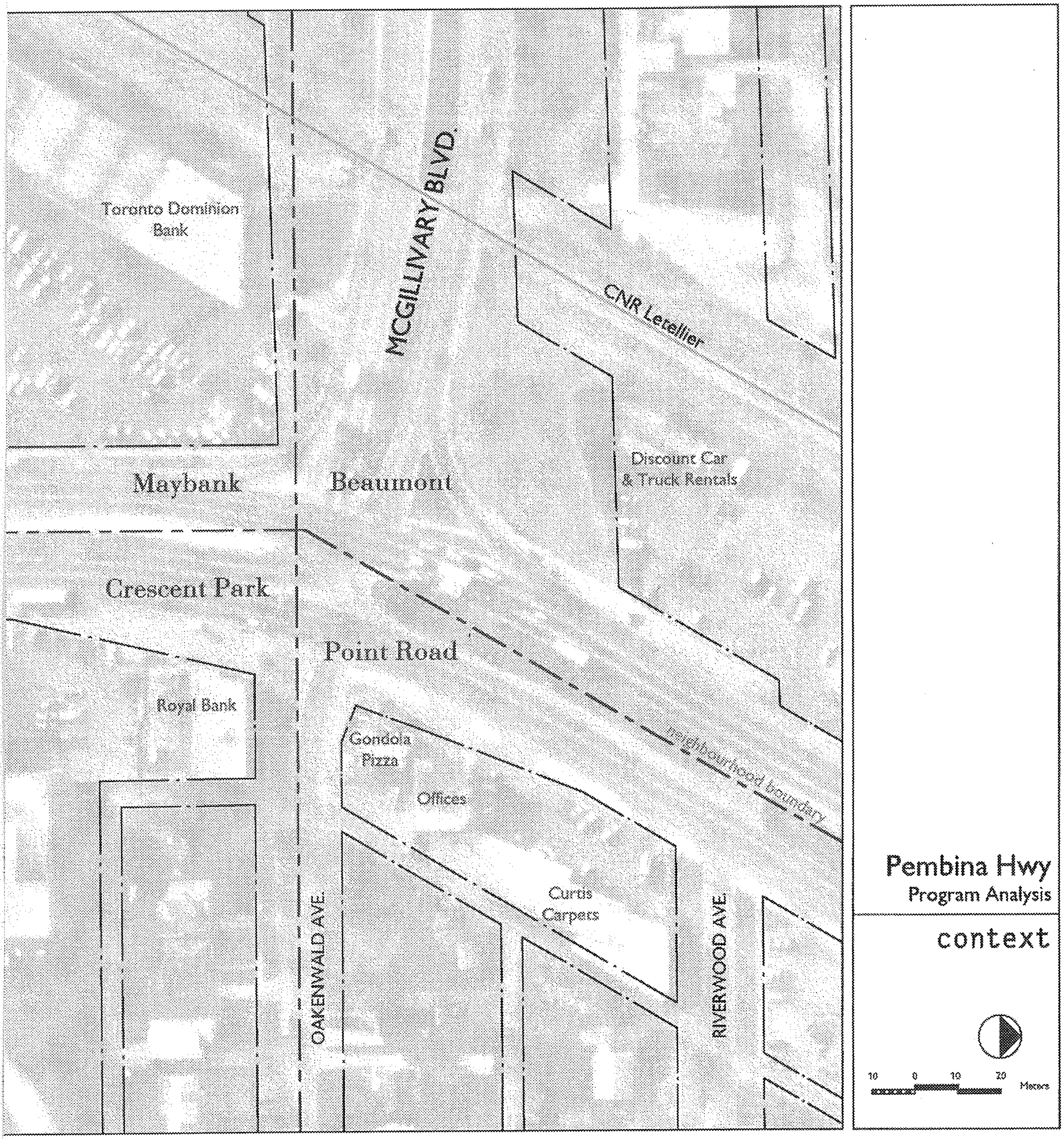
Pembina Highway Site Analysis
Vehicular Circulation

Pembina Highway Site Analysis
Edge Perception

appendix C
pembina highway: site context







Pembina Hwy
Program Analysis

context

appendix D
infrastructure summary table

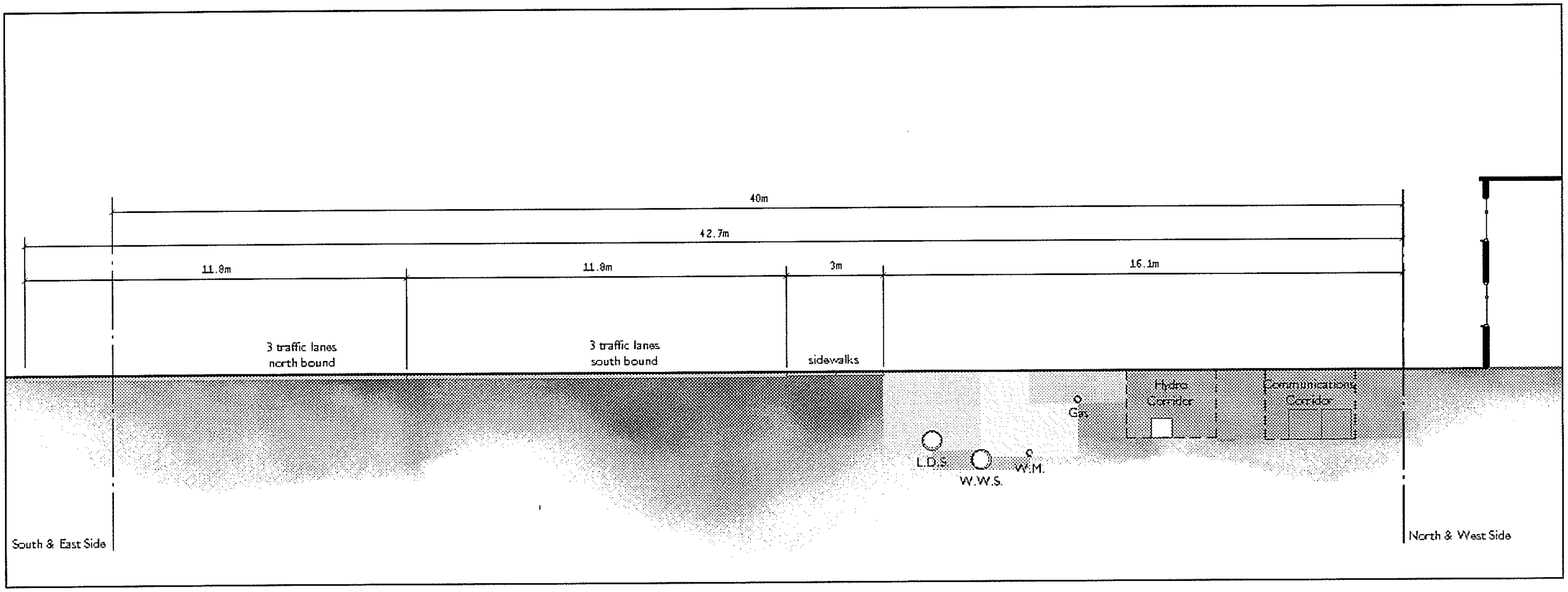
	Streets	Sidewalks	Bicycle	Communications	Cable	Electricity
Definition	Provides for the movement of goods and people.	Provides access for people to circulate through the urban landscape.	Provides a transportation route for cyclists.	Provides local, logdistance, wireless, directory & online services.	Provides cable television & online services.	Provides the distribution of electricity.
Designer/ Operator	• road design eng. • traffic engineer • highway engineer	• road desing eng. • traffic engineer • landscape architect	• P. Eng. • landscape architect	• electrical engineers • electrical technicians	• electrical engineer • technical designers	• electrical engineer • certified technicians
Type	• major throughfare (60m) • major arterial (40m) • minor arterial (32m) • industrial collector (32m) • residential collector (22m) • local industrial (22m) • local residential (18m) • backlane (6.25/7.25m)	N/A	• bicycle route • bicycle lane • bicycle path: • bicycle-only • multi-use rec. pathway	• underground • overhead	• underground • overhead	• underground • overhead
Component in R.O.W.	• paved lanes • curb	• pathway • boulevard	• path • signage • parking	• copper cable • manholes & concrete duct • switches, splices & amplifiers.	• fibre optic cable • rents space from M.T.S. • amplifiers	• cable • manholes & concrete duct • transformers • street lights
Placement in R.O.W.	• on centre of R.O.W. • median boulevard may • consists of two or more lanes. • lane width: 4.0-5.0m.	• 1.5 m minimum • 300 mm from property line.	• shared roadway w/ vehicle 4.3 m • separate path: one way: 2.5 m two way: 3.0m • min. design speed: 35km/h	• min. depth: 1.0m	• min. depth: 1.0m	• min. depth: 1.0m • ht. on pole: 12.2m
Maintenance	• snow ploughing • pothole filling • sweeping • joint/crack repair • asphalt overlay • complete reconstruction • annual distress surveys	• snowplough & sanding • temporary asphalt overlay • sweeping (in high use areas only) • complete reconstruction	• paved surfaces require sweeping. line painting & surface restoration. • scarification, smoothing & compaction. • sign maintenance	• annual inspections • repairing & replacing cable	• annual inspections • repairing & replacing cable	• transformer monitoring • overhead inspections • street lamp maintenance • underground inspections
Equipment				• back-hoe • various trucks & vans • bucket trucks & ladders	• back-hoe • various trucks & vans • bucket trucks & ladders	• back-hoe • various trucks & vans • bucket trucks & ladders
Materials	• reinforced concrete • asphalt overlay • crushed limestone base • geotextile fabric • PVC pipe	• concrete and/or pavers • crushed limestone base	• asphalt or concrete path with crushed limestone base • crushed limestone path	• woodpoles • buried cable • manholes	• mainline cable • amplifiers • pedestal space	• transmission towers • woodpoles • street lights • manholes & concrete duct • transformers
Lifecycle	25-30 years, plus an additional 10-15 years with an asphalt overlay.	25-30 years	asphalt: 20-25 years | limestone 5-10 years	underground 25 years | overhead 15-20 years	underground 25 years | overhead 25 years	underground 45 years | overhead 35 years
Construction Time*	new 8 weeks | rehabilitation 12 weeks	new 2 weeks | rehabilitation 2 wks, 2 days	asphalt: N/A | limestone N/A	underground 125m/day | overhead 8 days	underground 4 days | overhead 4 days	underground 4-6 weeks | overhead: 2 weeks
Costs	new: $2 million | rehabilitation $3 million	concrete $30/m2 | pavers $60/m2	asphalt** $63,840/km | limestone** $26,880/km	underground $1000/lot | overhead $600/lot	$10-50/m	underground $750-1000/m | overhead: $75-100/m
Problems	• traffic disruption due to maintenance. • inadequate maintenance budget. • environmental conditions.	• kicking • damage by trees • environmental conditions	• providing cyclist comfort. • asphalt cracks. • vehicle collisions • lack of connectivity between existing paths. • environmental conditions	• third party digging • vehicle contact • tree damage • water damage • environmental conditions	• third party digging • vehicle contact • tree damage • water damage • environmental conditions • crushed cable	• third party digging • vehicle contact • tree damage • inability to determine underground failure until one occurs. • environmental conditions
Separation	• minimize the effects of maintenance from other infrastructure.	• infrastructure is typically placed under the sidewalk. • safety for the pedestrian.	• safety for the cyclist.	• maintains minimum maintenance distances.	• maintains minimum maintenance distances.	• maintains minimum maintenance distances.
New Technology	• geotextile fabric • fibreglass dowels • salt free deicers • performance asphalts	• base materials	N/A	• overair technology • fibre optics	• fibre optics	• efficient transformers • water trench technology

* Typical construction time for two blocks of a typical arterial street.
** cost for a 3.0m wide path.

Gas	Waste Water & Land Drainage	Water	Street Trees	Signs	Snow Clearing & Ice Control	Traffic Signals	Public Trasit
Serves to provide the distribution of natural gas.	Serves to dispose water & waste from land & sewer.	Serves to ensure an uninterrupted supply of potable water.	Trees planted along city boulevards.	Provides advice & direction to the public.	Reduce the hazards of icy conditions.	Provides advice & direction to the pubic.	Provides the public with a safe and reliable form of transportation.
• civil engineer • mechanical technologist	• municicpal engineer	• municipal engineer • mechanical engineer • structural engineer	• Forestry Branch • landscape architects	• Traffic Service Branch	• Streets Maintenance Div.	• electrical engineer	• Planning & Schedule Div. • Operating Division • landscape architect
• underground	• combined • separated	• aqueduct • watermain • feedermains	• large size trees • medium size trees • small size trees	• regulatory • advisory • guide	• Priority I Street • Priority II Street • Priority III Street • Alleys • Sidewalks	• electric control signals • pedestrian corridors • reversible lane signal • flashers • railway crossings	• regular • special • emergency
• underground pipe	• underground pipe	• underground pipe • hydrant	• boulevard	• sign attached to pole or street lamp.	• streets, alleys & sidewalks. • boulevards are utilized for snow storage.	• signal support poles • signal indicators • steel-cased cabinets • vehicle detectors	• diesel bus, which operates primarily the curb lane. • bus stop: with misc. amenities.
• min. depth of 760mm	• wastewater sewer min. depth: 2.4m • land drainage sewer min. depth: 1.8m	• min. depth: 2.4m	• plantings are to be placed in a straight line along the boulevard at 3.5m from the property line. • large: 13-16m • medium: 10-13m • small: 7-10m	• motorist sign ht: 2.1m min. • cyclist sign ht: 1.2-1.5m min. • pedestrian sign ht: 1.35m min.	N/A	• 8 poles min. • cabinets placed near intersections. • vehicle detectors in pmt surface: 150-460mm. • poles & detectors from curb face: 1.2m	• bus stops on boulevards: • nearside: 33m (no stopping zone) • farside: 40m • midblock: 40m • intervals along boulevard: 200-300 m • obstruction free zone along boulevard: 7.75m min.
• 0.75m wide by 2.4m min. long service trench. • seasonal pressure adjustments	• 0.75m wide by 2.4m min. long service trench.	• 0.75m wide by 2.4m min. long service trench.	• planting • pruning • removal • clean-up • disease	• repair or replacement due to age, vandalism and vehicle contact.	• ploughing • use of salt on city streets • use of treated salts • removal of high piles • windrow removal • vehicle maintenance	• preventitive maintenance • corrective maintenance	• weekly cleaning of shelters. • vehicle maintenance
• back-hoe • various trucks & vans	• back-hoe • various trucks & vans	• back-hoe • various trucks & vans	• bucket trucks & ladders. • chipper.	• pick-up truck	• motorgrators • front-end loaders • truck ploughs • spreaders • sidewalk ploughs	• bucket trucks & ladders.	• van
• pipe • regulators	• PVC or precast concrete pipe • catchbasin • manholes • liftstations	• pipe • pumping stations • hydrants • valves	• tree	• aluminum sign • steel post or streetlamp • concrete base	• salt • chemical deicers • sand	• steel poles w/indicators • copper cable • steel cabinets containing electromechanical or microprocessor controller.	• bus • paved walk • steel & glass shelters
plastic: 40-50 years steel: 20-30 years	50 years	50 years	natural: 100 years urban: 7-10 years suburban: 20-30 years	7-12 years	6 years***	40-50 years	bus: 35years shelter: N/A
300m/day	2 weeks	2 weeks		1/2 hour per STOP sign	1 hour	6 weeks	bus stop with shelter: 3 weeks
$15/m	W.W.S: $800 L.D.S.: $1,450	new: $250/m rehabilitation: $425/m	2" caliper tree $175-225	NO PARKING: $5 STOP: $40	$300/lane/km	$90,000/intersection	bus: $250,000 shelter: $3,200
• third party digging	• hidden infiltration • combined sewer back-up • combined sewer overflow • pollution into river system • environmental conditions	• third party digging • vehicle contact w/hydrants • watermain break • environmental conditions	• tree damage to sidewalks • salt damage	• vehicle collision • snoughplugh damage • vandalism • fading by the sun	• sidewalk obstacles • inadequate snow storage capacity along boulevards. • inadequate overhead clearance. • windrows may pose as barriers to pedestrians.	• vehicle collison • third party excavation environmental conditions	• vandalism • vehiclular collisions • traffic congestion • mechanical problems with buses. • environmental conditions
• maintains minimum maintenance distances.	• maintains minimum maintenance distances.	• maintains minimum maintenance distances.	• planted to allow maintenance of underground utilities.	• never placed under overhead utilities.	N/A	• 1.5 m min. is required to prevent adjacent services to cause a short circuit.	• placed near usable services. • placed away from possible hazardous infrastructure.
• longer lived resins. • vibraplow & statiplow installation.	• CCTV • chemical grouting • NuPipe	• leak detection • cathodic protection • computer modelling	N/A	• longer lived inks • computer manufacturing	• automatic spreaders. • tripping mechanisms. • R-WIS • chemical deicers	• ATCs • two-way communications • wireless technology • GPS	• internet route information • smart cards • GPS • passive solar shelters.

*** this equipment is utilized year round for other tasks.

appendix E
minimum spatial requirements



appendix F
bioswale design process

1) Determine size of the drainage area.

2) Calculate the peak runoff rate for a 25 year minor storm and a 50 year major storm.

3) Find the time of concentration for the runoff to reach the swale.

4) Find the peak discharge rate.

5) Calculate the water quality design flow.

6) Size the swale.

7) Determine the critical velocity of the swale.