AN INNOVATIVE STORMWATER MANAGEMENT STRATEGY FOR A RESIDENTIAL SUBDIVISION IN THE PRAIRIE REGION OF WESTERN CANADA

By
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MASTER OF LANDSCAPE ARCHITECTURE

ABSTRACT

Stormwater management strategies for the Prairie region of Canada have evolved from conventional underground conduit systems to combined conduit / retention lake systems. This study explores the evolution of the retention lake system into a river corridor retention system for future stormwater management.

The evolution addresses the functional issues of stormwater storage, the social issues of; safety, maintenance, aesthetic appeal, recreation, territorial relationships between public and private properties, and the general economic repercussions of employing such a concept in subdivision planning.

The river corridor concept is explored as one possibility for stormwater management that responds to the natural form and process of drainage in the prairie environment.

The conceptual planning strategy is compared in context with an existing combined conduit/retention lake system, to demonstrate the environmental and economic opportunities of enhancing or altering existing stormwater management theory in future subdivision planning.

ACKNOWLEDGEMENTS

This practicum is dedicated to my grandfather Robert E. Almas, U.E.L., one of the many dedicated pioneers who homesteaded in Manitoba and inspired many family and friends to value the Northern landscape.

Sincere thanks to all:

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1.0 INTRODUCTION

1.1 INTENT

Many urban centers situated in the Prairie region of Canada and the United States have been settled on lands which in general, are flat impervious clay beds. Where the settlement of large numbers of people has grown, so has the problem of providing storm water drainage systems. The impervious soils do not easily accept water through infiltration and the cost of installing underground conduit systems to drain the land increases as subdivisions are located farther away from natural riverbeds.

In Winnipeg, Manitoba, a prairie city within the Red River Valley of Canada, storm water run-off has historically been controlled by an underground storm water drainage system. Stormwater is collected in catch basins and transported through underground pipes to outfall points on one of the three major rivers running through the city. However, as the City expanded, the increased distance between the collection points and river outlets made this system of stormwater drainage economically prohibitive as larger sizes and quantities of conduit pipes were required.To reduce costs for storm water management in these conditions engineering professionals introduced retention lakes in the 1960's.

Typically, retention lakes have been situated centrally within communities where they collect and temporarily hold storm water runoff. Smaller, less expensive underground pipes are then used to slowly drain the water into a river outlet.

City guidelines established in the 1960's have governed the design and use of the lakes, which, have influenced their perceived value within the community. This study accepts the challenge of: **reviewing** the existing guidelines governing design and development of the stormwater retention lakes, **understanding** the economical, physical and social forces that direct the lake design and development, **examining** alternative strategies for waterbody design within the stormwater runoff management system, **proposing** an alternative design strategy for constructing water oriented subdivisions.

1.2 PROBLEM STATEMENT

Within the City of Winnipeg, the Waterworks, Waste and Disposal Department (WWD) and the Parks and Recreation Department (P&R) have a vested interest in the design and upkeep of retention lakes. In 1964, the interests of these two departments were amalgamated in a joint effort to outline design guidelines for stormwater impoundments. These guidelines were formulated to primarily address functional concerns for safety, and adequate stormwater storage (WWD initiatives) and secondarily the potential recreational use of the lakes (P&R initiative). Pursuant to these guidelines, the Waste, Water and Disposal Department outlined and executed long term maintenance programs for the lakes that adhere to economic and functional concerns.

The retention lake design guidelines have served an important purpose in controlling the design and development of retention lakes in the urban environment. Over the past three decades both positive and negative patterns of lake design and lake use have become evident. This study isolates the issues and concerns, expressed by both the subdivision planners and the long term residents, that have been left unanswered by the planning strategies evolving from those guidelines. The following concerns will be addressed:

Long Range Planning;

A review and evaluation of the original guidelines has not been undertaken since their formation. As a result, considerations such as the concerns of lakeside residents and patterns of public use of the lakes within the communities have remained unstudied. The enhancement of existing design strategies to incorporate these considerations and integrate ecological, educational or environmental goals would greatly assist policy makers in formulating objectives and long range plans for the future improvement of the lakes.

Traditional Design Approach;

Traditional engineering approaches toward retention lake design, enforced through city by-laws, have thwarted imaginative articulation of water oriented landscapes. Although the engineering approach has solved the functional requirements of water management and reduced economic cost for the developer. The potential assets however, which are difficult to assess in terms of dollar value such as recreational use of the lake, wildlife habitat , and the overall aesthetic quality of the lake have largely been ignored. (Bartlett, 1976). Multidimensional objectives must be considered in the initial strategic planning of the stormwater management system within the watershed area.

Social Concerns;

Residential retention lakes in Winnipeg have a public fringe along the entire water's edge and have residential housing next to that public lake fringe along 50% of the shoreline. Demarcation of where public lake fringe ends and private property begins has been left to the individual homeowner to define. As a result, homeowners have installed fences to the water's edge, essentially claiming the lake fringe next to their property as private land. Although this solution reduces tension for the private homeowner by eliminating access to the back of their property, it also dissects the shoreline into numerous private parcels, disallowing the development of continuous recreation corridors along the lake edge. The ability to approach the water is restricted and a perception of the lakeshore as private property is reinforced by these measures. To enhance a comfortable co-existence of public access activities along the lakeshore next to private properties, landscape design strategies must address the issue of territorial definition as an integral part of the reformation of the waterbody shoreline profile.

Territorial ambiguity exemplifies only one issue of social concern that can be addressed through design strategies. Issues which affect the quality of environment including the perception of space, understanding of ecology, and the diversity of environment, have yet to be addressed through shape, form and scale of the retention lake system (Juck, 1984).

Safety;

Concepts for preventing accidental drowning in retention lakes have included grading the banks at a 7:1 slope, posting signage saying; "no wading, no swimming, no power boats and no dumping" and the problematic and even less safe recommendation of fencing the entire lake . These typical solutions will not stop children's natural drive to explore their environment. The acceptance, understanding and planning for environmental education and exploration provides a viable alternative that has yet to be explored by designers. for parents desire safe environments for their children and school boards need to reduce potential liability hazard. The existing planning guidelines must be enhanced to encourage exploration of new design strategies that may address these community needs.

Maintenance;

Maintenance problems of eroding shorelines, algae and aquatic plant growth, and water stagnation have been addressed through both maintenance programs and new design strategies. These include, alterations in the lake size, lake depth and the inlet angles, addition of revetment treatment, and addition of aeration systems in the water body. The continued enforcement of specific design guidelines that require all shoreline slope gradients be constructed at a ratio of 7:1 will continue to created ideal conditions to perpetuate aquatic weed growth in the lakes. This guideline must be evaluated with respect to overall planning strategies and on-going maintenance programs to assess its viability in modern retention lake planning.

1.3 OBJECTIVES

The purpose of this study is to present a design strategy for stormwater retention that will add to the existing body of knowledge suggestions for planning that will: ameliorate current conditions causing tension in lake oriented communities, integrate design strategies that will enhance the environment (as determined in the residents survey), and represent an economically viable design solution for the developer. To attain this goal specific tasks of the study will include:

1. To **become familiar** with the current planning practices as they relate to the development of urban retention lakes in Winnipeg and the resultant effect they have on the value of the lake.
2. To **determine** how water retention systems can be designed to develop environmental conditions that will enhance residents comfort in the community.
3. To **explore** how the overall plan of the lake, as well as, the profile of its edges can be manipulated to provide:
   * a diverse habitat for wildlife,
   * a new waterbody form conducive to environmental exploration and education
   * a new waterbody form conducive to the dual objectives of developing community attractions in public parks and maintaining passive recreational activities proximate to private residential lots
   * a design strategy that will increase the potential for ground water recharge through infiltration.
   * an alternate design strategy that will reflect drainage systems consistent with prairie vernacular
4. To **demonstrate** how exposing the entire retention lake system can increase the number of residential lots along the water edge offering new orientations for viewing, and an increased profit margin for the developer.
5. To **compare** two subdivision layout strategies for the same site. The first will represent an existing subdivision plan designed and implemented by developers according to existing design guidelines. The second will represent an alternative subdivision plan laid out by the author according to the findings of this research

1.4 LIMITATIONS OF THE STUDY

The intention of this study is to propose one alternative stormwater management strategy and corresponding sub-urban subdivision layout. The scope of this study will be limited in the following respects;

i) Research and discussion pertaining to current planning practices will be limited. Issues that lake side residents have expressed concern about and the factors which restrict designers from addressing those concerns will be the focal scope ofthe study. The historical evolution and numerous positive effects of integrating retention lakes into the urban environment will not be reviewed in this study.

ii) Demonstration of the alternative subdivision plan for the study site will be limited to general planning principles and layout plans for the subdivision . Detail design, including: specific planning strategy of the proposed water corridor, proposed park landscaping and proposed park features such as foot bridges, or wildlife attraction areas will not be demonstrated in detail.

iii) Demonstration of the alternative waterbody form will include storage capacity calculations, but will not include calculations to determine velocity of flow, flow rate or the gradient over the length of the stream.

iv) Research and discussion pertaining to the economic differences of the two design strategies will be limited to the projected return values for residential lot sales according to the zoning categories established in conventional residential planning. All values recorded are non-representational of actual costs invested in the construction of the existing design strategy or return values actually received in the development of the actual site plan. The following costs will not be outlined or discussed in the economic comparison;

*large scale cut and fill operations,
*detail grading of residential lots and park areas,
*detail contouring of the waterbody cavities,
*installation of water,sewer or service lines,
*purchase and installation of water control structures,
*landscaping and protection of waterbody shorelines,
*installation of vehicular and pedestrian bridges

2.0 COMPARATIVE STUDY APPROACH

2.1 PURPOSE OF COMPARISON

The comparative analysis of two design strategies for lake oriented subdivisions consists of, an evaluation of one lake oriented subdivision, and the design, evaluation and comparison of a new design alternative for the same site. The study inquires into the economic and ecological repercussions of two divergent design strategies that have been designed to solve the same problem of stormwater runoff management in the sub-urban environment.

The comparative study of the two design strategies involved:

A) Determining the water retention capacity of reservoirs required to service the land area of the study site.
B) Examining design strategies and tabulating land use areas of the existing subdivision plans.
C) Presenting an alternate stormwater management design strategy in a subdivision layout that provides, at least equal stormwater retention capacity and equal land area allocations for schools, parks and commercial grounds as determined in the existing design strategy.
D) Estimating cost for the conduit pipe required to service each of the design strategy layouts.
E) Tabulating potential value of residential lots sales in each subdivision plan.
E) Comparing differences of each design strategy.

2.2 SELECTION OF THE STUDY SITE

One lake oriented residential subdivision was selected for the comparative study. The following factors influenced the choice of site:

1. The stormwater management system incorporate the use of a combined conduit and retention lake system constructed according to existing City of Winnipeg development guidelines and therein be representational of the numerous retention lake systems throughout the City
2. The subdivision be one of the newest, incorporating past experience and knowledge into the subdivision design and the marketing strategy of residential lot sales.
3. The subdivision be completely man-made requiring extensive grading to achieve drainage and waterbody formation, and extensive landscape planning to develop desirable community parks.
4. The retention lakes be considered the central marketing feature in the community.
5. The subdivision plan offers a variety of residential lot classifications targeted at an extensive economic range of homebuyers.

The subdivision selected was River Park South, in south St. Vital of Winnipeg, Manitoba. The community exhibits characteristics of modern lake oriented subdivisions including the conditions listed above.

2.3 THE STUDY SITE, "RIVER PARK SOUTH"

In the early 1970's Qualico Developments Ltd. assembled 1200 acres of farmland five miles from the City core, in Winnipeg's south St. Vital district, see figure 2. As the city expanded the land holdings became a viable, valuable asset for the development of residential communities.

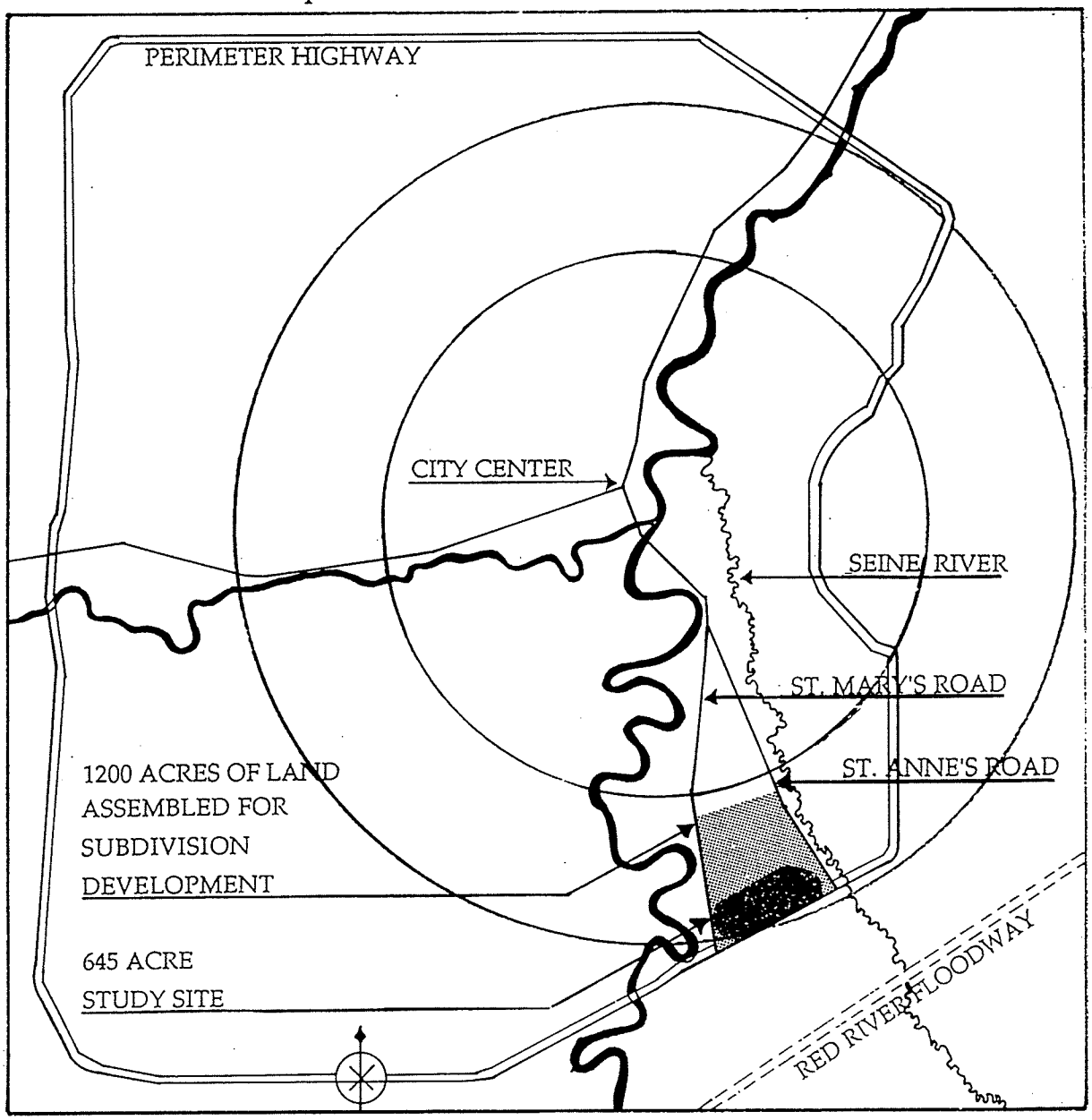


Figure 2 Location of "River Park South" in Winnipeg
Source: Edwards

2.3.1 STUDY SITE DEFINITION

Presently the entire 1200 acre residential development of River Park South is drained by a series of underground conduit systems and surface retention lakes. The conduit system operates as a series of dendridic pipe lines underground that have been defined into watershed pockets for the site. The most extensive watershed pocket within the 1200 acre development is a 645 acre parcel south of Warde Ave. that is drained by a combined conduit /retention lake system.

For the purposes of this study, this limited 645 acre watershed area will be used as the "study site" so that both the existing stormwater drainage system and an alternative drainage design strategy can be compared in reference to one watershed pocket.

This 645 acre land parcel will henceforth be referred to as "River Park South". The site is bound on the West by St. Mary's Road , on the East by St. Anne's road, on the South by the Perimeter Highway and on the North by an irregular line that falls south of Ward Street, see map 1.

2.3.2 PHYSICAL FEATURES OF THE SITE

Remnants of the last glaciation have shaped the land surface, influenced soil typology and determined drainage patterns of the prairie region of Canada in general and the study site of "River Park South" specifically. The following factors have contributed to features of the study site:

i) As glaciers retreated in a northwest - southeast direction, glacial abrasion etched striations into the bedrock formation. Evidence of this action is evident in the north draining patterns of the Red and Seine rivers that flank the study site.

iii) The Red River and it's major tributary, the Seine River, both meander and wind extensively as they travel north to drain. The absence of surface relief in south central Manitoba has contributed to the extensive meandering of the Assiniboine and Red Rivers and their tributaries (Lockery, 1984).

Topography between the Red and the Seine River is minimal offering little relief. The Seine river acts as a Yassou stream running parallel to the Red River for miles before emptying into its basin. (Tim Ball personal communication, Dec. 1989)

ii) As the glaciers melted and water pooled in the central prairies, glacial Lake Agassiz was formed and clays and silts were deposited. As the lake retreated the flat, the silt and clay which covered the floor of the lake basin was exposed as the new landscape of the region. The soil reconnaissance survey of 1953 indicates impervious clay and silt deposits 15 feet or more have been left over parent bedrock as remnants of glacial Lake Agassiz. Specific soil types and associated vegetation patterns include:
St. Norbert Clay: lacustrine fine clays supporting oak, aspen, hazel, saskatoon and dogwood. Smooth topography with sluggish internal drainage impeded by the "B" soil horizon ;
Red River Clay: lacustrine fine clays supporting tall prairie grasses, meadow prairie grasses, herbs, aspen and willow. Slight ridges and micro-relief with slow drainage requiring surface drainage channels; and
Fort Garry Clay: clay over light grey to pale yellow sandy clay calcareous subsoil, supporting prairie and meadow grasses, herbs, aspen and oak. Level with micro-relief. Imperfect drainage with localized ponding.

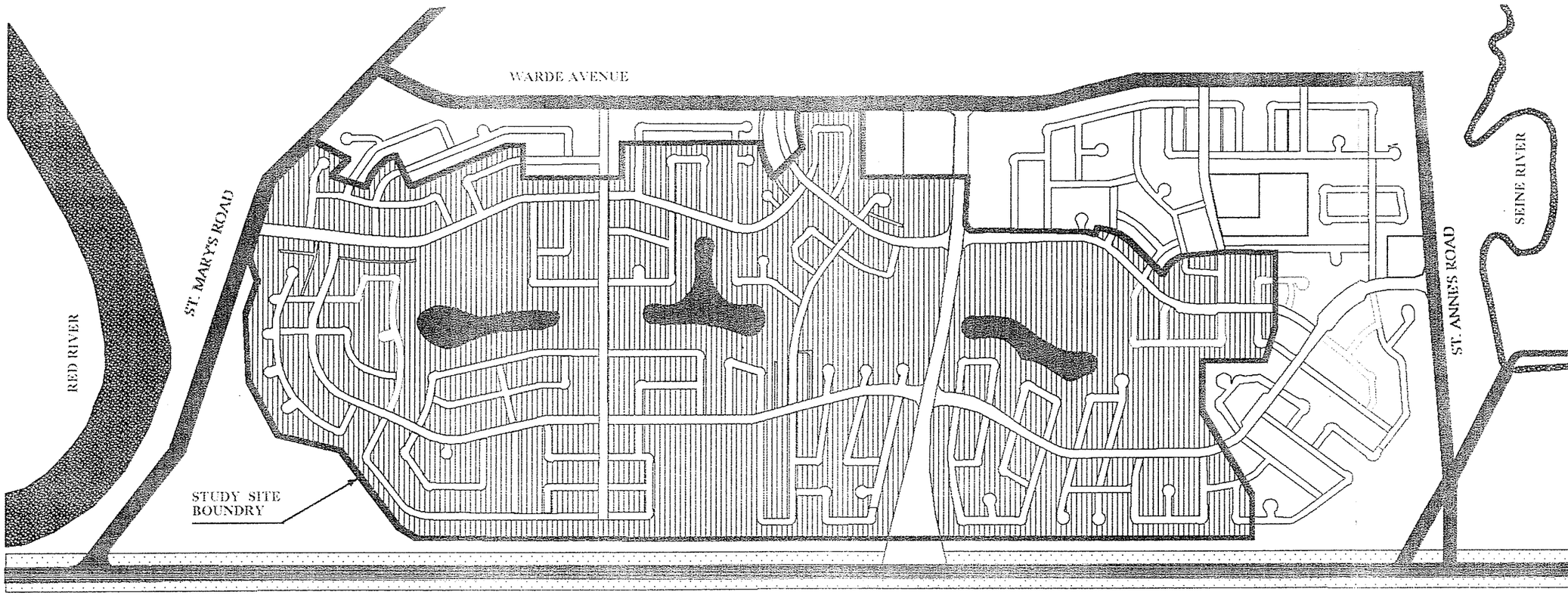
The relatively flat floor of the former lake basin, riddled with micro- relief has soil features of predominantly lacustrine fine clays with sluggish, slow drainage and localized pondings. These features enhance the site's ability to hold pockets of water until some form of surface drainage is provided or evapotransporation takes place.

2.3.3 DEFINITION OF THE DRAINAGE DISTRICT

Closer evaluation of the specific topography of the 1.5 miles of land between the two rivers, shows that a natural drainage split occurs approximately at the extension of Dakota Street. From this point (elevation 764 feet) the land slopes west to drain into the Red River (elevation 760 feet) and east to drain into the Seine River (elevation 760 feet), see map 2. (Templeton Engineering, 1975, and Underwood McLellan Ltd.).

This natural drainage split was considered in the preliminary drainage studies undertaken by Templeton Engineering in 1964 . The divide defined the Eastern edge of the land mass that drained West to the Red River. This land area was studied by Templeton Engineering to determine the costs of installation of three types of land drainage systems, a conduit system, a combined conduit/retention lake system and a linear pond system. Although the linear pond drainage system was determined to be the least expensive the study recommended a combined conduit/retention lake system be installed.

This recommendation, detailed further by several engineering firms over the past two decades, has been developed into a system of three retention lakes, connected by underground conduit pipes, that drain the site from East to West, and eventually out to the Red River, see map 3.

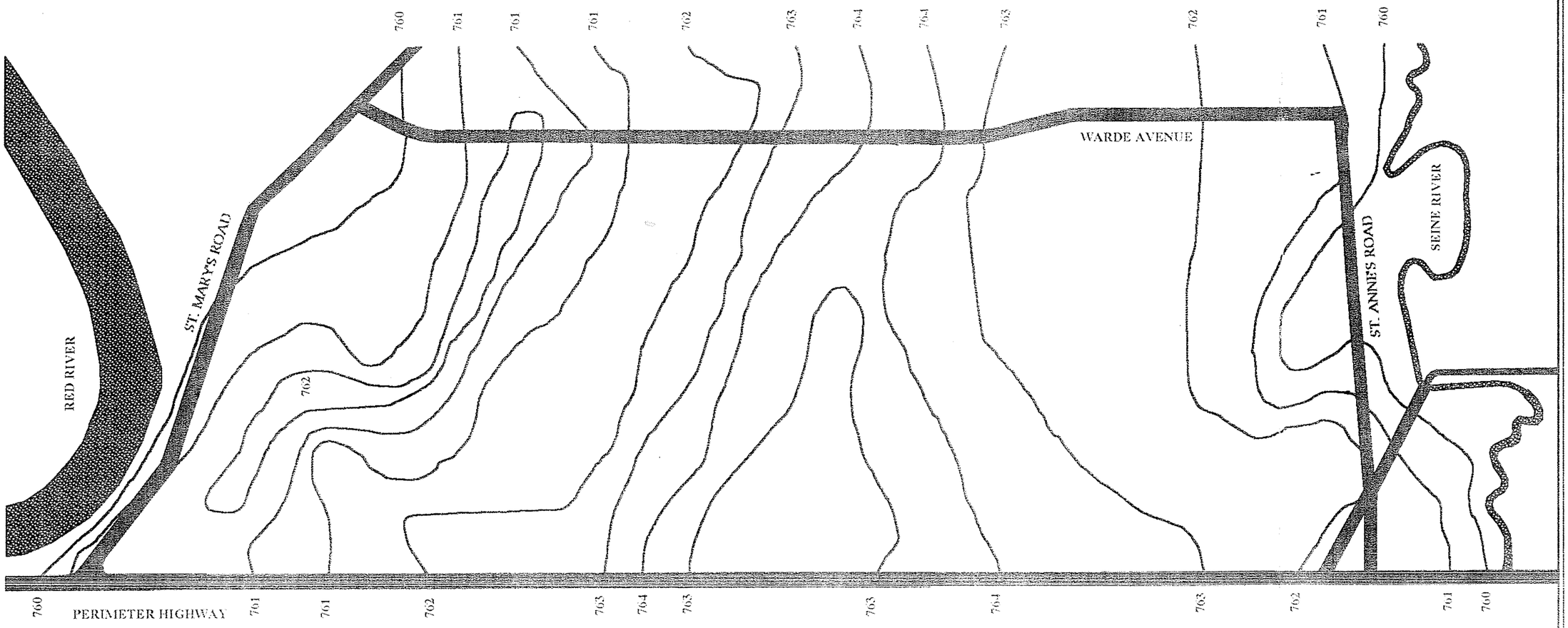


MAP 1

STUDY SITE

"RIVER PARK SOUTH" EXISTING DESIGN SOLUTION

SCALE 0 50 150 300

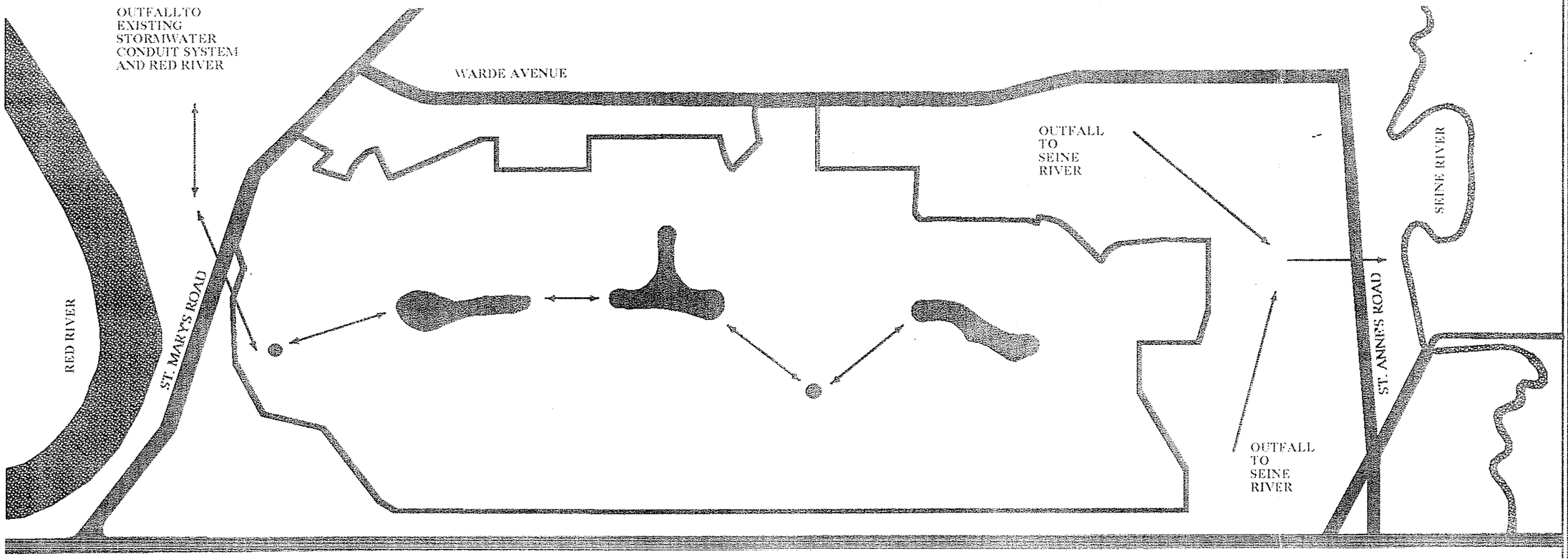


MAP 2

TOPOGRAPHY PRIOR TO DEVELOPMENT

"RIVER PARK SOUTH" EXISTING DESIGN SOLUTION

SCALE 0 50 150 300



MAP 3

WATERSHED OUTFALL PATTERN

"RIVER PARK SOUTH" EXISTING DESIGN SOLUTION

SCALE 0 50 150 300

3.0 THE EXISTING SUBDIVISION LAYOUT FOR 'RIVER PARK SOUTH'

3.1 INTRODUCTION

The following chapter presents an analysis of the existing subdivision plan for "River Park South". The discussion includes the following topics:

i) The general objective of planning the lake oriented subdivision of "River Park south".
ii) The specific design approaches employed in the subdivision design strategy.
iii) The design standards employed for conduit pipe and retention lake layout. This section describes both the lake system seen above ground, and the underground conduit support system found underground,
iv) The evaluation of land use areas. School grounds, parks and commercial /retail areas have been tabulated to establish a minimum standard to be achieved in an alternate design strategy for the site. The land area allocated for residential lot development has been differentiated into zoning categories of R1-5 lake front lots, R1-5 regular lots and R1-4 lots. A monetary value for these conventional residential lot classifications has been associated to determine a potential economic value for residential lot sales in the existing subdivision design strategy.

3.2 DESIGN OBJECTIVES

The detail panning and construction of each phase of the subdivision of "River Park South" has been undertaken by several engineering firms over the past two decades. Throughout the process the directive of maximizing economic return for the development company while providing an aesthetic and marketable community featuring the stormwater retention lakes as a unique attraction for future homeowners has been maintained.

Over the extended time frame required to construct this project, the development company's economic investments have continually increased due to factors such as interest rates, inflation, and increases in construction cost. To recover costs and secure future markets the developer has had to be continually creative in design and construction strategies. These market pressures encourage developers to provide a high quality subdivision that will interest future homebuyers aesthetically and be affordable economically.

3.3 DESIGN APPROACH

Two specific factors influenced the design approach utilized in the existing subdivision plan for "River Park South".

1. From drainage studies provided by Templeton Engineering, and past experience ascertained from designing subdivisions in Winnipeg, the developers recognized installation of a combined lake/conduit stormwater runoff management system as a positive endeavor. The primary design consideration was to incorporate a combined lake/conduit system in the layout of "River Park South".

2. The installation of retention lakes required the developer to follow the recommendations adopted by City of Winnipeg council on June 25, 1975 for the design of the lakes. * Those included:

(i) that the impoundment area be defined as all lands around the perimeter of the lakeshore up to the high water line plus the area described in paragraph

(ii) that a minimum of 50% of the lakeshore perimeter and a minimum lakeshore equivalent to 100 feet in depth measured from the normal water line along that minimum length of the perimeter be reserved for public access and use and included in the impoundment area;

(iii) that any private lot adjacent to an impoundment area be established at the estimated normal water line and an agreement entered into with the City recorded by caveat prohibiting any structure except minor structures permitted by the Commissioner of Works and Operations below the high water line and prohibiting any structure except a temporary structure approved by the said commissioner of works and Operations within two vertical feet above the high water line;

(iv) that in determining the area of land to be dedicated to the City or the sum of money to be paid in lieu thereof no portion of the impoundment area, as defined to include the lands reserved for public access and use, shall be included;

The following engineering guidelines were also recommended:*

(i) that impoundment systems be of the permanent lake type having not less than five acres of water surface.

(ii) that impoundments have a minimum water depth of four feet and side slopes of 7:1 for safety and that all impoundment slopes between the normal and high water levels be sodded and that the area in the vicinity of the normal waters edge be suitably protected.

(iii)that where residential and park areas abut any impoundment the design for water rise be four feet with a maximum of six feet where open space only abuts.

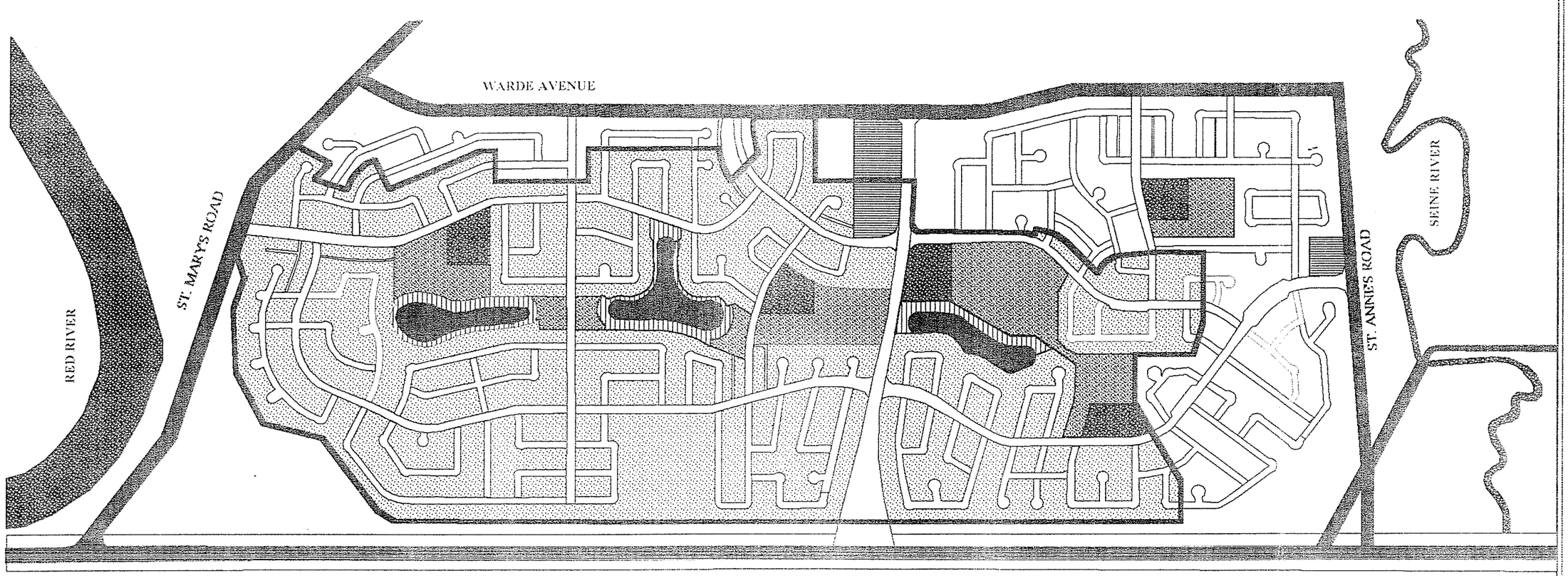
(iv)that a supplementary water supply be incorporated to assure minimum water levels during extended dry periods.

(v) that impoundments anticipated to be stocked with fish have a water depth of six feet or more.

The design strategies incorporated in the planning of the subdivision focused on the following concepts to maximize the use of the retention lakes within the community:

* Three lakes were installed into the subdivision (rather than one very large lake) and dispersed through the community to maximize the length of shoreline available for residential lot development;
* The lakes were located visually central within the subdivision to enhance their image in the subdivision;
* A continuous green belt corridor was developed through the subdivision to connect the lakes with public open space;
* School sites were located throughout the subdivision next to public parks and the retention lakes where possible;
* Highly valuable lake front lots were developed along 50% of the lake shorelines and smaller, less expensive lots were developed around the periphery of the subdivision.

The integration of these planning strategies, in conjunction with the requirement of providing access onto the site from the major thoroughfares of St Mary's Road, St. Anne's Road and Dakota Street, directed the formation of the existing subdivision layout plan for "River Park South", see map 4.
The specific components of this subdivision design have been analyzed to provide a baseline for comparing an alternate design strategy for the site.



MAP 4

SUBDIVISION PLAN

"RIVER PARK SOUTH" EXISTING DESIGN SOLUTION

SCALE 0 50 150 300

3.4 THE STORMWATER RUNOFF MANAGEMENT SYSTEM

3.4.1 INTRODUCTION

One of the largest expenses incurred in any subdivision development is the installation of a stormwater management system. Two engineering firms, I.D. Engineering and Solmundson Engineering, have been involved in the initial watershed drainage concept and the detailed layout of the system, which is currently 80% constructed in "River Park South". The system incorporates three lakes on ground and an extensive underground conduit system underground to collect, store and eventually drain stormwater runoff into the Red River, see map 5.

For cost estimation purposes of this study the layout of the remaining 20% of the conduit system has been been determined by the author using design criteria incorporated by the engineering firms involved. Those criteria have been detailed below.

3.4.2 RETENTION LAKE DESIGN

The design of the three retention lakes within "River Park South" was determined predominantly by three factors: the required storage capacity of the lakes, the design guidelines outlined by the City of Winnipeg, and the directive of providing maximum shoreline for residential lot development within the subdivision plan.

The general storage capacity requirement of the retention lakes was determined using the computer program S.W.M.M. (Stormwater Management Model). Through computer modeling applications it was determined that the combined storage capacity of the lakes should be 3,843,000 cubic feet or 108,822 cubic meters. (Don Mulder, personal communication, April 1990)This provides approximately 6000 cubic feet of water storage capacity per acre of subdivision. The storage capacity of the lake is considered the amount of water the lake holds between the normal water level and the high water level.

The individual lakes hold the following capacities at high water level:

lake 1 = 1,294,359 cu. ft. ,
lake 2 = 1,434,622 cu. ft.
lake 3 = 1,114,021 cu. ft.,
total = 3,843,000 cu. ft. of storage

The design criteria outlined in the City's "Stormwater Management By The Use of Impoundments" directed the formation of the lakes within the residential communities, (Doug McNeil, personal communication, April 1990). Each of the lakes have the following features:

i) The lakes have a minimum 5 acre water surface, at normal water level;
ii) The lakes have a minimum 6 foot water depth;
iii) The maximum rise in water level from normal water level to high water level is 4 feet in residential areas and 6 feet in park areas;
iv) The lakes have a side slopes of 7:1, extending 30 feet into the water. The slopes above the high water line have been sodded, and stone revetment has been installed between the normal water level and the high water level (with no trees or shrubs in this zone);
v) The lakes have been designed to accommodate a 25 year storm.

3.4.3 LAND DRAINAGE SEWERS

All land drainage sewers were designed to accommodate stormwater runoff flows, surcharged through the pipes, for a storm return period of 5 years. Surface flooding of the streets, up to the curb, is acceptable for a period no longer than one hour.

Both I.D. Engineering and Solmundson Engineering firms utilized the Rational Method for calculating the volume of stormwater runoff for the specific sectors of the the 645 acre study site they have designed. (all calculations were computed in imperial measure and will continue to be for consistency in later comparison).

The Rational Method describes the volume of stormwater runoff for any land parcel through the equation $Q = CIA$.
Q = flow in cubic feet per second
C = runoff coefficient.
I = rainfall intensity
A = area in acres

For planning purposes; the runoff co-efficient was generalized for the residential subdivision as $C = 0.35$, (Don Mulder, personal communication, April, 1990) and Winnipeg's rainfall intensity was represented by the equation

$$i = \frac{47.2}{(t+8)^{.8}}$$

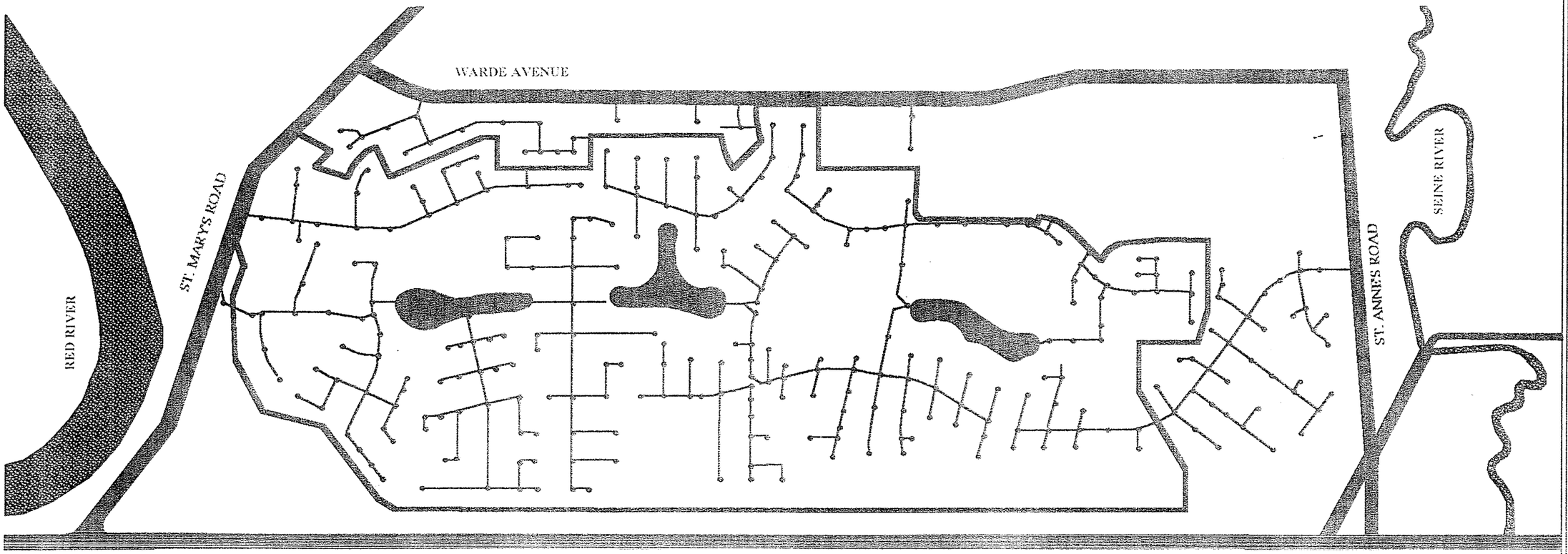
$i = 3.52$, when t = rainfall intensity generalized as 15 min. duration, for a five year return storm (Don Mulder, personal communication, April, 1990) see appendix 3.

The conduit pipe installed on the study site follows several dendridic patterns to collect stormwater from the subdivision and deliver it to the nearest lake, see map 5. The diameter, length and cost for the conduit pipes required to drain the site have been tabulated to provide a representational cost for the conduit pipe. The following chart outlines the breakdown of costs for the pipes in 1988 dollars, (Don Mulder I.D.Engineering, personnel communication, Jan. 1988).

3.4.4 SUMMARY

The combined conduit / retention lake stormwater management system installed in the existing subdivision plan of "River Park South" meets the functional requirements of water storage as determined by the two engineering firms who have been responsible for the design. The lakes offer 3,843,000 cubic feet of storage capacity to accommodate waters that would accumulate in a 25 year return storm, while the conduit pipes have been designed to accommodate water from a 5 year return storm. The conduit system which may cost approximately $2,200,000.00 to install will provide expedient removal of stormwater for residents.

Within the functional engineering requirements of the system all requirements have been met. The social and aesthetic effects the lakes have in the residential environment will be reviewed in chapter 4.



MAP 5

UNDERGROUND CONDUIT SYSTEM

"RIVER PARK SOUTH" EXISTING DESIGN SOLUTION

SCALE 0 50 150 300

3.5 THE SUBDIVISION LAYOUT

The existing layout plan for "River Park South" demonstrates how current design strategies have been integrated into the lake oriented subdivision planning, see map 4. The lands utilized for specific uses of schools, parks, and commercial/retail areas have been measured to establish the minimal land area required for identical uses in the alternate design strategy for the site.

3.5.1 SCHOOL GROUNDS

The design strategy for "River Park South" allocated five sites for school ground development, on the assumption a number of the schools will be French and a number of the schools will be English. The decision whether to develop all five sites as school grounds in the future remains a political decision that will not be changed or influenced by this study. The five sites, illustrated in map 6, have the following land areas:

site 1	**3.38 a**
site 2	**3.34 a**
site 3	**3.32 a**
site 4	**4.07 a**
site 5	**3.28 a**
total area	**17.39a**

It should be recognized that the school sites have been dispersed throughout the subdivision plan, all sites are adjacent to public open space, and the sites are proximate to, or connected by, public open space to, the waterbodies wherever possible.

3.5.2 COMMERCIAL GROUNDS

There was no allocation for commercial land space within the study site of "River Park South". Commercial grounds have been located outside the designated study site at the intersection of Warde Avenue and Dakota Street.

3.5.3 PARKS

The design strategy for "River Park South" allocated seven parcels of public open space and three public lake fringe parks. The open space parcels, illustrated in map 6, have the following land areas:

parcel 1	**10.66 a**
parcel 2	**1.62 a**
parcel 3	**1.44 a**
parcel 4	**3.04 a**
parcel 5	**1.85 a**
parcel 6	**9.83 a**
parcel 7	**20.67 a**

total of public open space **49.11 a**

It should be recognized that the public open space is located centrally within the subdivision to maximize visual accessibility for residents. The park space is continuous (except for three crossroads). The retention lakes are advertised by the development company as unique focal points within the parks.

3.5.4 RETENTION LAKES

The design strategy for River Park South incorporates three lakes, see map 7. The land area covered by water at the normal water line (N.W.L.) and high water line (H.W.L.) includes:

lake 1	6.9 a (N.W.L.)	7.9 a (H.W.L.)
lake 2	7.6 a (N.W.L.)	11.04 a (H.W.L.)
lake 3	6.0 a (N.W.L.)	7.94 a (H.W.L.)
total area	**20.5 a** (N.W.L.)	**26.88 a** (H.W.L.)

The 25 year flood frequency covers a further 28 feet around the perimeter of the lake from the normal water line.

As required bylaw a minimum of 50% of the lakeshore perimeter and a minimum lakeshore equivalent to 100 feet in depth measured from the normal water line along that minimum length of the perimeter has been reserved for public access.

Both public and private shoreline conditions exist along the lakeshore. Each lake reserves approximately 50% of the shoreline for public use as required by City of Winnipeg design guidelines. The lakes of"River Park South" offer the following shoreline conditions, see map 7.

waterbody	public park/lineal feet	private lot/lineal feet
lake one	1115 ft.	1312 ft.
lake two	1345 ft.	1640 ft.
lake three	1214 ft.	1312 ft.
total	3675 ft.	4265 ft.

3.5.5 RESIDENTIAL LAND DEVELOPMENT

Land allocated for residential lot development has been calculated by measuring the lineal " front footage ". This measure has been described as the street frontage of land area measured approximately 40 feet back from the road, (Qualico Homes, April, 1989). The total length of "front footage" available for residential lot development in "River Park South" measures 85761 ft. (26140 m).

Economic analysis of the land available for residential development has been utilized by developers to determine the potential value for lot sales in the subdivision design strategy. The land is differentiated into lot zoning categories to which an economic value is associated, see appendix 6. Three categories of lot zoning have been identified in the design strategy for the existing subdivision layout of "River Park South". These have been illustrated in map 8 and are described as follows:

i) **R1-5 Lake Front Lots**
These are residential lots that back onto the waterfrontage and have the highest economic return value for the developer. The value ranges from $950.00 to $1000.00 per lineal foot front . The existing "River Park South" subdivision layout offers a total of 4380 feet (1335 m) of 'R1-5 Lake' zoned lots. An estimated return value from lot sales ranges from $4,161,000.00 to $4,380,000.00 or an average of **$4,270,500.00**

ii) R1-5 Regular Lots

These are larger residential lots, not backing onto the lake, but offering marketing features such as:

a) location adjacent to park space; or

b) location on a cul-de-sac.

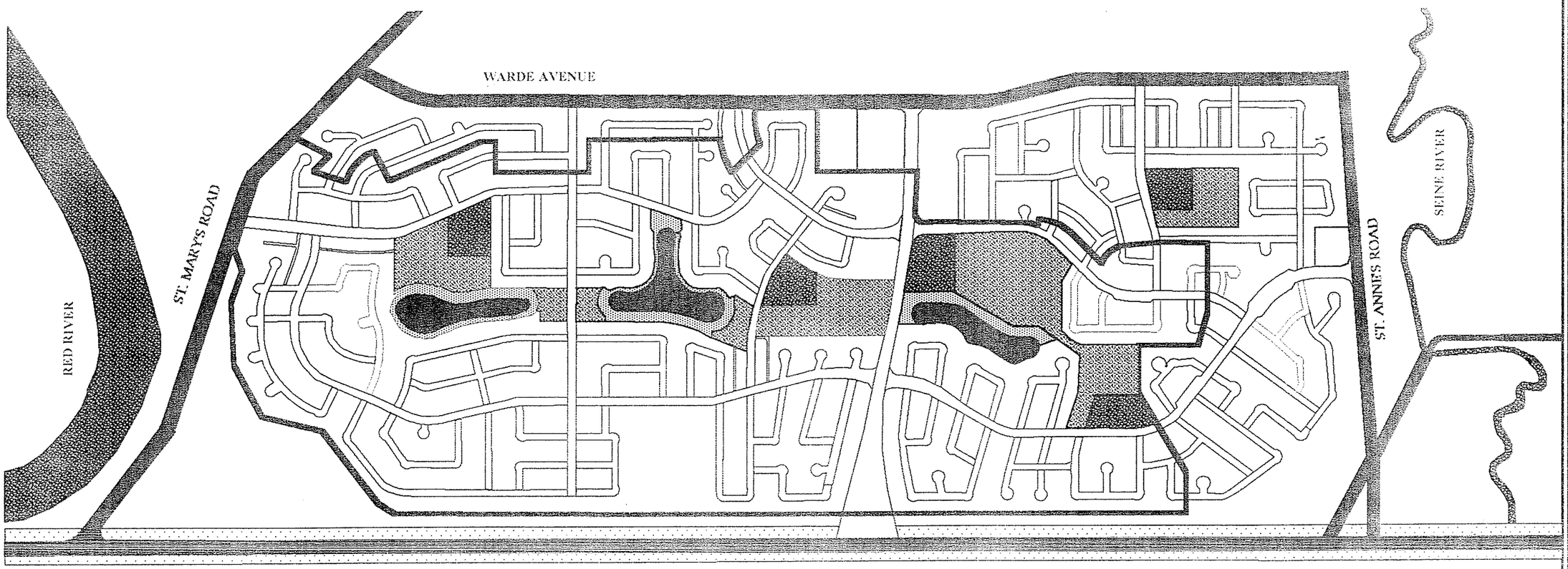
They have the second highest highest market value for the developer. The value ranges from $850.00 to $900.00 per lineal foot front. The existing "River Park South" subdivision layout offers 13025 feet (3970 m) of 'R1-5 Regular' zoned lots. An estimated return value from lot sales ranges from $11,071,250.00 to $11,722,500.00 or an average of **$11,396,875.00**

iii) R1-4 Interior Lots

These are residential lots of 4000 square feet or smaller, that are bound by roads or other residential lots. They have been classified as interior lots. The return value ranges from $550.00 to $650.00 per lineal foot front for the developer. The existing "River Park South" subdivision layout offers or 68356 feet (20835 m) of 'R1-4 Interior' zoned lots. An estimated return value from lot sales ranges from $37,595,800.00 to $44,431,400.00 or an average of **$41,013,600.00**

The potential return value from residential lot sales in the existing subdivision strategy for the developer is as follows:

zoning	frontage (Lin. ft.)	value per frontage foot	estimated return value range
R1-5 Lake	**4380**	**$950.00 - $1000.00**	**$4161000.00 - $4380000.00**
R1-5 Regular	**13025**	**$850.00 - $1000.00**	**$11071250.00 -$11722500.0**
R1-4 Interior	**68356**	**$550.00 - $ 650.00**	**$37595800.00 -$44431400.0**
-			
Estimated value for residential lot sales			**$52828050.00 - $60533900.0**

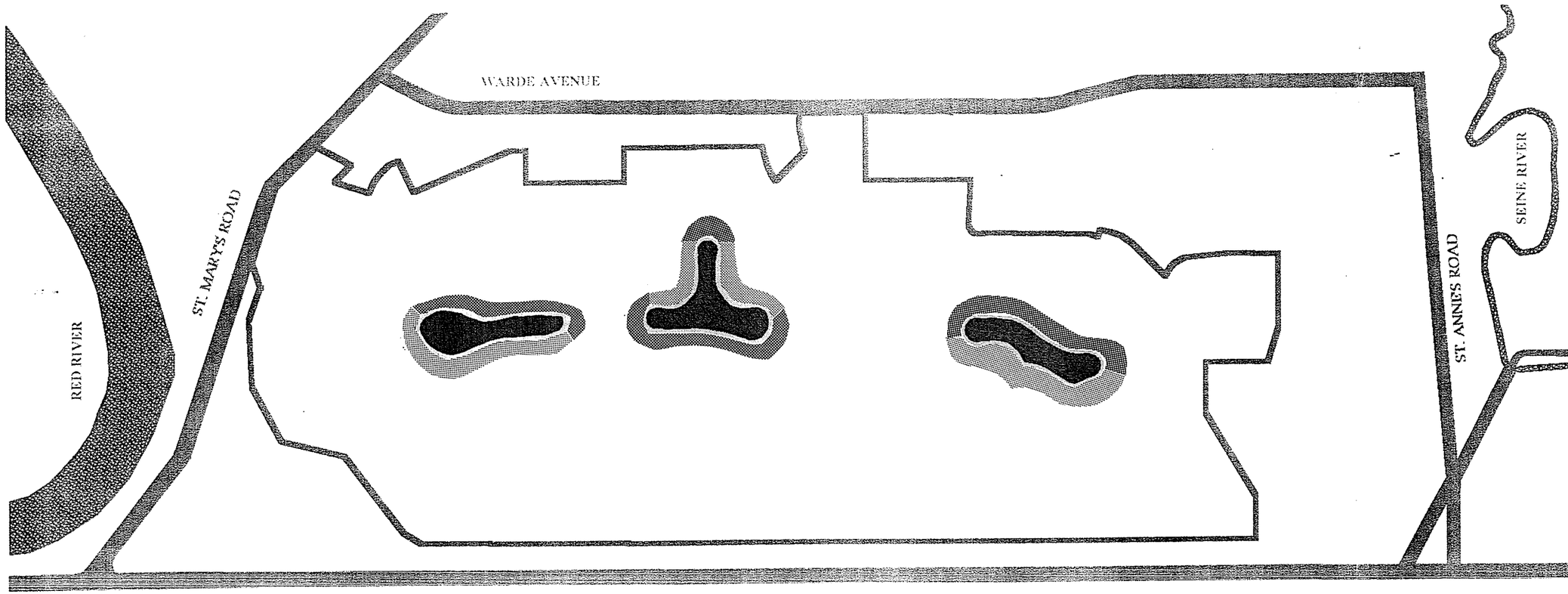


MAP 6

SCHOOL GROUNDS AND
PUBLIC PARK LOCATIONS

"RIVER PARK SOUTH" EXISTING DESIGN SOLUTION

SCALE 0 50 150 300

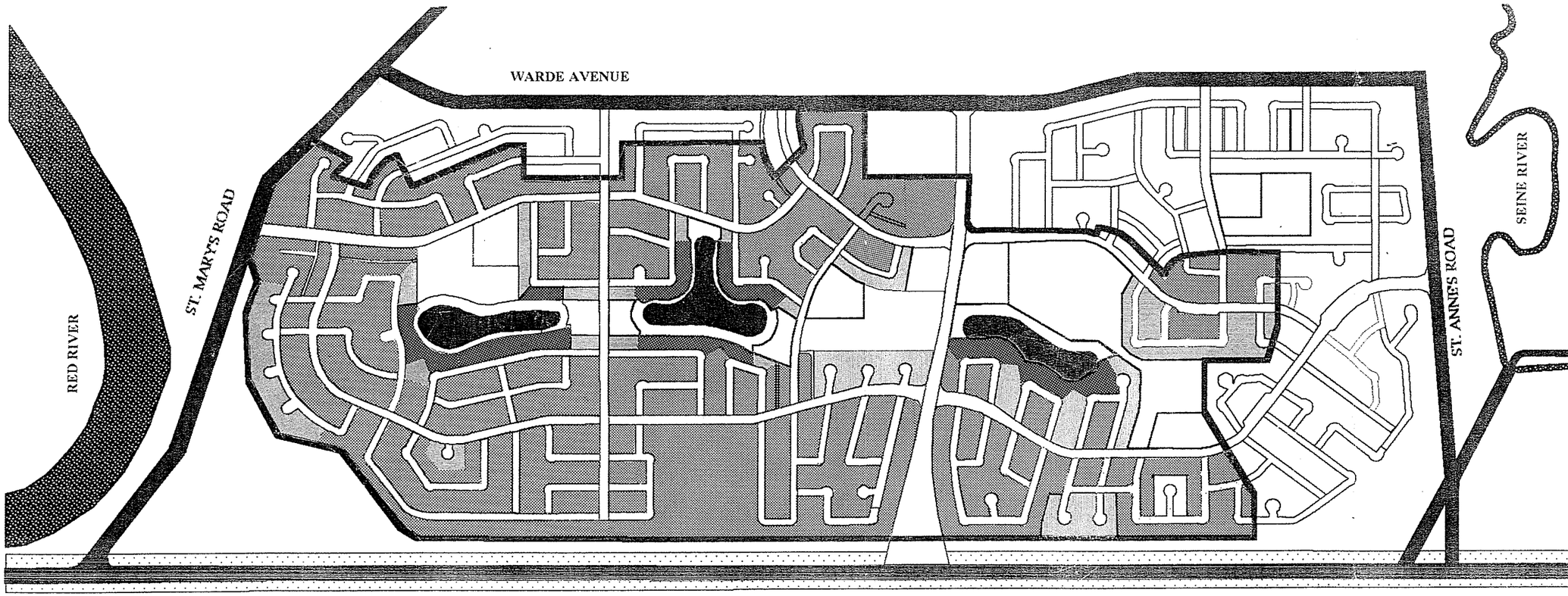


MAP 7

RETENTION LAKES AT N.W.L. & H.W.L.
ALONG PUBLIC AND PRIVATE LAKESHORES

"RIVER PARK SOUTH" EXISTING DESIGN SOLUTION

SCALE 0 50 150 300



MAP 8

RESIDENTIAL LOT ZONING

"RIVER PARK SOUTH" EXISTING DESIGN SOLUTION

SCALE 0 50 150 300

3.6 SUMMARY

The initial stormwater management concept for the study site outlined in 1970 incorporated a combined retention lake/ conduit system. That system was designed to become the focal feature of the subdivision.
The combined stormwater management system incorporates retention lakes that are typical of the many lakes found in lake oriented subdivisions in Winnipeg. These lakes have been designed to conform to the City of Winnipeg's design guideline requirements. In this particular subdivision plan, three lakes are connected and fed stormwater runoff through a series of conduit systems. The conduit system has an estimated value of **$2,200,000.00** in1988 dollars.

Within the 645 acre subdivision, 85761 lineal "foot frontage" of land has been allocated for residential lot development. It has been estimated that the subdivision design strategy may generate **$56,681,000.00** from residential lot sales according to conventional zoning categories. The developer can expect to receive approximately 20 -25% of this total revenue generated from residential lot sales, (Qualico Homes, Jan. 1990), as the costs for purchase of land, large scale grading operations, landscaping of park areas, road construction, and installation of service lines must be factored into the return value for lot sales. From this generalized estimation, the developer may expect to receive: **$11,337,000.00** to **$14,170,000.00** for lot sale revenues .

To attain these revenues the development company must secure markets for the residential community being created. Several design strategies have been employed to enhance the community toward that end in "River Park South" including the use of the retention lakes as a focal marketing feature within the parks.

Since these lakes have been developed according to guidelines which stress the functional/ engineering use of the lakes, it is important to determine how the lakes are perceived by current lake side residents. What positive and negative features of the lake have impacted on residents feeling of comfort and security in the lake oriented community?

Assessment of the social implications of lake design may help developers to know how to improve lake oriented subdivisions to secure future markets, and policy makers to develop standards for design that improve on the successful concept.

The following chapter opens discussion on issues and concerns effecting the quality of the environment for lakeside residents that have been created through the construction of stormwater impoundments according to existing City of Winnipeg design guidelines.

4.0 CURRENT ISSUES IN RETENTION LAKE DESIGN

The City of Winnipeg oversees for the public both the initial design and the ongoing maintenance of retention lakes in residential communities. The design of the lakes is controlled through recommendations outlined jointly by the Water Waste and Disposal Division of the Works and Operation Department (WWD) and the Parks and Recreation Department of the City of Winnipeg. Long term maintenance is undertaken by the Weed Control Branch of the Parks and Recreation Department, according to the advice of the WWD.

Through the joint control program the lakes have proven physically effective and economically prudent stormwater management tools from an engineering perspective. Current maintenance programs incorporating chemical treatment of the water has perpetuated the use of the lakes as an engineering tool. Both facets of design and long term maintenance "in effect have been seen as an engineering problem with aesthetics and recreation as an incidental benefit" (Hough).

The following discussion outlines specific environmental conditions that have evolved as a direct result of adhering to City of Winnipeg design guidelines in retention lake construction. The conditions have been documented as issues of concern that exist in existing lake oriented subdivisions for community residents.

An attempt has been made to review the rationalizations inspiring the development of the specific guidelines that have impacted or directed the development of unpopular environmental conditions. The ultimate objective of the exercise is to suggest alternative design solutions that may address the same issues in a more popular manner.

This discussion will: isolate specific environmental conditions created in retention lake communities, define the issues and address the current design guidelines that may be enhanced to make future improvements in retention lake communities possible.

The discussion has been organized into four categories.

1. Predetermined "solutions" restricting the designer;
2. Safety;
3. Residential tension created through territorial issues;
4. Long term maintenance programs.

4.1 PREDETERMINING DESIGN SOLUTIONS

Two specific design guidelines restrict the designer from exploring new bank slope conditions and waterbody forms for the stormwater retention basin:

1. impoundment systems be of the permanent **lake type** having not less than **five acres of water surface.**

2. impoundments have a minimum water depth of four feet and **side slopes of 7:1** for safety, and all impoundment slopes between the normal and high water levels be **sodded,** and the area in the vicinity of the normal waters edge be suitably protected, see figure 2 .

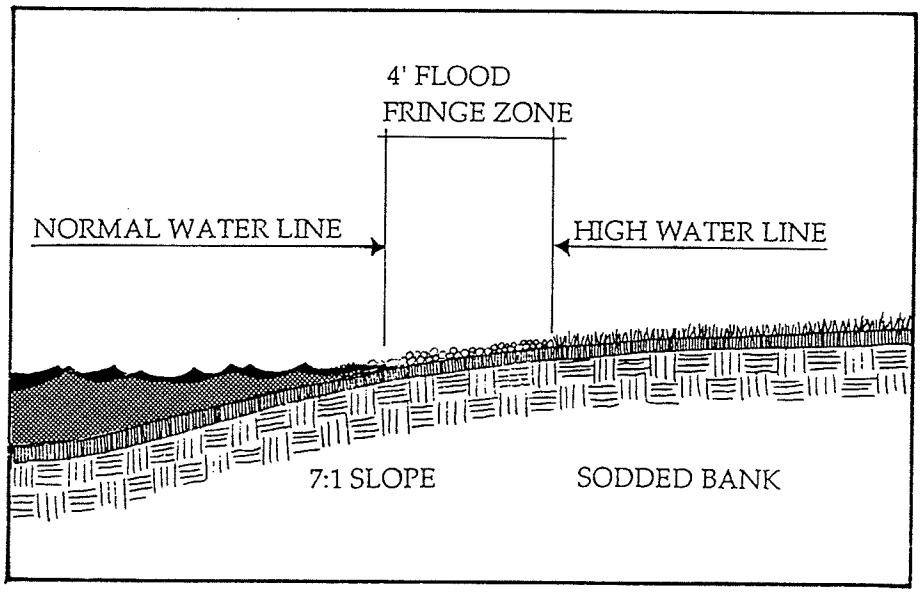


Figure 2 Retention Lake Shoreline Condition
Source: Edwards

Although the engineering function of the lakes for storm water management is not effected by these recommendations, the opportunities for exploration of aesthetic and environmental improvements through construction of new waterbody forms is severely, and probably unnecessarily, restricted. The perception of space, approachability of the environment, understanding of ecology and the diversity of environment, have been restricted to one design solution through the inhibition of proposals that do not fall within the norm. These two guidelines have predetermined the shape, form and scale of the retention lake system by ensuring that all lakes have identical conditions. There appears to be no rational purpose to such conditions, other than code and standard limitations based solely on engineering and/or maintenance procedure.

The visually uninteresting and environmentally unnatural condition of uniform shallow slopes along all retention lakes severely restricts innovate exploration of shoreline design, perpetuating the problems of aquatic plant growth into every new lake-oriented community. The opportunity to develop bank conditions suitable for fish spawning, waterfowl habitat or interactive waterplay is severely restricted or precluded.

Environmental education and understanding of lake ecology is compartmentalized around the singular man-made condition these guidelines perpetuate. Aesthetic appeal and approachability of the water environment is restricted to the non-interactive minimum five acre lake.

The dichotomy between the euphoric image of nature and the realities of the hydrological cycle in the city emphasizes the isolation of urban life from the natural processes.(Hough) Resolution of this problem is a cornerstone in environmental awareness and environmental education.

The visual discontinuity of the hydraulic process including the isolation of the lake from other water bodies with which they interact, and the compartmentalization of lakes above ground and conduit pipes underground encourages the urban dweller to view the lake as an amenity to be manipulated for personal use. A variety of conditions along the lakeshore begin to emerge as residents personalize the environment. The variety of idealized images for lake development and lake uses have not been co-ordinated, organized or explored as concepts that can contribute to the overall ecological function of the lake and the aesthetic appeal of the lake.

4.2 SAFETY ISSUES

In addressing the argument presented by City representatives for implementation of the guidelines that predetermine waterbody design one must include the concern for safety around the lake perimeter. The two guidelines outlined in the previous discussion were not set in place to predetermine design, but were intended to alleviate safety concerns of the urban lake environment.

Insofar as can be determined, City representatives have enforced the construction of 7:1 shoreline bankslopes extending thirty feet into the water so that: ***if children wander into the lake, the bottom will be shallow and extended so they can either walk out again or be afforded rescue by others who cannot swim.***

Even though ultimate analysis is at best conjectural, an attempt must be made to recognize how such rationalizations realistically and physically perform in the environment. Only then can we decide if they are appropriate solutions for safety.

4.2.1 DEFINING THE PROBLEM OF SAFETY

The issue of safety transverses a variety of disciplines including design of the environment, social behavior and psychology. As designers we can evaluate the physical cause of safety problems around the lake and prevent extremely hazardous environments from being installed but we cannot guarantee absolute safety as we cannot control human behavior.

In addressing the rationality of guidelines intended to ensure that environments are safe, it is essential that we distinguish between the very different needs of prevention of accidental entry into the water and the requirements for safe environments in which exploration takes place. The former is providing safe conditions for the unknowing and uneducated, generally very young, children of preschool age, while the latter is providing safe conditions for the active, intended exploration and interaction with the environment undertaken by those who challenge rules.

The dilemma between designing environments for these two aspects of safety is a complicated task. There are two separate problems to address: the physical or contextual conditions created, and the behavior of both potential victims and purposeful abusers of the environment. This is where the rationality of current design guidelines appears inappropriate. The discussion has been focused on these two topics: Young Children and Unintentional Entry, and The Rule Breakers.

4.2.1.1 YOUNG CHILDREN AND UNINTENTIONAL ENTRY

Accidents happen. When adults turn their backs momentarily to unfold the stroller, or pick up the blanket the young child is unintentionally unleashed to explore the environment. In and around water that exploration can be fatal.

Have we as adults made the environment safe for ourselves or safe for young children? In the past we have assessed the accidental situation as heros, saying " if the water is shallow we can run in and rescue the child", but we are not always afforded that possibility. What we have not dealt with directly is the interaction that is encouraged or discouraged between the young child and the retention lake according to how the young child perceives the environment. This assessment may better indicate what is actually safe for young children rather than what adults have inappropriately superimposed as safe in the environment for themselves.

Young children when left unsupervised in the water environment assess the environment from their level of understanding to interpret its meaning. What factors will entice or attract the child into the water and what factors will prevent or delay entry into the water?

Understanding the cognitive development of the young child is essential in determining at what age and at what level of physical development the child is capable of understanding rules . Prior to understanding the concept of rule development a child will have no comprehension of the meaning of the City of Winnipeg warning, "no wading, no swimming, no power boats and no dumping" posted on signage around the lakes. To the child they are meaningless, the physical attributes of the environment are the elements that he will respond to.

Jean Piaget, a Swiss psychologist has hypothesized 4 major stages of cognitive development and three stages of rule consciousness development which a child progresses through before maturity, see figure 3 .

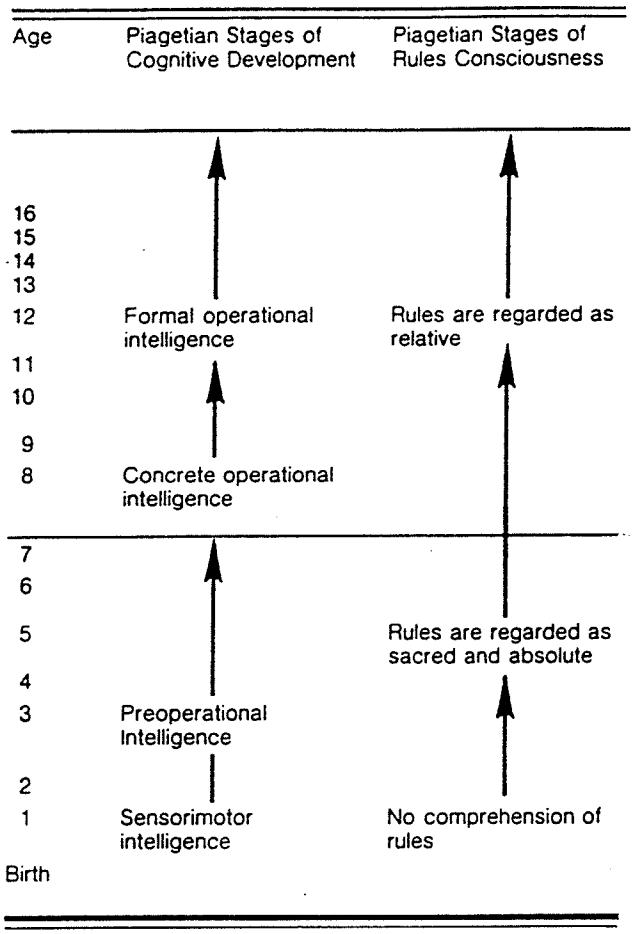


Figure 3 Piagetian Stages of Cognitive and Rule Consciousness Development
Source: Adapted Physical Education and Recreation

In the area of cognitive development, sensorimotor and preoperational intelligence are the highest level of intelligence reached before rules are understood and obeyed.

Through sensorimotor intelligence, attained through the use of sense modalities, primarily visual, kinesthetic, vestibular and tactile, infants come to know their environment and develop an awareness of self, others and objects. During this stage they begin to recognize objects and environments by color, form and size. They develop spatial relationships and the ability to imitate and play imitation games.

Environments we expose children to are registered in their inner language representing units of experience (Sherrill). Through their sensorimotor awareness physical environments such as "the beach" are transformed into symbols of meaning. In this case associated with play, fun, exploration of sand and water and generally an acceptable environment. The environment, its spatial relationship, color, form, and tactile sense represent a unit of experience, a symbol of meaning to the child. For the child that cannot express language or yet understand the meaning of words and rules an inner language has developed relating to this experience.

The second level of preoperational intelligence development occurs between the ages of two to seven. During this stage children develop representation, the ability to link meaning to objects or environments and subsequently to symbols. Thus the shallow slope of water may be equated with play, swimming, splashing and "safe" as it has been associated in past experience at the beach in wading pools, in the bathtub or at the cottage.

Evaluating the physical makeup of today's retention lakes, there are several features of the lake that represent symbols and meaning associable with other safe water environments and very few distinguishing features that indicate the true nature of the water as a holding tank for water that is not to be entered.

The misrepresentation would not be made if the child was viewing the Red River. Spatial relationships of shoreline, watermass, water depth , noise and physical barriers discourage easy access through walking or crawling into the water. A cross-sectional comparison between a typical retention lake, a riverbank, a wading pool and a beach illustrates the symbolic similarities and differences.

It is essential to critically analyze the environment from a new perspective, that of the child's. Consider the tactile similarity and differences of crossing the ground surface immediately before reaching the water. Consider the spatial relationship of three-dimensional physical environments and deterrents the child must move around and/or over to reach the water such as, trees, shrubs, reed grasses, rocks, railing, fencing. Consider conditions of the shoreline where entry occurs.

Figure 4 Natural Shoreline Succession Zones
Source: Freshwater Ecology

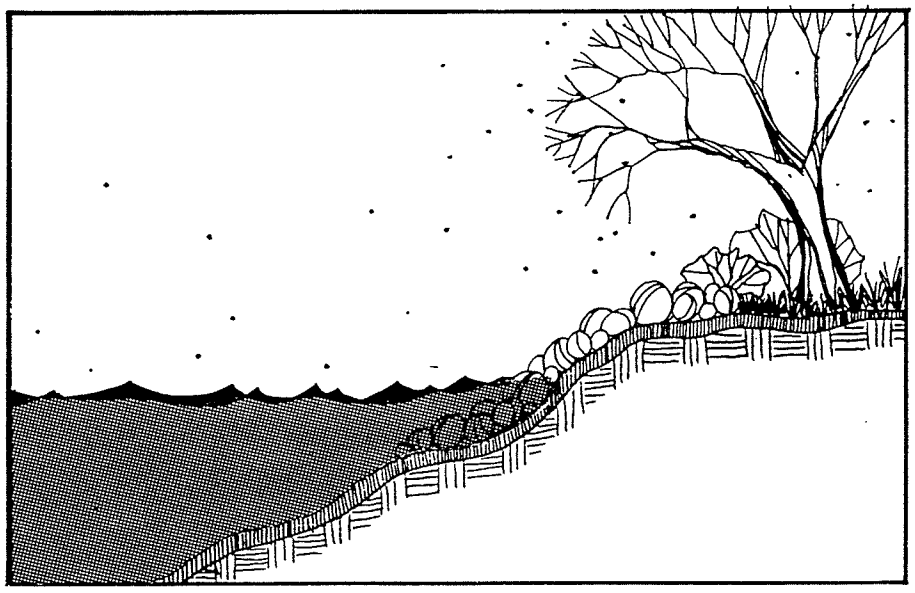


Figure 5 River Shoreline Stabilized
Source: Edwards

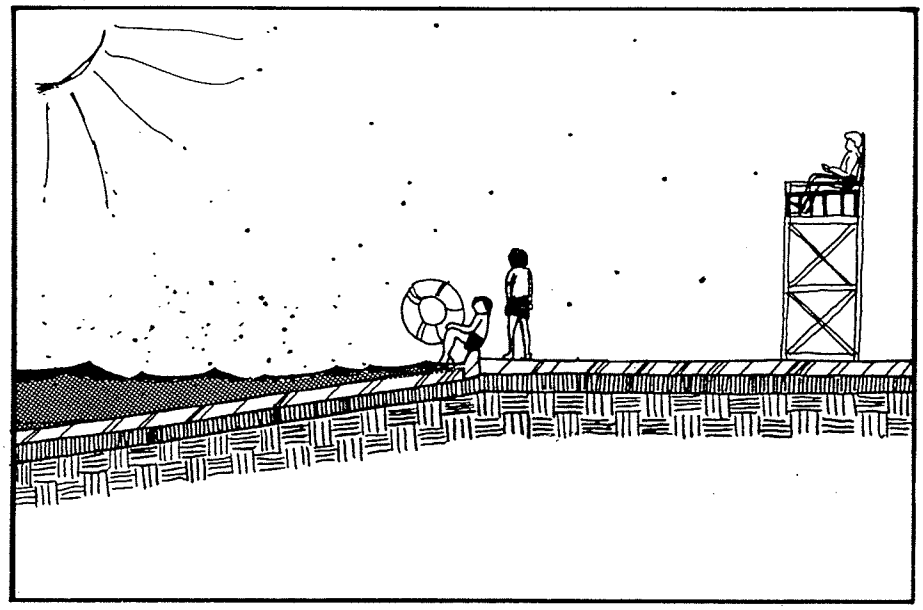


Figure 6 Hard Surface Wading Pools
Source: Edwards

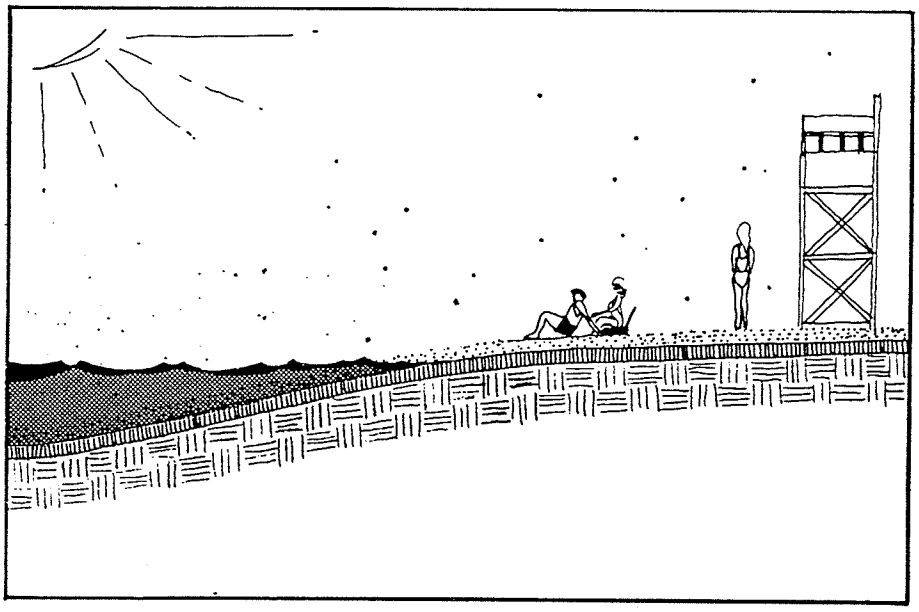


Figure 7 Soft Sand Beaches
Source: Edwards

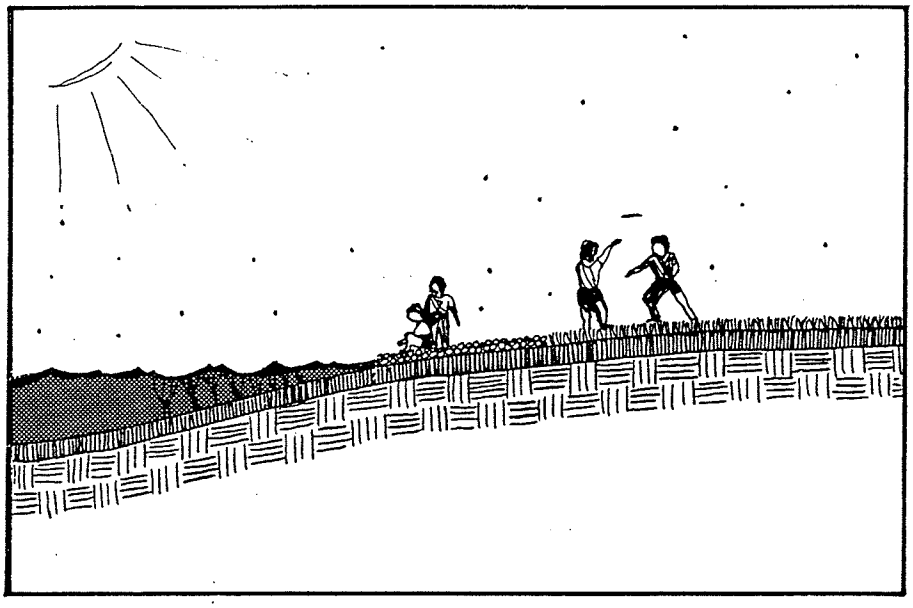


Figure 8 Sodded Retention Lakes
Source: Edwards

Does the shallow sloping bank condition encourage very young children to access the water by providing a barrier free environment? i.e. no slopes to climb up or down, no trees, shrubs or rock to climb through to access the water?

Do preschool children perceive the shallow water conditions as conditions similar to those at the beach and wading pools? and if so do they perceive safe swimming conditions?

According to the National Lifeguard Association of Canada and the Red Cross Society of Canada the conditions created by the construction of shallow water bank conditions is inviting and easily accessible to young children. The shallow slopes provide no more a barrier or deterrent for small children than does a beach and has an edge condition conducive to weed growth that could easily tangle a child's leg holding the child in the lake rather than allowing him to move easily out of the water.

To effectively design safe water environments for young children we should strive to develop water systems that express themselves as unique hydrological systems quite different than the safe water environments young children have become accustomed to. We cannot assume children have sufficient language skills to understand concepts and respond to simple verbal instructions such as "don't go in the water."

4.2.1.2 THE RULE BREAKERS

Misuse of an environment can be assessed as an act of vandalism, simply defying the rules, or as a creative exploratory process children engage in to understand their environment.

Curiosity is a natural creative drive that may be seen as inquisitive and wonder; toy with ideas; be open to explore puzzling situations; ponder the mystery of things; to follow a particular hunch just to see what will happen (Sherrill). Affective exploration in creative physical actions includes risk taking, curiosity and imagination, testing objects and self in the environment by using familiar components in divergent ways and new combinations.

Several motivating factors may draw children into the retention lake environment against the"do not enter" rules. For the more curious, retention lakes become one more component in the environment to be tested. In combination with peer pressure to participate, challenge rules and challenge themselves in the environment older children may be drawn into the lake regardless of how the lakeshore is designed, or what barrier fence may be erected, whether urban design is accepting or not.

According to Piaget's theory of rule consciousness development, figure 3, children at age twelve begin to view rules as relative entities, to be interpreted for their value in individual situations. The value of the "don't swim" sign is challenged with the question "why not?" and with the natural drive of curiosity to physically explore the situation. It is at this critical point where we as adults have several choices to make.

1. Do we erect a six foot chain link fence to keep the children out? If children climb over the fence help is not available. Will this stop them or add to the incentive of exploration?
2. Do we simply say "obey the rules because they are the rules", and hope the children will listen?
3. Do we enhance environmental education programs to answer the questions of the curious?
4. Do we re-design the lake to expose its natural and hydrological processes so the physical questions of function are self answering?
5. Do we remove the dangerous elements of the lake that make it hazardous for exploration?

4.2.2 SAFETY MEASURES

Providing environments that are safe for exploration presents a completely new mandate for designers that has not been explored due to the restrictive nature of retention lake guidelines. Until designers are afforded the flexibility to make the lake environment more accepting toward interaction and environmental understanding we can at least recognize the potential conditions of danger in existing retention lakes in order to begin to prevent accidents inspired through exploration. Consider:

i) Chemically treated retention lakes present toxic, attractive nuisances for those who enter the water accidentally or purposefully;
ii) Children wading into the water may be caught in aquatic vegetation under the water they have not anticipated or seen. Although visually obtrusive emergent vegetation may be removed chemically there may be no awareness that submergent vegetation exists. Perhaps the physical factors that encourage the proliferation of submergent aquatic vegetation can be redesigned along the waterbody where a clean edge is required while both emergent and submergent vegetation is encouraged to establish in areas designed for wildlife habitat. The use of the shoreline can enhance either objective as long as the expectation of the environment is consistent with visual and physical messages.
iii) Older children examining the lake, testing themselves in their environment have been drawn into the lake by currents that suck water into the outflow pipes of the lake. Underwater currents are perhaps unexpected in a lake that shows no visual signs of water movement on the surface, and gives no environmental message that the water from the lake actually flows somewhere, see figure 9. Solutions to this dangerous condition rest in environmental education about the engineering function and the physical interflow of water underground between lakes. The folly of the lake as a self contained unit could be exposed. If the true connection of the water flow is exposed for all to see and understand there are no hidden dangerous surprises.

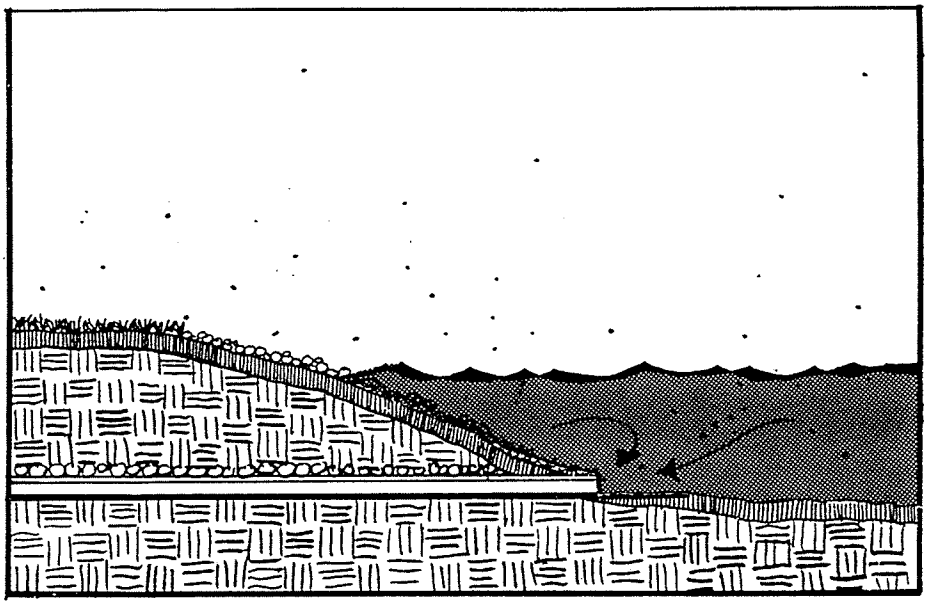


Figure 9 Outflow Currents Near Conduit Pipes
Source: Edwards

The issue of safety in the environment is clearly a difficult one that has both legal and economic implications. Presently, physical and psychological conditions created in man-made retention lakes are no more safe, and perhaps more inviting, for young children than the miles of natural river shoreline in the urban environment.

Potential safety hazards exist for both "the young child" and "the rule breaker" in man-made retention lakes. Specific environmental conditions that are unsafe have been outlined to demonstrate to decision makers that the rationality used to date in the formulation of design guidelines is not absolute and perhaps even inappropriate, in creating "safe water environments" in the residential subdivision.

Current design guidelines direct the waterbody development toward society's euphoric image of a lake environment. The illusion is played to the full extent in marketing strategies. Unfortunately it is left up to homeowners to explain to children that the lake is not really a "lake" and that what is presented is dangerous to enter.

Enhancement of current design guidelines may give designers flexibility to offer new water environments in the residential subdivision that are both visually interesting and less enticing for small children.

4.3 TERRITORIAL ISSUES

Stormwater retention lakes are considered a component of the open space system by the Parks and Recreation Department. In maximizing the visual and recreational opportunities offered by the lake for all community residents, the City has endeavored to preserve 50% of the water's edge in the public domain to ensure public access and movement through the subdivision (Plan Winnipeg, Parks and Recreation Component). The design guidelines that ensure this include:

1 In residential areas, a maximum of 50% of the lakeshore perimeter and a minimum landshore area equivalent to 100 feet in depth measured along the shorter length of the perimeter shall be preserved for **public access and use,** see figure 10.

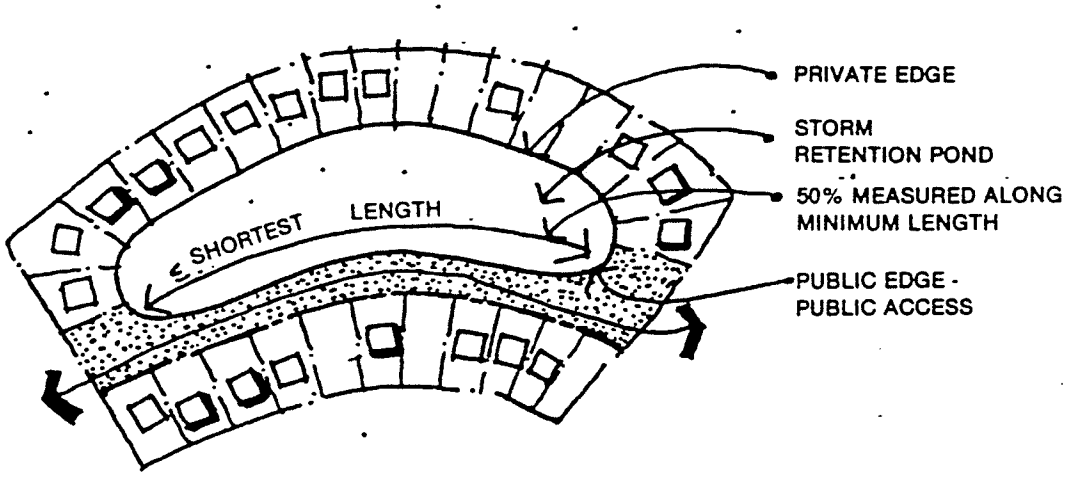


Figure 10 Public /Private Lakeshore Perimeter
Source: Plan Winnipeg, parks and Recreation Component

2 the impoundment area shall be defined as all lands around the perimeter of the lakeshore up to the high water line plus the area described in figure 8 as the basic 100 foot public dedication.

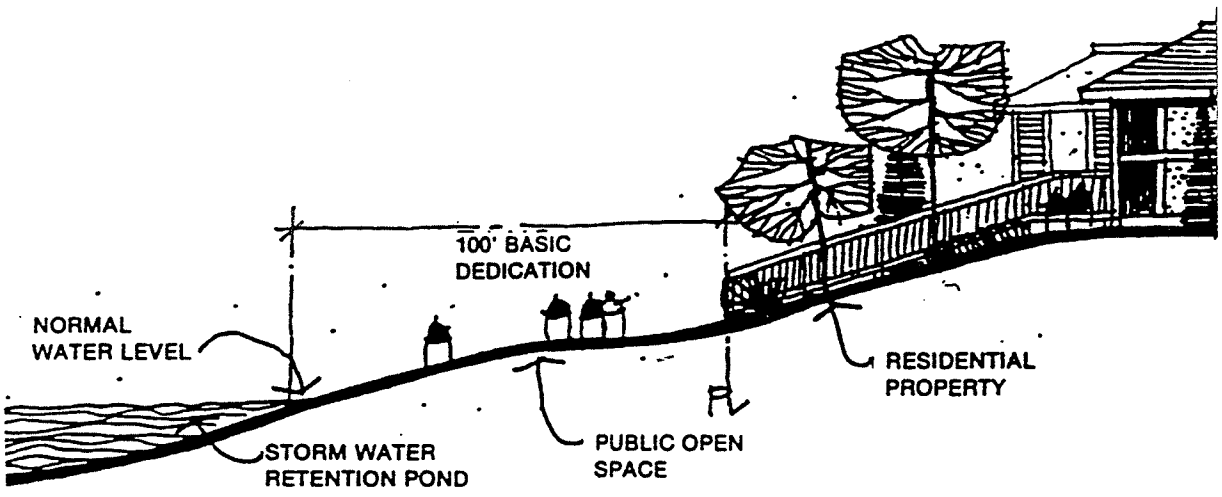


Figure 11 Public Park Adjacent to Lakeshore
Source: Plan Winnipeg, Parks and Recreation Component

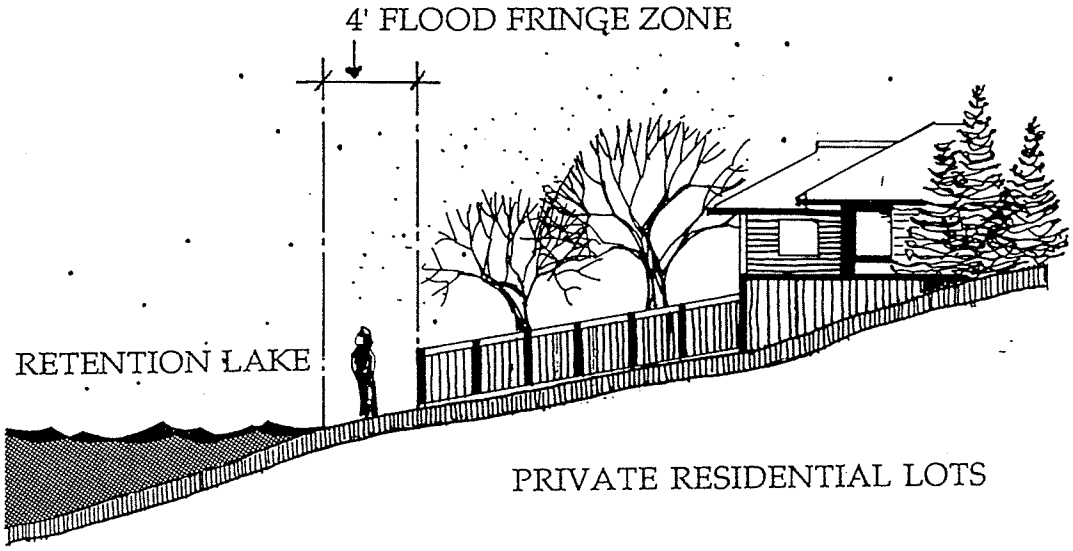


Figure 12 Private Property Adjacent to Lakeshore
Source: Edwards

As illustrated in figure 11 and 12 the definition of public and private territory is dissimilar along either side of the lake. Therein unique territorial conditions arise.

Along the **public shoreline** the demarcation of private residential property is well-defined. The 100 foot wide public park system, separating the residential yards and the lake, allows for comfortable community lakeshore access without infringing on private backyards. Residents clearly define their private outdoor space with fencing or terracing, see figure 8. Clear definition of land ownership creates a defensible space for residents along the public shoreline of the lake.

Along the **privately-owned shoreline** territorial definition is not as clear. Residents purchasing property along the privately owned shoreline believe they should control the property right down to the water in the lake. Although the lots are marketed and sold with this intention (by the developers) the ownership title and use of the **flood fringe zone** does not correspond with this ideology. As stated by law, the City of Winnipeg maintains public rights and access along the flood fringe zones of the lake, restricting construction along the lakeshore:

> "any private lot line adjacent to an impoundment area be established at the estimated normal water line and an agreement entered into with the City recorded by caveat prohibiting any structure except any minor structures permitted by the Commissioner of Works and Operations below the high water line and prohibiting any structure except a temporary structure approved by the said Commissioner of Works and Operations within two vertical feet above the high water line."

Specifically, between the normal water line and the high water line of the lake, residents are by law forbidden to erect any structure such as fencing. The flood fringe zone functions as a four foot wide path that does not properly accommodate the public but does physically allow the public access along side private outdoor territory. To relieve the tension and prevent public access, lakeside residents have extended their side yard fences into the water, regardless of the by-law, see figure 13.

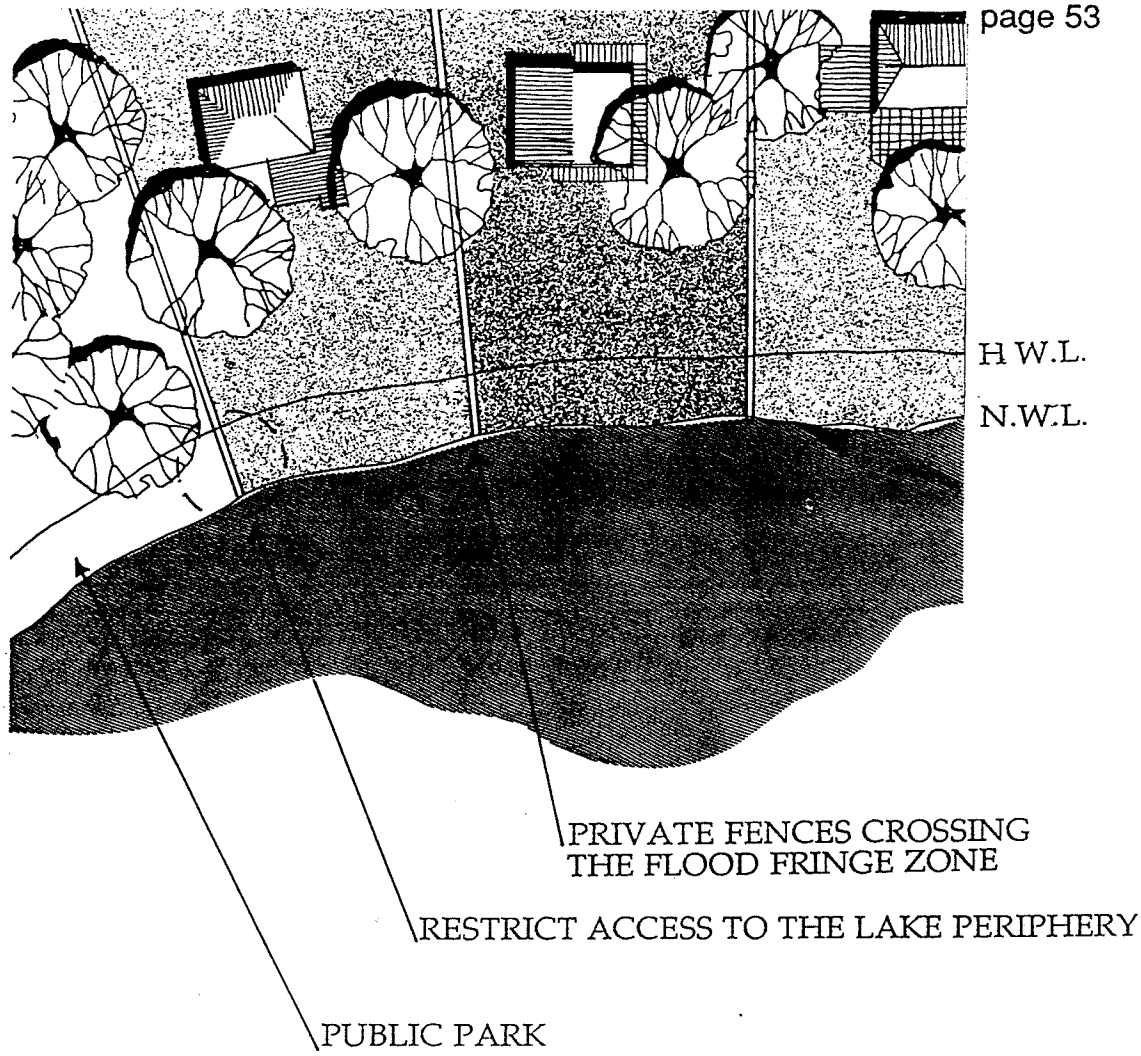


Figure 13 Parcelization of Shoreline
Source: Edwards

Individualized shoreline parceling can be seen around a number of lakes in Winnipeg where residents have not been satisfied with territorial demarcation of public and private space. The practical solution of fencing to the normal water line has adverse affects on the aesthetic value of the lake. Rectification of the problem lies in re-evaluating the initial concept of shoreline ownership and developing appropriate design solutions.

4.4 MAINTENANCE ISSUES

The City of Winnipeg assumes the task of maintaining the euphoric image urban dwellers correspond with "clean lakes". Unfortunately, to date the maintenance problems of eroding shorelines, algae bloom, aquatic plant growth and water stagnation have been addressed through maintenance programs rather than design solutions. Maintenance has become an ongoing battle against the forces of nature that react to the physical configurations and structures of the waterbody.

Maintenance problems on existing retention lakes evolve due to three interactive factors;

1. the **physical design** of the bottom and edge condition;
2. natural **ecological cycles** that react on those conditions;
3. **human alterations** and interventions in those processes.

The **physical conditions** of a lake including form and depth configuration has a profound effect on the ecological function and ensuing maintenance requirements of the lake. The City of Winnipeg guidelines direct that, in respect of lake form layout:

1. impoundment systems be of the permanent lake type having not less than five acres of water surface.

2. impoundments have a minimum water depth of four feet and side slopes of 7:1 for safety, and that all impoundment slopes between the normal and high water levels be sodded and that the area in the vicinity of the normal waters edge be suitably protected.

Following these directives retention lakes shoreline conditions will encourage unwanted aquatic plant growth due to expansive shallow water surface areas that have little or no second story vegetation along the bank to provide shade.

The **ecological cycles** active in photosynthetic processes and the production of aquatic vegetation have ideal conditions for propagation. The three primary factors regulating lake productivity: the rate of nutrient supply to the water, form and depth configuration of the lake basin, and climate, (light and temperature) are optimal in existing retention lakes.

The eutrophic tendency of the lake is exaggerated as abundant shallow water conditions along the shoreline allow sunlight to penetrate encouraging the proliferation of emergent, floating leafed and submergent plants, see fig. 14.

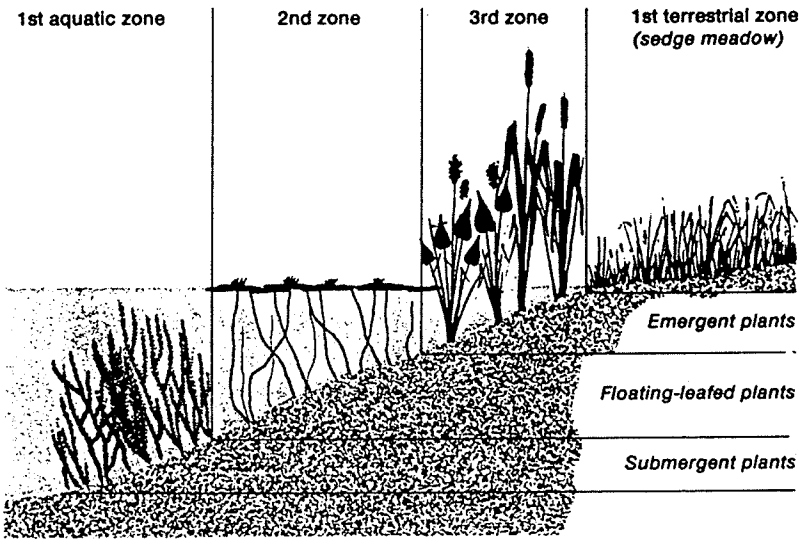


Figure 14 Aquatic Vegetation Zones in Retention Lakes
Source: Freshwater Ecology

The exaggerated shallow water shoreline conditions in conjunction with the natural affinity of the lake to act as a sedimentation basin, collecting a continual build up of chemicals and nutrients that are not flushed out rapidly or completely as in rivers, have made most lakes eutrophic, and toxic for wildlife when chemically treated.

Human intervention in this cycle of plant and algae production has occurred on two levels. The cycle of plant production has been accelerated through the addition of nutrients, phosphorus and nitrogen, into the lake as chemical by-products of lawn fertilizers and pet animal excrements, while the irradication of aquatic plants and algae bloom is attempted through chemical treatments to the water body.

The rationality for the enforcement of the guidelines that create physical conditions conducive to unwanted plant growth regardless of the maintenance problems they create has centered around the issue of safety. The long shallow bankslopes are perceived as a safe environment for young children. It is indisputable that safety issues should proceed maintenance problems, but as previously discussed the appropriateness of these particular guidelines as they relate to safety is questionable.

The ecological repercussions that effect lake function and produce maintenance problems have remained secondary issues to inappropriate rationality. Chemical maintenance techniques used as a secondary solution to appropriate form and depth configuration of the lake basin, have been selected through economic cost criteria. Cost savings are consistent with the engineering directives of the WWD who direct the maintenance of the lakes in the City of Winnipeg. The result is retention lakes which remain sterile water environments, toxic and untouchable with the full potential for ecological and educational goals unexplored due to these practices.

This study will explore new resolutions to safety issues in the water environment. Alternative long term maintenance programs will correspond to new waterbody design strategies. Non-chemical alternatives will focus on weed harvesting, natural controls through introduction of wildlife, illumination of the shallow water condition through terrace shoreline design and application of hard edge treatments along the shoreline.

4.5 SUMMARY

The problem areas outlined in this discussion focus on situations evolving through the enforcement of existing guidelines. The issues are presented as conclusions of observational research.

To determine what community residents perceive as positive and negative aspects of the lakes, these issues have been incorporated into a survey for lake-oriented communities. The results of this survey have been incorporated into a synopsis of resident opinions and concerns.

5.0 CONSUMER OPINIONS ON RETENTION LAKES

5.1 INTRODUCTION

Consumers must be satisfied by a variety of factors in order to invest in the purchase of property in any community. In lake-oriented subdivisions developers have utilized the recreation and aesthetic benefits of the retention lake to draw interest in the community as a special environment.

It is important to determine whether the residents are comfortable and feel satisfied by the environment for both the developer and the City of Winnipeg. The developer can assimilate residents' feedback into future lake-oriented subdivisions to ensure future markets, while the City of Winnipeg will benefit from residents who take a personal interest in the lake environment.

Each resident will judge the lake's physical, biological and social setting against their own perception of what the lake should offer. Where general satisfaction and comfort levels have been accommodated in the community a "neighborhood watch" may evolve. But if residents feel apprehensive, disconnected or afraid of the activities the environment may attract, an "I don't care" attitude may develop. Without supervision the incidence of vandalism, garbage dumping, noise and general disturbance has a greater potential for germination.

In a hand delivered survey, residents were asked to describe their opinions about the retention lakes in their community to determine what features were facilitators or attractors and what site features were constrainers or detractors.

The survey asked residents to indicate whether site specific components in the categories of **visual satisfaction, safety, maintenance, and recreation,** would greatly detract, detract, have no effect, improve, or greatly improve the lake and the community. For discussion purposes the five point scale was collapsed into three categories, "detract", "have no effect" or "improve", to identify pronounced trends and facilitate statistical analysis of the data. As a cross reference for answer consistency the survey asked participants to agree or disagree with several general statements. Refer to appendix 2 in which a sample of the survey is shown.

5.2 SURVEY SIZE AND LOCATION

The study area for the survey consisted of 200 homes in the subdivisions of Waverly Heights and Southdale. These lake oriented subdivisions were selected for the following reasons:

i) The communities are at least 5 years old. Participants have resided in the community long enough to observe the seasonal changes of the lakes, and the lakes and the communities have been completely developed.

ii) Both subdivisions are located in the southern sector of the City of Winnipeg. The location of study site for this practicum is also located in the southern sector. All three subdivisions seek to attract a similar market and socio-economic class of homebuyers.

iii) Both Waverly Heights and Southdale were designed and constructed according to the 1964 City of Winnipeg Development Guidelines. They are representative of typical retention lake design within the City of Winnipeg.

200 surveys were hand delivered to 100 homes in each of the two subdivisions (therein 50 lakeside residents and 50 non-lake residents). In total 68 lakeside and 75 non-lake responses were picked up. The total number of responses,143, gives the survey a 71.5% response rate. For descriptive purposes, the results allow a 90% confidence (give or take 10%) that the answers received are accurate for all residents of lake oriented subdivisions (University of Manitoba Statistical Department). Survey results are detailed in Appendix 2.

5.3 RESULTS AND DISCUSSION

5.3.1 VISUAL SATISFACTION

To determine what variations to the lake surround would make it visually attractive or unattractive, a series of conditions were listed. Residents responded by indicating whether each condition would improve, detract, or have no effect on lake attractiveness.

The most valued visual attraction, expressed by 85.6% of the residents, was **wildlife**. Accordingly, 88% of the community residents would like to see the lakes designed to support wildlife. More specifically, 53% of the residents preferred to have waterfowl and fish control aquatic plant growth and 51% of the residents agreed to maintaining natural aquatic vegetation to provide food and cover for the wildlife, see figure 15.

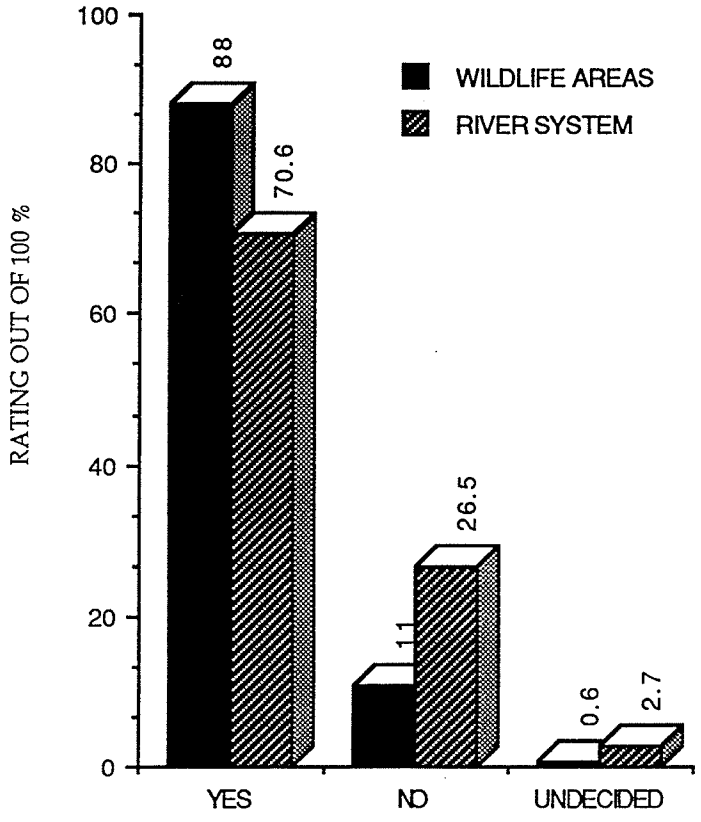


Figure 15 Wildlife on Retention Lakes
Source: Edwards

Four factors, supporting wildlife areas along the lakeshore, the desire to live next to the retention lake, accepting the use of fish and waterfowl to control plant growth, and retaining natural plant growth for wildlife food and cover were compounded to attain a score out of 400 points. The composite score recorded was just under 300 points for residents in favour and just under 100 for residents not in favour of the changes, figure 16.

In addition to wildlife, 70.5% of the residents suggest the waterbodies would be improved visually if there were a river link between them . This finding is consistent with the fact that 70.6% of the participants would live next to a river system. The appeal of living next to a waterbody seems to transverse the detail of whether it is a lake or a river system. A river linkage between lakes supporting the required food and cover for wildlife rated a composite score of 300 out of 400, see figure17.

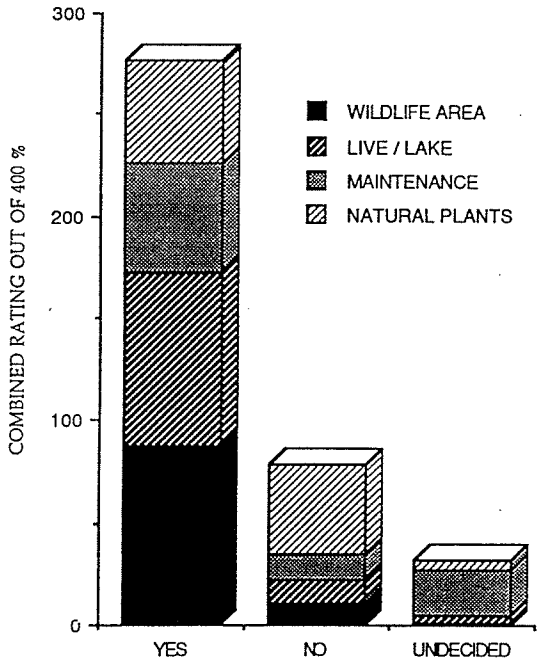


Figure16 Wildlife Support Systems on Retention Lakes
Source: Edwards

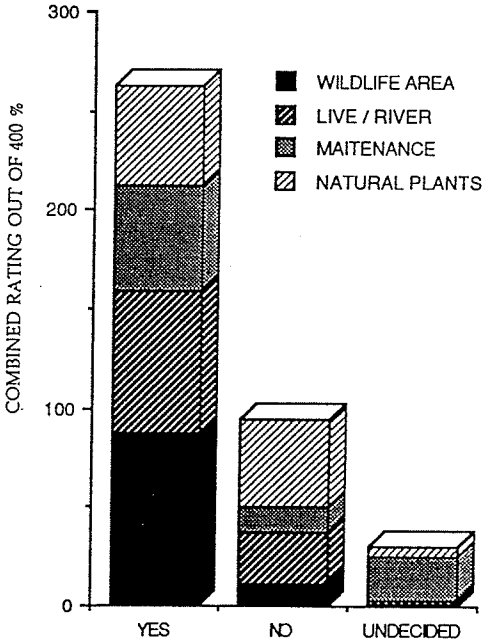


Figure17 Wildlife Support Systems on River Systems
Source: Edwards

Other visual attractions such as **waterfalls and fountains** were perceived as an improvement by 79.6% of the residents, figure 18. This suggests and hydrological processes could be enhanced with a variety of conditions more visually stimulating than flat water surfaces. Integrating new waterflow systems has the potential of enhancing the function of the lake by providing aeration, therein preventing oxygen depletion, mosquito breeding, and algae blooms.

The visual attraction of surficial waterplay, wildlife and water linkage systems between the lakes can be developed to enhance the attractive quality of the lake and fulfill residents' expectations of the water systems.

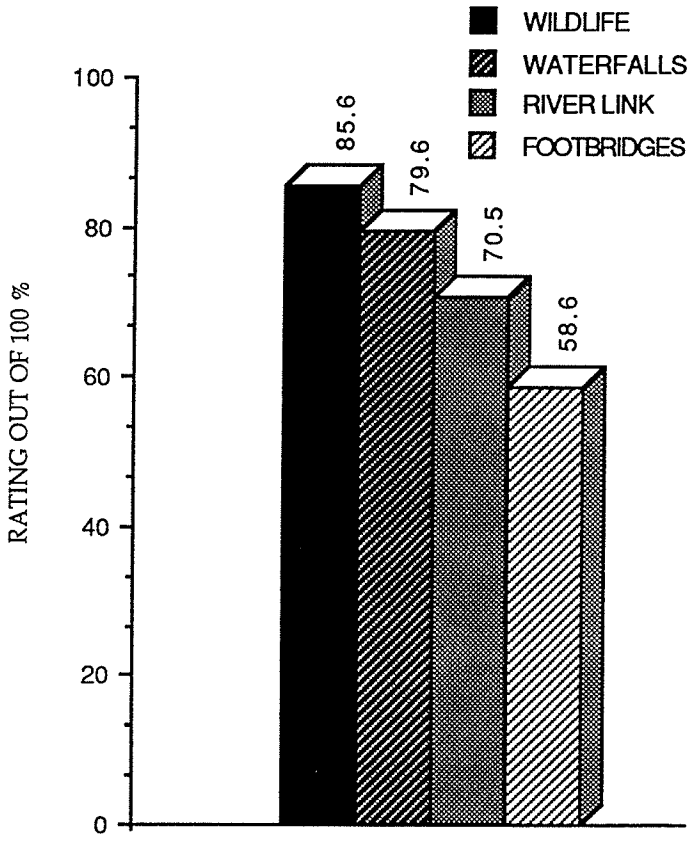


Figure 18 Visual Attractors on Retention Lakes
Source: Edwards

Not all lake conditions are attractive. Specifically 87% of the participants responded that a six foot chain link fence around the entire lake would be extremely offensive and unattractive. This concept had been discussed by the City of Winnipeg as an option that may be implemented to ensure the lakes did not become a safety hazard for children. In addition to the visual obstruction, 92% believe the fence would not keep children out of the water and would actually provide an attraction for them to climb.

The second most offensive lakeshore development seen unattractive by 71.2% of the participants was the individualization or parceling of the shoreline, see figure19.

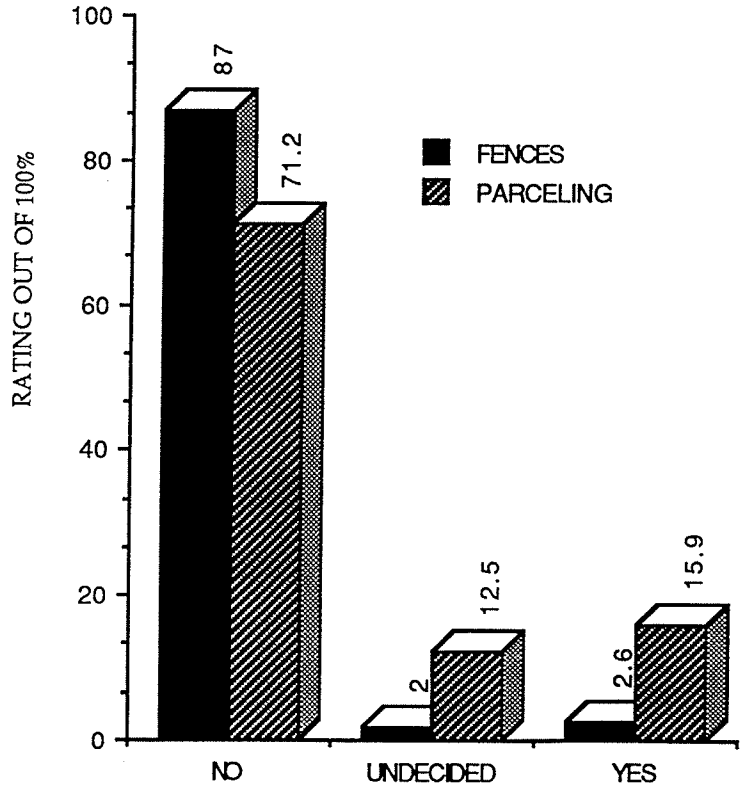


Figure 19 Visual Detractors on Retention Lakes
Source: Edwards

The visual interest in footbridges, boardwalks, lookout towers or playgrounds was not overly appealing. 58.6% of the residents stated footbridges may be a visual improvement to the appearance of the lake but less than 40% of the residents believed boardwalks, lookout towers or playgrounds would be attractive to view, see figure 20.

The disinterest with these development options as visual attractors is consistent with the rating of these items for actual recreation activities. The development of boardwalks for the public activities of fishing or boat docking was seen as a detraction or negative attribute by 58.5% and 72.6% of the residents respectively.

The use of lookout towers in the recreation setting was considered a positive idea by 38.3% of the residents. Even lower ratings of 29.2% and 34.1% were given to the recreational value of the junior playground and tot lot respectively. As indicated through the general comments the visual value of these items is outweighed by the perceived noise and vandalism nuisance they may invite into the community.

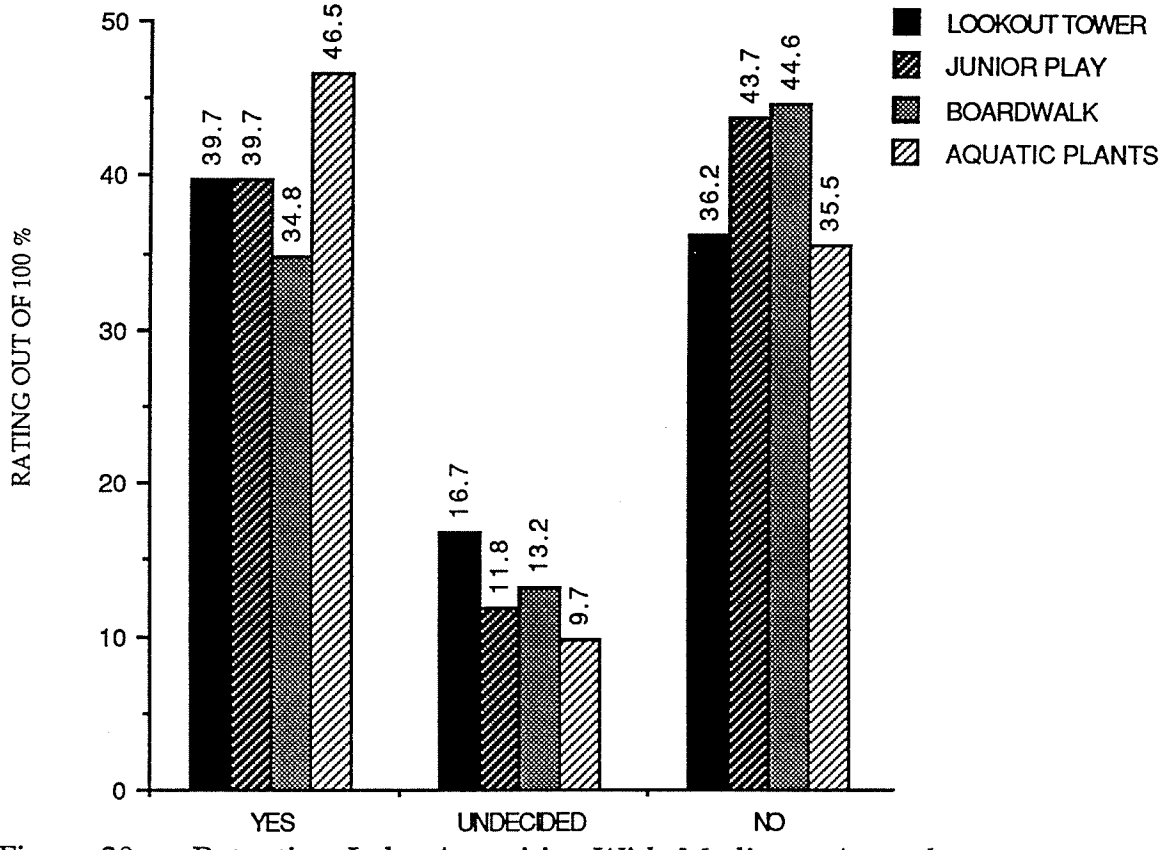


Figure 20 Retention Lake Amenities With Mediocre Appeal
Source: Edwards

5.3.2 MAINTENANCE

Although residents do not deal with maintenance of the lake or waterbody directly, they certainly enjoy the consequences of a well done job or suffer the disturbances of neglect. The City of Winnipeg takes the responsibility of grass cutting, controlling algae blooms, and removing aquatic vegetation in retention lakes generally as a reactive measure to complaints phoned in by residents or as a reactive measure to warm weather.

Five methods of controlling aquatic plant growth were listed in the survey, of which one was chemically oriented and four were not. Residents have indicated how they feel about the use of the various methods, see figure 21.

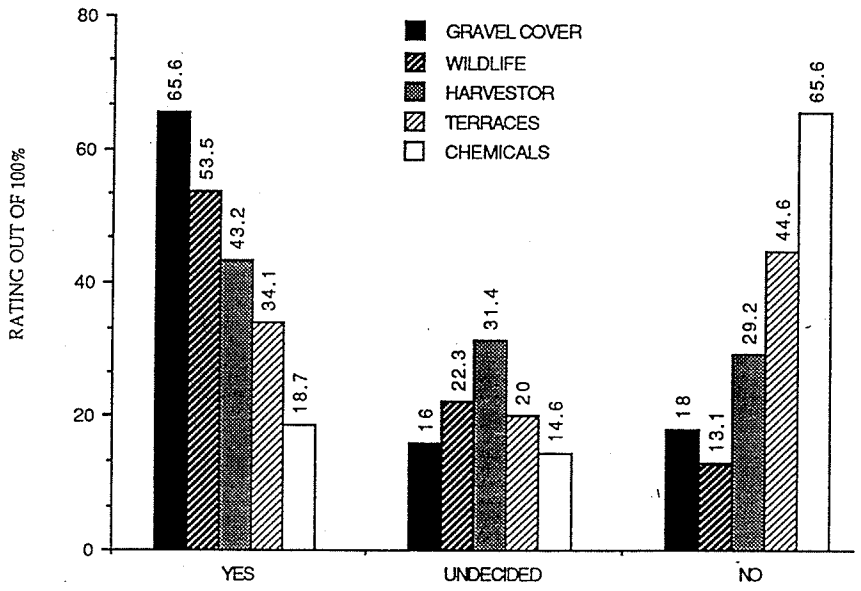


Figure 21 Methods of Retention Lake Maintenance
Source: Edwards

The use of several **chemicals** such as Round-Up, 2-4-D, and copper sulfate to name a few, to control aquatic plant growth is common practice in the City. For 65.6% of the residents this method of water maintenance is a detractive lake quality. The use of chemicals is incompatible with the support of wildlife in the lakes reinforcing the need to re-evaluate present lake design and incumbent maintenance programs.

Four **non-chemical** alternative methods of aquatic weed control were named in the survey of which two were generally acceptable. 66.2% of the residents agreed the application of rock and gravel over the lake floor in shallow water areas would improve the lake, and 62.5% of the residents believed the encouragement of wildlife and waterfowl as natural controls would be acceptable.

Recognizing that people are receptive to the idea of integrating waterfowl and fish into the urban environment, a combination of new lake form design and non-chemical maintenance techniques could be organized to provide a more receptive habitat. Translating those objectives into practice will require new flexibility in design guidelines and new approaches to ongoing maintenance. Without doubt the initial design of the waterbody will directly effect the future long term maintenance program.

5.3.3 RECREATION

Water quality is a constraining factor on the range of water based recreation opportunities in all lake oriented subdivisions in the City. City policy recommends stormwater lakes be used for secondary, non-contact activities such as canoeing, paddleboating, fishing, and skating, and for tertiary land based activities. Primary contact activities such as swimming, wading, waterskiing are not permitted due to potential health hazards associated with poor water quality and potential safety hazards (City of Wpg., WWD. 1964)

Community recreation amenities have enormous potential for development in lake oriented subdivisions. Although primary water contact is not recommended in the lake , the water feature offers unique potential to integrate secondary activities such as canoeing, fishing, bird watching, skating, and ice hockey in addition to the numerous tertiary based activities that are developed in typical community park.

Residents in these communities may enjoy the extensive range of potential recreation activities or may be displeased with the added noise or intrusion of outsiders in the environment seeking use of the facilities. How the recreation amenities are perceived by community residents will have a profound effect on sense of enjoyment, security and safety in the community.

In the survey residents were asked to differentiate between recreation amenities that were perceived as attractors, and those that were detractors. Effective recreation planning and management in the residential water environments should respond to residents' needs and desires rather than the application of typical community recreation standards.

Feedback from the residents survey clearly indicates there are specific likes and dislikes in potential amenities that are clearly linked to concerns of privacy, intrusion and safety.

To maintain the quiet, scenic and serene setting residents associate with the lake setting, specific passive summer recreation activities were attractive to lake side residents. Those included summer uses such as sitting areas 71%, jogging trails 53.7%, wildlife viewing 52.3%, education programs 46%, and bike trails 46%. Popular winter recreation activities included ice skating 74%, tobogganing 58.6% and cross country skiing 52.3% respectively, see figure 22.

The high values given on the **detractive** end of the scale for public activities such as motorbike trails 88.7%, snowmobile trails 88.7%, public docks 72.6%, public beaches 65.1%, public fishing 58.5% indicates both lake and non-lake residents believe these activities would be unwanted in the community. The perceived invasion of non- community members into the neighborhood to utilize these amenities creates several concerns: vandalism of personal property, invasion of private territory fronting onto the lakes, destruction of the lake itself (such as throwing the rock and gravel from along the lakeshore into windows, at wildlife, or at other children), noise intrusion, and safety. Similarily, activities such as hockey, skateboarding, junior playgrounds or tot lots have rated poorly. Their presence is perceived as an activity that will attract non-community members into the area to play who may not have proper instruction or supervision when playing around the lake, see figure 23.

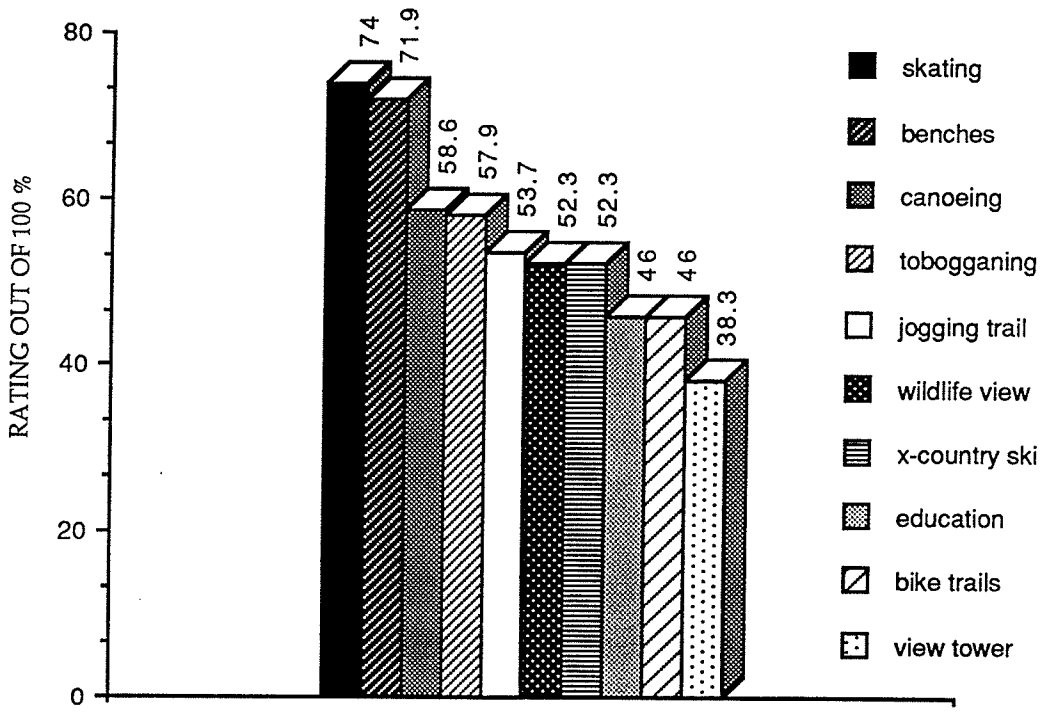


Figure 22 Popular Recreation Activities
Source: Edwards

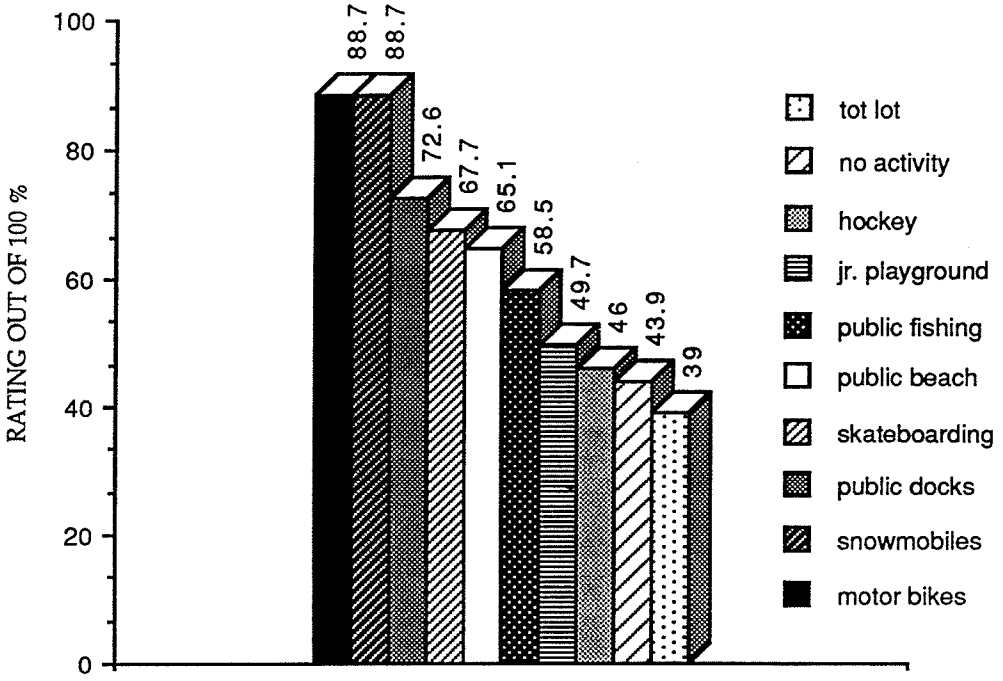


Figure 23 Unpopular Recreation Activities
Source: Edwards

Although residents' participation was not recorded for these activities, the presence of opportunity itself is very important. The perceived availability of appropriate recreation opportunities, reinforced through marketing strategies of the developer, are important in shaping and forming the character of the neighborhood, and the value of the sub-division.

Recreation activities highlighted by community residents as desirable complement the preservation of the serenity and scenic quality of the lakes. The spatial, visual and acoustical consistency of the lake and the activities which take place around it are important issues which will reinforce residents' comfort. Public, noise oriented activities are viewed as unattractive. Potential noise disturbance, vandalism concerns, and safety concerns are problems residents would like to avoid.

5.3.4 SAFETY

Safety issues were descriptively expressed in statements to which the respondents were asked to agree or disagree. Survey results indicate that there is a very strong feeling that individual households should take responsibility for their childrens' safety by educating them about the lake.

As outlined in previous discussion the City of Winnipeg has directed that the construction of all retention lake shorelines have a 7:1 bank slope condition 30 feet into the water, see figure 3. The original intent of this direction was to provide a safe bank condition by ensuring the water could be easily exited by a child if he was in trouble (Al Reimer, City of Winnipeg). But it is questionable whether the physical and psychological conditions of this environment are actually safe. 68.5% of the residents believe these slope conditions are unsafe and provide an easy access invitation into the water for small children.

Conditioning may play a part in this situation as children learn at a very young age that other water bodies with similar gentle slopes such as wading pools or beaches are safe for recreational swimming. 68.5% of the residents believe young children by association may see the inviting slope of a retention lake as a sign of welcome.

Even less safe was the concept of erecting a six foot chain link fence around the entire lake. 90.2% of the residents believe such a structure would serve as a challenge for kids to climb over and once over the barrier there would be little chance of a expedient rescue, because of the fence.

Although there is no easy answer to the issue of safety in design, the residents have clearly indicated, through general comments on the survey, that they do not want their children locked out of the environment. Both the designers and the public at large must accept the fact that children will always want to understand and learn about their surroundings both physically and mentally. 76.2% of the residents believe safety can be designed into the lake environment by accepting the fact that the children are going to explore their environment.

5.4 SURVEY SUMMARY

Responses given on the surveys indicate several prominent changes could be made to the lake systems to improve the quality of the living environment for the community. To improve visual quality, wildlife would be most welcome . The watercourse itself would be more attractive if there were a river link between the lakes and if water features such as waterfalls and fountains were integrated into the design of the system. The unattractive condition of having the shoreline dissected into individual parcels should be addressed and in so doing the uncomfortable/ unresolved territorial issues that deal with the demarcation of public and private land must be dealt with.

A varied selection of winter and summer recreation activities including ice skating, seating areas, canoeing, tobogganing, jogging trails and wildlife viewing, would improve the lake and park system. Other recreation activities that appeal to the more general public and therein may present noise or intrusion problems such as motor bike & snowmobile trails, public docks, public fishing, or public beach areas, are considered unattractive and unwanted by the community residents.

Although there was not an overwhelming response to any one type of maintenance system outlined for the lakes, there was a dislike associated with the use of chemicals. The use of a rock or gravel cover in shallow water areas was a more acceptable means of controlling plant growth in specific residential areas. The use of weed harvesters and the acceptance of aquatic plant growth for wildlife habitat are options worth exploring in conjunction with new waterbody design and have not been disregarded by the respondents as options. To design a water environment that supports wildlife habitat maintenance techniques becomes a sensitive issue. The initial waterbody design must be responsive to the maintenance requirements it creates.

Safety will always be a concern where water is present in the environment. The current design solution of gentle slopes into the water may provide a welcome sign for children to enter the water. Trying to lock children out of the water environment by building a chain link fence around the entire lake would be both useless and unattractive. The value of education and appreciation of the water environment is an important task that should be reinforced by both individual family units and outdoor education programs.

6.0 AN ALTERNATE DESIGN STRATEGY FOR 'RIVER PARK SOUTH'

6.1 INTRODUCTION

This chapter presents an overview of an alternate design strategy for a stormwater management system and subdivision layout for "River Park South". The discussion includes the following topics:

i) The general objectives for introducing a new form of waterbody into the design of a residential subdivision for the purpose of stormwater retention;
ii) The design approaches employed in the formation of the stormwater management strategy;
iii) The design standards employed for the layout of the stormwater management system;
iv) The layout of the subdivision and evaluation of land use areas for school grounds, parks and commercial / retail areas. The area allocated for residential lot development has been differentiated into zoning categories of: R1-5 lake front lots, R1-5 regular lots, and R1-4 lots. A monetary value for these conventional residential lot classifications has been calculated to determine a potential economic value for residential lot sales.

6.2 DESIGN OBJECTIVES

Several design issues outlined throughout this study present challenges that must be addressed in the overall planning strategy for future lake oriented subdivisions. These issues have been integrated into the formation of planning objectives listed below:

i) To maintain or increase the economic return for the development company while providing an aesthetic and marketable community featuring the stormwater retention system;

ii) To provide a realistic representation of a natural drainage system for the prairie landscape. We must consider opportunities for urban design that develop a vernacular expression of water that is in tune with the natural process (Hough, 1984);

iii) To develop a stormwater management strategy that will increase the amount of time water remains on the ground surface and therein the possibility of ground water recharge;

iv) To enhance the visual attractiveness and understanding of natural processes by providing a continuous water system or linking of lake systems within the drainage district;

v) To address the issue of safety by providing shoreline conditions that are associated with natural riverbank conditions, that are not openly accessible or enticing as easy access shallow shorelines;

vi) To provide a well defined pedestrian flow system that will allow all residents to access passive recreation activities (that residents desire) along the recreation corridor;

vii) To introduce a variety of shoreline conditions and water attractions to enhance the scenic quality of the waterbody and diversify interest along the shoreline. This may include design solutions that develop conditions to:

a) attract wildlife nesting in designated park areas such as shallow bankslopes to encourage vegetative habitat growth, and a sinuous shoreline edge to increase the length of potential nesting grounds;
b) complement the hydrological functions and reduce aquatic plant growth that causes maintenance problems along residential shorelines such as shade vegetation along the banks and steeper bank conditions to reduce sunlight penetration and ensuing growth of submergent vegetation;
c) define territorial boundaries of public and private land ownership, such as bank terracing along the shoreline and flood terracing as a natural bankslope condition.

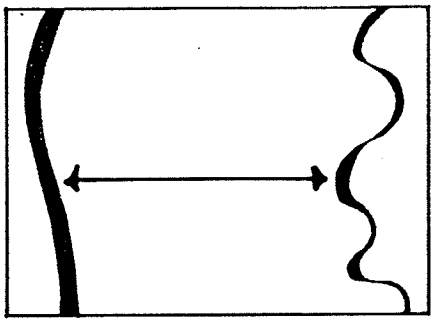
6.3 DESIGN APPROACH

Proposing an alternate stormwater storage system for the site has provided the opportunity to address new planning objectives through the exploration of new scale, form and shape of the waterbody. This study will illustrate one new alternative for urban stormwater runoff.

The alternative stormwater management strategy presented in this study explores the possibility of introducing a continuous meandering river system to collect stormwater runoff. This concept will illustrate how a man-made interpretation of the prairie river system fed by streams, channels and coulees can provide a surface drainage system for the sub-urban subdivision.

A series of ideograms with notations has been included to illustrate the planning strategy formulation. The conceptual ideas have been developed into the detailed subdivision plan.

i) Design Strategy:

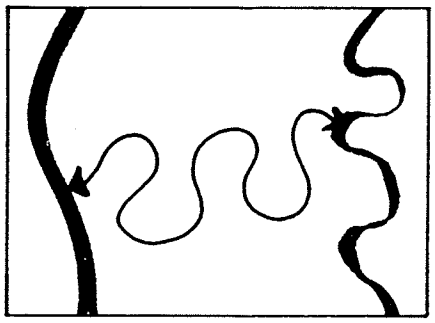


Provide a continuous drainage flow across the site that respects the natural drainage divide . Lands to the East are outside the study site and drain East. Lands to the west are on the study site and all drain West

Reflected Changes:

1. A continuous recreation and wildlife corridor will flow through the subdivision acting as a spine of activity for all residents to enjoy.
2. The water will flush through the system to eliminate stagnant water and associated algae, weed and mosquito growth thereby improving natural maintenance systems.
3. A visual and psychological link will be reinforced between the man-made watercourse and the natural watercourse which interact "ecologically".

ii) Design strategy:

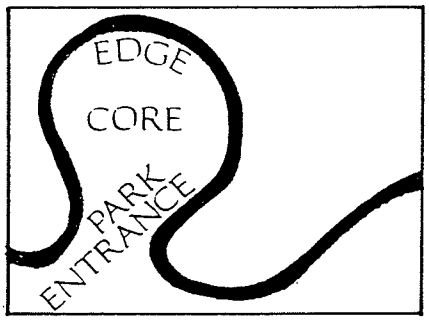


Wind the water course through the built form of the residential subdivision.

Reflected Changes:

1. The watercourse will simulate prairie rivers that meander to collect water not naturally absorbed by the soil.
2. The extended watercouse will reach a larger surface area enhancing surface drainage and ground water recharge.
3. The length of the watercourse will be maximized to extend waterfront land for private lot development and for public park development.
4. The extended watercourse will increase the volume of storage area.

iii) Design Strategy:

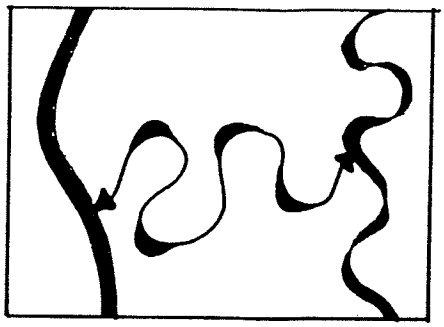


Curve the watercourse to enhance community pocket development.

Reflected Changes:

1. The sense of community will be enhanced by developing pockets within the subdivision wherein the residents can identify with special features. Community pockets may range in size from 500 to 700 residents.
2. The watercourse will be used as a defensive edge (a rejuvenation of the 'defensive moat') for the community pocket. An identifiable defensible edge will be developed for the community group.
3. The water course will be used to define a uniquely identifiable "ceremonial" green space at the entrance of each community pocket.

iv) Design Strategy:

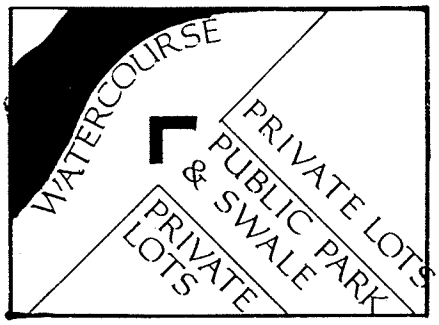


Introduce aquatic environmental attractions along the watercourse.

Reflected Changes:

1. A passive public park network will be maintained along the length of the shoreline where private residences back onto the river corridor while more active wildlife and environmental attractions will be located in public open space locations.
2. "Active" public attractions will be decentralized along the watercourse to equalize interest along the entire system.

v) Design Strategy:

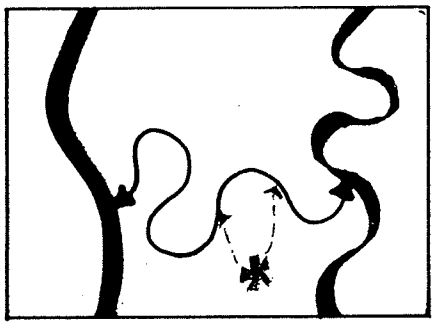


Integrate a surface stormwater collection system within the public open space system behind all residential lots.

Reflected Changes:

1. A public access system will be available for all residents to reach the watercourse and recreation activity spine.
2. Safety will be improved by eliminating roads between park space and the home environment.
3. The potential for ground water recharge will be maximized by increasing the ground surface area water travels over before reaching the river systems.
4. Stormwater drainage costs will be reduced or minimized by eliminating subsurface conduit pipes.

vi) Design Strategy;



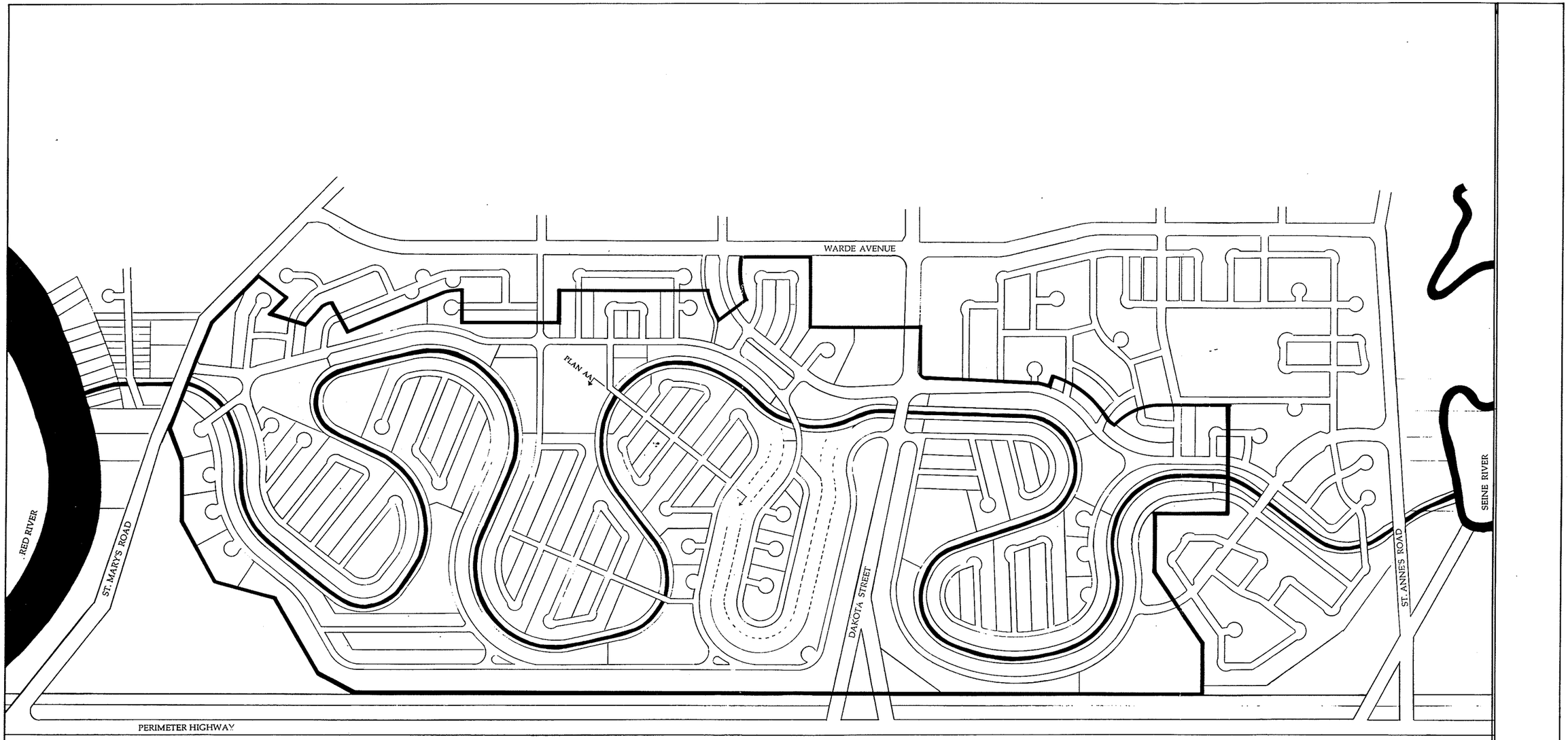
Integrate a snow dump site into the open space system that will self empty into the river corridor.

Reflected Changes:

1. A large scale snow storage area will become a part of the drainage system. Snow storage will be the primary function and recreation such as toboganning will be a secondary feature. Melting snow will drain into the river corridor.
2. The landscape designed for snow storage will be used as an emergency water overflow area during floods greater than the 25 year storm capacity and as a public park during summer months.

3.The unique landscape feature will decrease snow removal transportation costs for City maintenance programs.

The alternate design strategy for "River Park South", illustrated in map 9 demonstrates how these design strategies have been integrated into a residential subdivision plan. The conceptual strategies have been developed further to demonstrate how the system may operate to achieve the planning objectives.



MAP 9

SUBDIVISION PLAN

"RIVER PARK SOUTH" PRACTICUM DESIGN SOLUTION

SCALE 0 50 150 300

6.4 AN ALTERNATE STORMWATER RUNOFF MANAGEMENT SYSTEM

6.4.1 INTRODUCTION

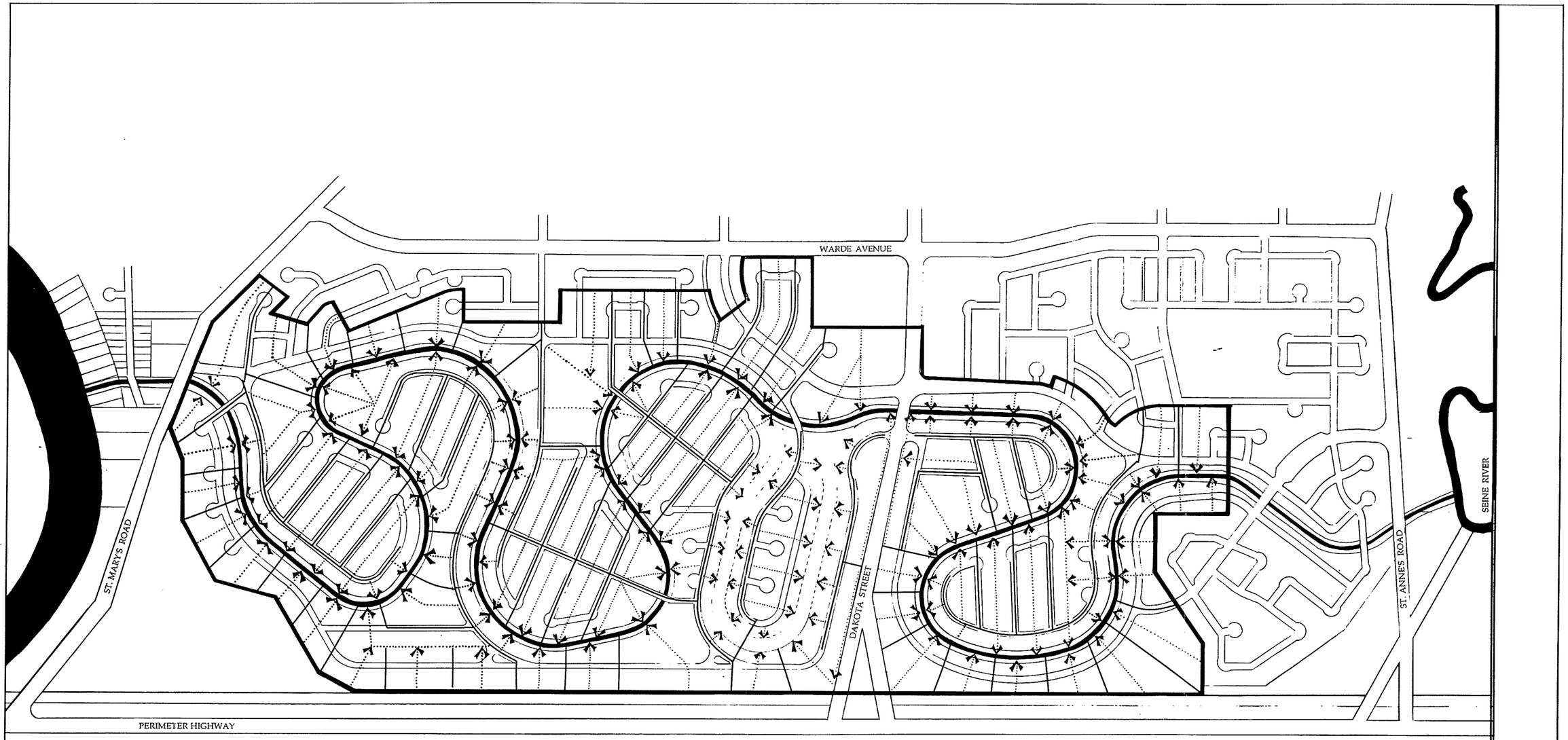
The stormwater runoff management system features a river corridor that has been designed to meander through the subdivision for functional, economic and aesthetic reasons. The river channel is fed stormwater runoff that is collected and delivered to the system by a series of drainage swales and channels, see map 10 .

The alternate stormwater retention system maintains the same storage capacity standards as the retention lake storage system on the original layout plan. The waterbody storage capacity will be for a 25 year storm. The alternate system will provide approximately 6000 cubic feet of storage for every acre of subdivision. There will be 3,843,000 cubic feet of storage capacity provided between the normal water line and the high water line of the water impoundment.

The stormwater runoff generated on site will be collected by a dendritic system of swales and channels. The volume of waterflow each channel will be required to hold was determined using the Rational Method. For planning purposes, values referred to in Chapter Four for runoff coefficient and rainfall intensities were maintained for these calculations.

6.4.2 WATERBODY DESIGN

Two components of the proposed watercourse were detailed to examine how the waterbody could be developed in the residential subdivision to meet the functional requirements of stormwater storage and the new planning objectives. The first component dealt with the layout of the overall channel through the subdivision and the second component dealt with the cross sectional configuration of the channel.



MAP 10

STORMWATER MANAGEMENT STRATEGY

"RIVER PARK SOUTH" ALTERNATE DESIGN SOLUTION

SCALE 0 50 150 300

6.4.2.1 INTRODUCTION OF THE SINUOUS RIVER CORRIDOR

The channel meander path was determined to be advantageous in the residential subdivision plan for the following reasons:

i) The number of available collection points for stormwater runoff increases dramatically as the waterbody meanders through the residential subdivision;
ii) The sinuous channel, representative of natural prairie rivers, will slow water velocities along its course;
iii) The storage capacity of the channel increases as the length of the system increases;
iii) Community pockets have been defined by the meander of the watercourse;
iv) The extended water system will increase waterfrontage available for residential lot development;
v) Recreation trails that travel next to the watercourse become longer and offer new orientations for viewing and exploration as one moves along the waters edge.

The river corridor in the alternative design strategy is approximately 20,000 lineal feet. One section of the subdivision plan has been enlarged and detailed to provide an illustration of how the meander of the river corridor has been used to define the edge of the community pocket and to demonstrate how the drainage system pattern complements pedestrian flow patterns, see figure 24.

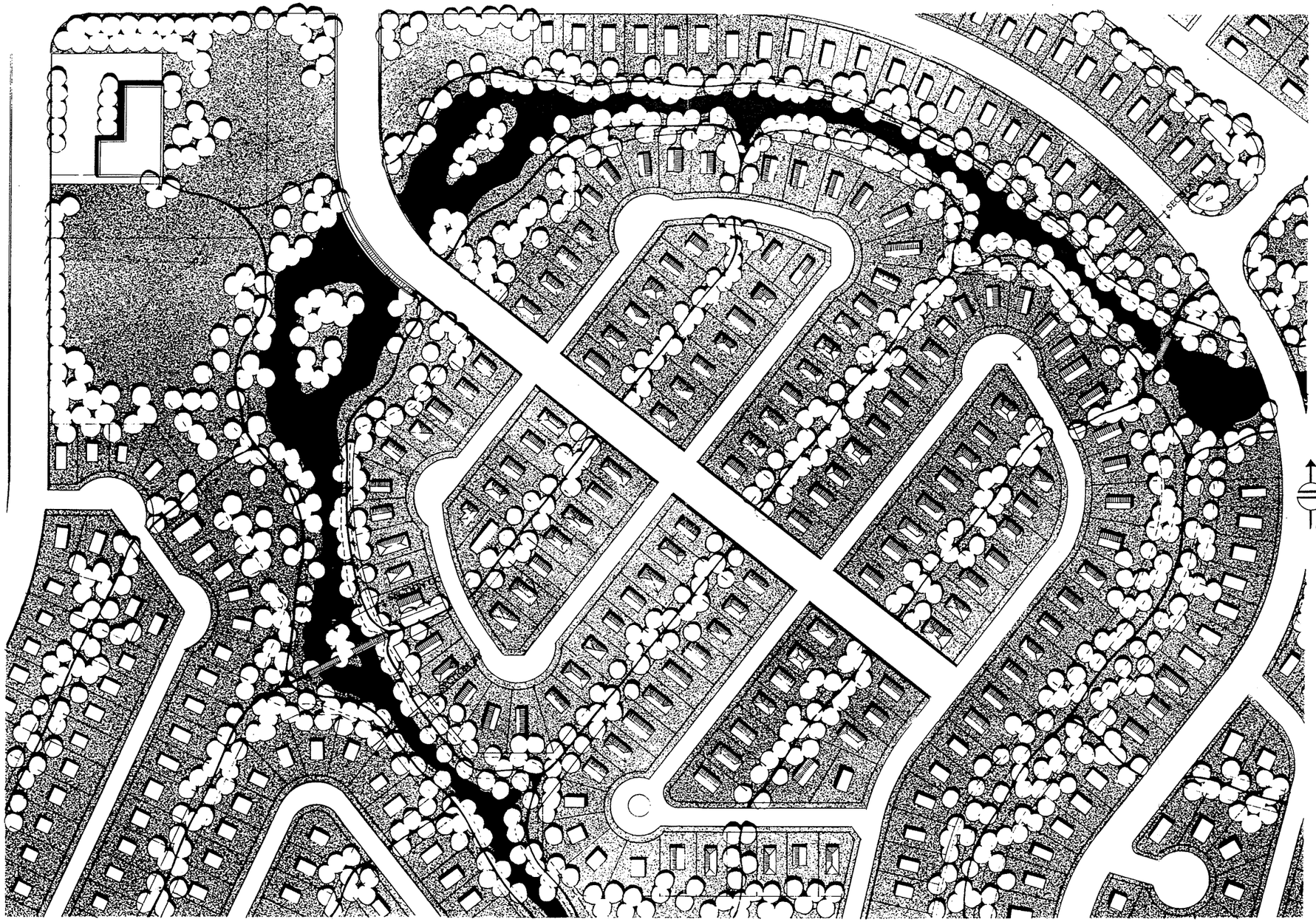


FIGURE 24

THE RIVER CORRIDOR DEFINING THE BUILT FORM OF THE COMMUNITY

PEDESTRIAN FLOW AND SURFACE DRAINAGE FLOW

PUBLIC PARKS AT THE BACK OF EACH RESIDENTIAL LOTS WILL PROVIDE TWO SERVICES:

1. DRAINAGE SWALES WILL RUN THROUGH THE PARK SPACE TO CARRY STORMWATER RUNOFF TO THE RIVER CORRIDOR.
2. RESIDENTS WILL HAVE ACCESS THROUGH THE PARKSPACES TO THE RIVER RECREATION CORRIDOR

WHERE PEDESTRIANS REQUIRE ACCESS OVER THE SURFACE DRAINAGE SYSTEM FOOTBRIDGES WILL BE INSTALLED. THESE FEATURES WILL BE DEVELOPED AS FUNCTIONAL AND ORNAMENTAL MARKETING FEATURES OF THE COMMUNITY.

SCALE 0 10 30 60

PLAN AA

6.4.2.2 CROSS SECTION OF THE RIVER CORRIDOR

Two approaches were considered in the cross-sectional layout of the waterbody channel.

1. To achieve the desired 3,843,000 cubic feet of storage, the 20,000 foot lineal channel could provide 190 square feet along the entire length of the system or,
2. To achieve the desired 3,843,000 cubic feet of storage, the 20, 000 foot channel may provide an average of 190 square feet along the length of the course.

The multidimensional nature of the water channel suggests several cross-sectional configurations of varying storage capacities may be integrated along the course to provide an average of 190 square feet of storage along the entire water course. However, for planning purposes of this study the entire length of the course was assumed to offer 190 square feet of storage capacity. The ultimate design solution over the entire length of the course will be program and site specific, and require velocity flow studies to determine the final design solution.

To address the new planning objectives, which have been formulated to respond to residents' feedback, the following design considerations were addressed in the cross-sectional layout of the channel:

PROGRAM CONSIDERATION: MAINTENANCE

i) The shoreline development may include uneven side slopes compatible with natural processes of erosion and deposition of sinuous channels.

ii) Installment of trees along the banks will be encouraged to provide shade along the shoreline to reduce erosion, water temperatures and conditions conducive to aquatic weed growth.

iii) Shoreline shelves may be designed 44% - 67% in steeper slope areas to limit plant growth, see figure 25.

iv) A series of recirculating systems will be installed to prevent stagnation and algae bloom in the water.

PROGRAM CONSIDERATIONS : WILDLIFE

v) Irregular bottom contours may be introduced to increase habitat diversity along the basin floor, and reduce erosion.

vi) Irregular bays, shoals, and islands may be introduced to increase habitat edge and the variety of habitat conditions along the watercourse.

vii) Instream devices such as checkdams, riffles, artificial meanders, overhanging banks and islands may be used to aerate the water and reduce velocities of waterflow in the channel.

viii) Shoreline shelves may be designed 11% - 22% in gradual slope areas to encourage plant growth for food and nesting habitat for waterfowl, see figure 26.

ix) Deep water pools will be encouraged along the channel bends for fish habitat (.5 to 1m deeper than the channel bottom).

x) The water channel will maintain a 6 foot water depth at all times. This may require artificial refilling of the impoundment during hot/ dry weather spells.

PROGRAM CONSIDERATION: SOCIAL INTERACTION

xi) 100% of the rivershore will be public reserve.

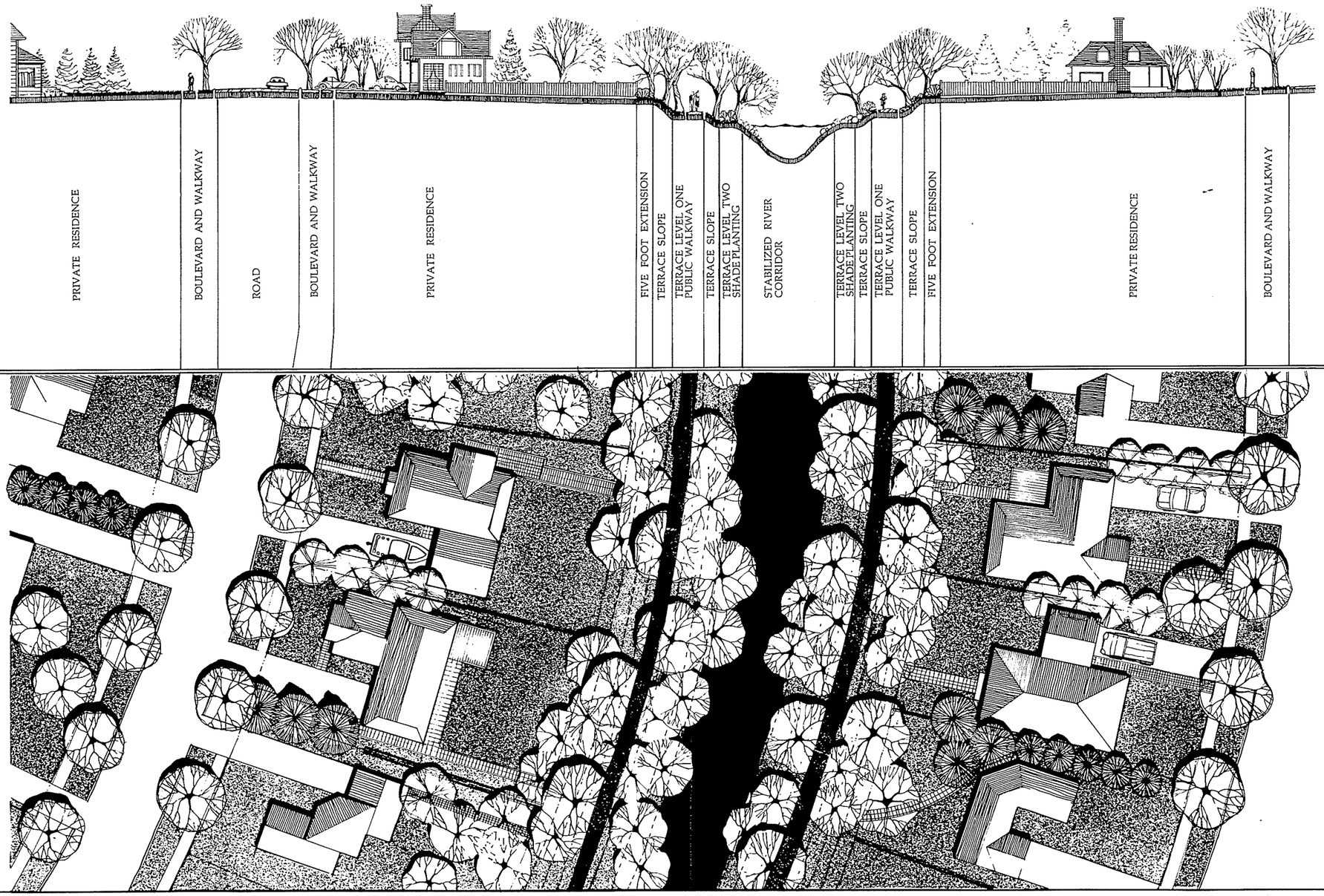
xii) A bank terracing system along the shoreline may be developed to define territorial boundaries of public and private land ownership, see figure 27 and 28.

xiii) There will be no fences below the terrace wall that separates public and private property.

xiv) Flood terrace levels will be developed along the banks of the waterbody to delineate 5 and 25 year flood levels.

xv) A riverbank shoreline condition with natural revetment of large rock, trees, shrubs may replace the easy access shallow shorelines that resemble beach conditions.

Figure 25 and 26 illustrate options for cross-sectional channel configuration that offer the 190 square foot storage capacity requirement. Further suggestions for river bank development will be limited only by the designer's imagination of how the shape and form of the waterbody profile can be detailed to meet the planning objectives within the economic constraints of the project.



SECTION AA

TERRITORIAL DEMARCATION

100% OF THE LAKESHORE WILL BE DEVELOPED AS A RECREATION CORRIDOR. PRIVATE RESIDENCES WILL BE LOCATED BEHIND THE CORRIDOR.

THE RIVER SHORELINE WILL BE DEVELOPED WITH PUBLIC PARKSPACE ON A LOWER TERRACE AND PRIVATE RESIDENCES ON A UPPER TERRACE.

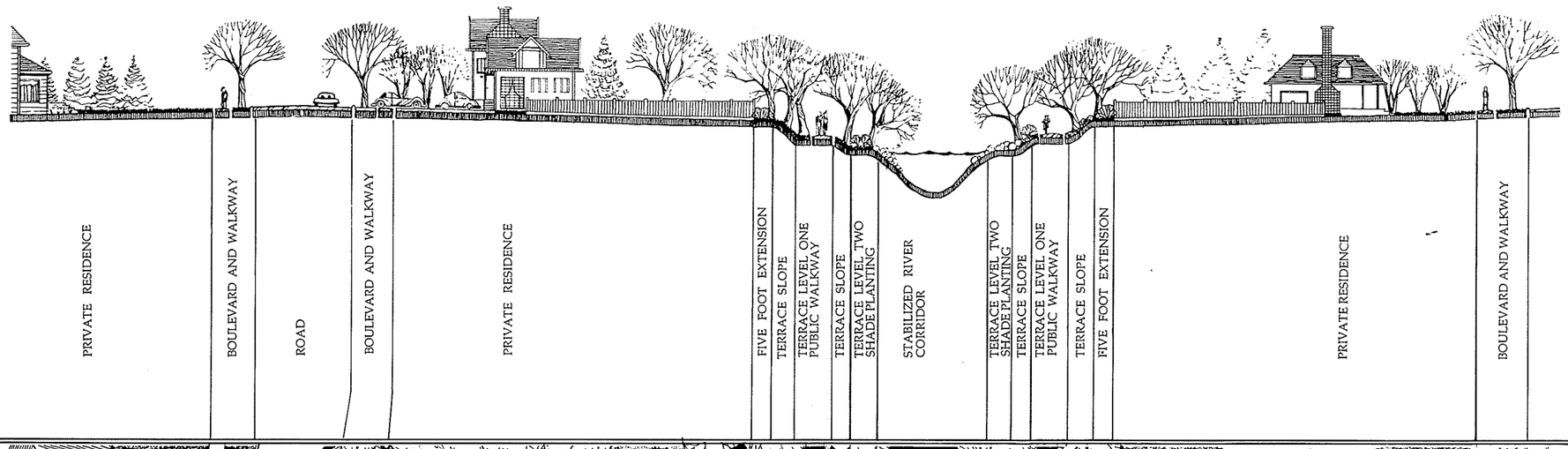
THE 25 YEAR FLOOD STORAGE CAPACITY REQUIREMENTS WILL NOT ENCROACH ON PRIVATE PROPERTY. NO PRIVATE RESIDENCES WILL BE ALLOWED TO FENCE ACROSS THE PUBLIC RECREATION CORRIDOR TO THE NORMAL WATER LINE.

CROSS SECTION OF PUBLIC AND PRIVATE TERRITORY DELINEATION

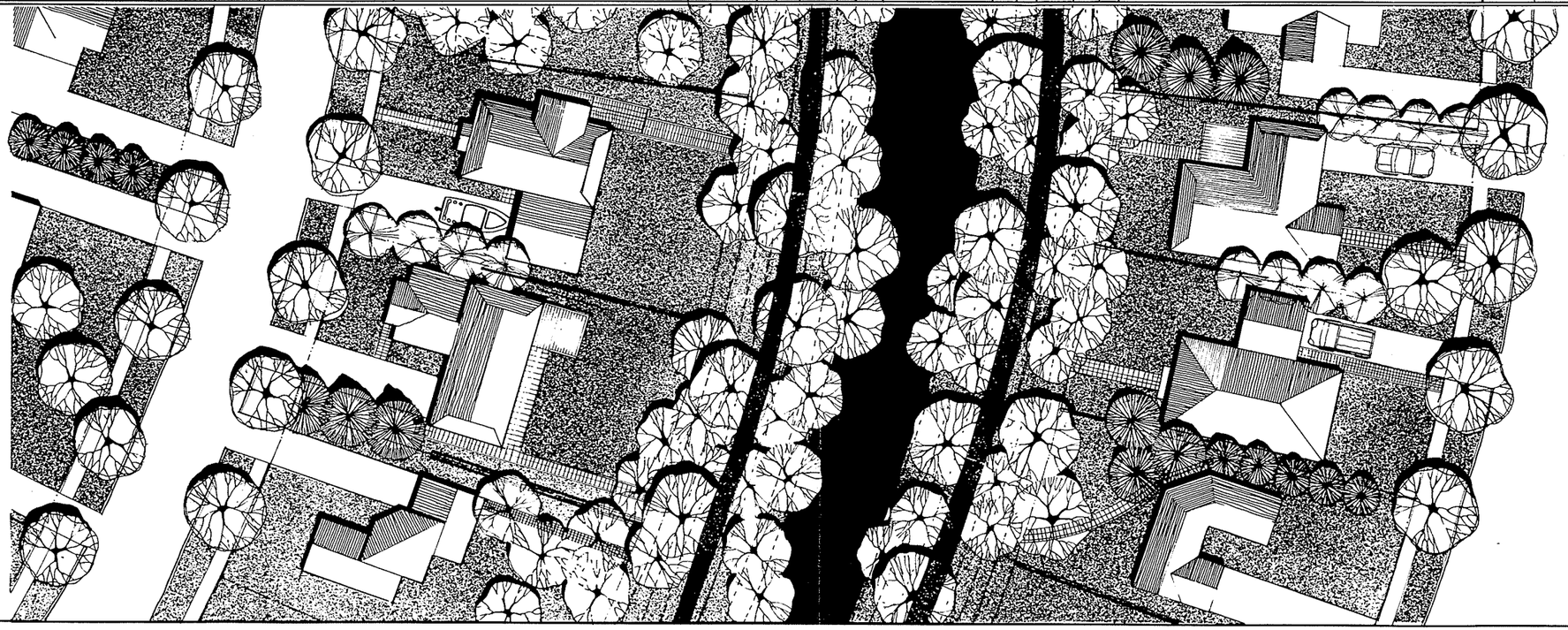
FIGURE 27

FIGURE 28

DETAIL PLAN OF PUBLIC AND PRIVATE PROPERTY DELINEATION



SECTION AA



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CROSS SECTION OF PUBLIC AND PRIVATE TERRITORY DELINEATION

FIGURE 27

FIGURE 28

DETAIL PLAN OF PUBLIC AND PRIVATE PROPERTY DELINEATION

6.4.3 LAND DRAINAGE SYSTEM

The existing land drainage system for "River Park South" is a complex system of underground conduit pipes, see map 5. A similar conduit drainage strategy could be developed to service the drainage requirements in the alternate subdivision layout for "River Park South", but for economic and ecological reasons that will be discussed, an alternate surface drainage strategy was developed.

The land drainage system illustrated in map 10 demonstrates the general flow pattern of stormwater from the land mass to the man-made river corridor. The detail flow pattern illustrated in figure 29 , demonstrates specifically how stormwater may drain from the residential streets, along the side of residential lots, to the public park space located at the back of residential lots. Herein water is collected by drainage swales that empty into the man-made river corridor.

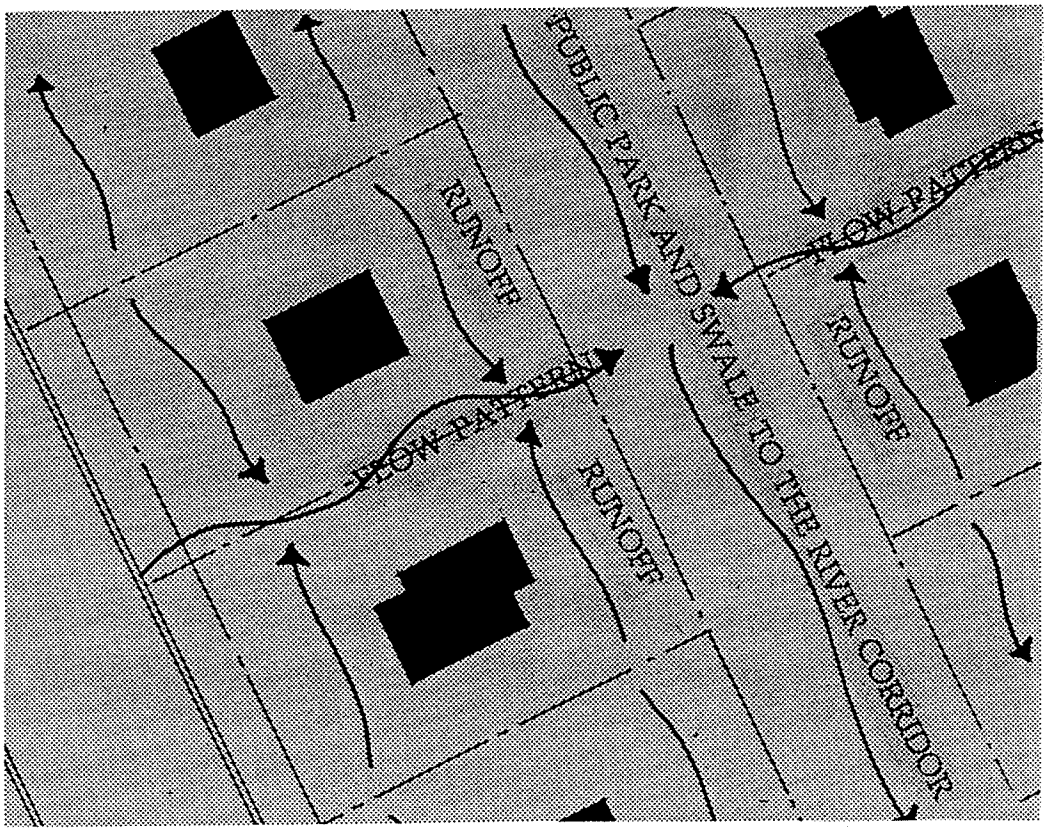


Figure 29 Detail Drainage Over Residential Lots
Source: Edwards

This surface drainage system collects water through a linked system of swales and ditches developed on public park land. The surface water flow pattern will complement the pedestrian flow pattern in the community, see figure 24. The functional operation of the system has been developed to offer the following features:

i) The public park at the back of each residential lot will link the water collection system with the river corridor and provide a public access corridor to the river/ recreation activity spine;
ii) Where pedestrian flow meets the river corridor, footbridges will be installed to maintain the continuity and connectiveness of the trail system;
iii) The surface water transport system will increase the time and distance water flows over ground to reach the water collection point, increasing the potential for groundwater recharge;
iv) The need for an underground conduit system will be reduced or eliminated and replaced by an on surface drainage system.

6.4.4 SUMMARY OF THE STORMWATER MANAGEMENT SYSTEM

The alternate strategic plan for the drainage of stormwater in "River Park South" has been designed to meet new planning objectives. These objectives, have been formulated through analysis and research of how existing retention lakes operate and impact on residents in existing lake oriented subdivisions. The objectives address issues such as visual impact, safety, territorial tensions, maintenance and ecological concerns. These issues have been addressed in the layout of the meandering river within the subdivision and the specific cross- sectional design of the water channel.

Functionally the alternate stormwater management strategy has been developed as a complete surface drainage system. Swales and channels operate in a dendritic flow pattern to collect and transport water to the man-made river corridor that meanders through the subdivision. The water impoundment, designed to replicate a prairie river system, offers 3,843,000 cubic feet of storage capacity for stormwater. Examples of the detail design configuration of the proposed channel are initial demonstrations of how the channel may be designed to meet the new planning objectives. Further exploration must be undertaken to develop the complex design strategy for site specific programs along river corridor system.

6.5 AN ALTERNATE SUBDIVISION LAYOUT FOR 'RIVER PARK SOUTH'

6.5.1 INTRODUCTION

The subdivision layout presented in the alternate design strategy for "River Park South" evolved as a second level of planning contingent on the layout strategy of the stormwater management system. Although the cross-sectional configuration of the river channel and public park shoreline fluctuate according to site specific programming, for the purpose of this study the river corridor park was assumed to be 100 feet in cross section, see figure 27.

The layout for the subdivision commenced with the allotment of a 100 foot cross-section for the river corridor and public parks. Standard residential lots, 100 feet depth and 50 feet wide, were designed to flank either side of the corridor, see figure 28 . Front road access and service for each lot was provided by roads of standard width for residential subdivisions. Where residential lots did not back onto the river corridor, they were designed to back onto public parks. This residential park system provides a location for the drainage swales that transport stormwater to the river corridor, see map 10 .

The minimum land area for school grounds, commercial grounds, and public parks, as established in the existing subdivision plan for "River Park South", have been maintained in the alternate subdivision land use strategy.

The following discussion outlines the land use area breakdown for the alternate subdivision layout for "River Park South". The land allocated for residential lot development has been separated into zoning classifications to estimate a potential return value for residential lot sales for comparison purposes.

6.5.2 SCHOOL GROUNDS

The alternate design strategy for "River Park South" allocates five sites for school ground development, see map 11. The approximate land area corresponding to each site is:

site 1	**3.39 a (1.37 h)**
site 2	**3.40 a (1.37 h)**
site 3	**3.32 a (1.34 h)**
site 4	**4.05 a (1.64 h)**
site 5	**3.28 a (1.33 h)**
total area	**17.44 a (7.05 h)**

School sites have been dispersed throughout the subdivision plan, all sites are adjacent to public open space, and the sites are proximate to or connected by public open space to the waterbodies wherever possible.

6.2.3 COMMERCIAL GROUNDS

There is no allocation for commercial land space within the study site of "River Park South" or the alternate design strategy.

6.2.4 PARKS

The alternate design strategy for "River Park South" incorporates three types of public open space:

i) **The River Corridor Park**
The river corridor winding through the subdivision offers passive public open space along its banks. The corridor is integrated into the overall plan to act as a connecting spine for the larger community parks and the smaller residential access parks, see map 11.

ii) Large Scale Public Open Space

Nine community public open spaces, designed for more intensive activity, have been dispersed along the river corridor to decentralize attractions along the activity spine, see figure 24. These larger open spaces cover a total of **51.85 a or 20.98 h**

iii) Residential Parks

Public green space will be provided along the rear of each yard, see map 11. The entire site plan offers 11.45 acres in residential parks. The residential park space will provide a swale system to carry stormwater to the river corridor and also provide a public access park to the river corridor for residents.

The total parkspace available in the alternate design strategy is 75.1 a (30.3 h).

Community parks:	**51.85 a (20.98 h)**
Public river corridor:	**11.8 a (4.8 h)**
Residential parks:	**11.45 a (4.63 h)**

6.5.5 THE WATER CORRIDOR

The river corridor has been designed as a functional engineering system for stormwater collection purposes. The entire length (100% of the shoreline) on either side of the water proper will be developed as a public recreation corridor, see figure 27 and 28.

The water surface at normal water level covers 12.8 acres. The water surface at high water level covers an estimated 42.2 acres. Stormwaters greater than the 25 year flood level will be stored in the temporary "oxbow" impoundment, that drains naturally into the river corridor, see map 12. The river corridor provides approximately 40,000 lineal feet of shoreline for recreation corridor development.

6.5.6 RESIDENTIAL LAND DEVELOPMENT

Land allocated for residential lot development has been calculated by measuring the lineal foot frontage (approximately 12 meters or 40 feet back from the road) available for development. The total foot frontage available for development measures **84,825** feet.

Analysis of the land available for residential lot development has been utilized by developers for marketing and economic analysis purposes. The land is differentiated into lot zoning categories to which an economic value is associated for cost estimation purposes. Specific marketing strategies are then devised to attract homebuyers. Three categories of lot zoning have been identified and illustrated in map 13, for the alternate design strategy for "River Park South". The available foot frontage in each category has been tabulated to determine an economic return value for the developer through lot sales.

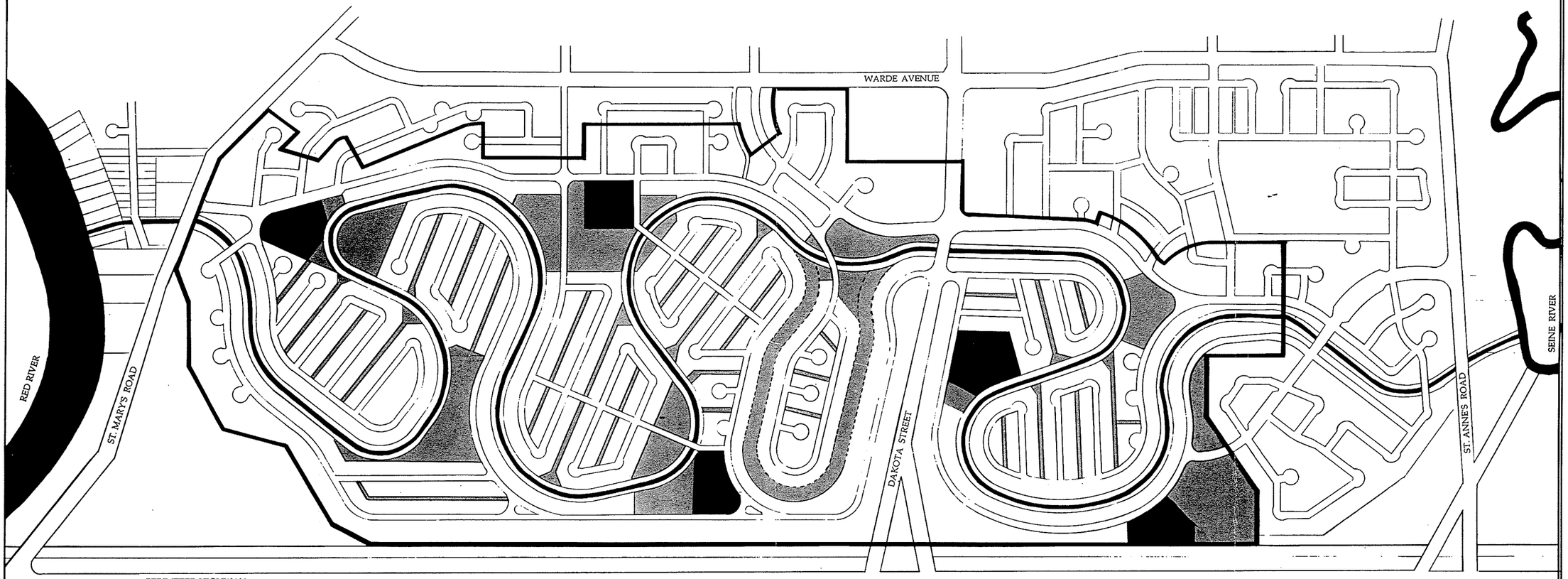
i **R1-5 Lake Front Lots**
Residential lots that back onto the waterfront have the highest economic return value for the developer. The value ranges from $950.00 to $1000.00 'per foot front' . The alternate subdivision layout for "River Park South" offers 27165 lineal feet of 'R1-5 Lake' zoned lots.

ii **R1-5 Regular Lots**
Larger residential lots, not backing onto the lake, but offering advantageous marketing features such as a location adjacent to park space or on a cul-de-sac, have the second highest market value. The value ranges from $850.00 to $900.00 'per foot front', for the developer. The alternate subdivision layout for "River Park South" offers 44701 lineal feet of 'R1-5 Regular' zoned lots.

iii **R1-4 Interior Lots**
Residential lots of 4,000 square feet or smaller, that are bound by roads or other residential lots, have been classified as interior lots. The return value ranges from $550.00 to $600.00 'per foot front' for the developer. The alternate subdivision layout for "River Park South" offers 12959 lineal feet of 'R1-4 Interior' zoned lots.

The potential return value for residential lot development in the alternate design strategy is as follows:

zoning	frontage	value per foot front	estimated return value range
R1-5 Lake	**27165**	**$950.00 - 1000.0**	**$25,806,750.00 - $27,165,000.00**
R1-5 Regular	**44701**	**$850.00 - 900.00**	**$37,995,850.00 - $40,230,900.00**
R1-4 Interior	**12959**	**$550.00 - 650.00**	**$ 7,127,450.00 - $ 8,186,750.00**
Estimated return value for residential lot sales			**$70,930,050.00 - $75,582,650.00**



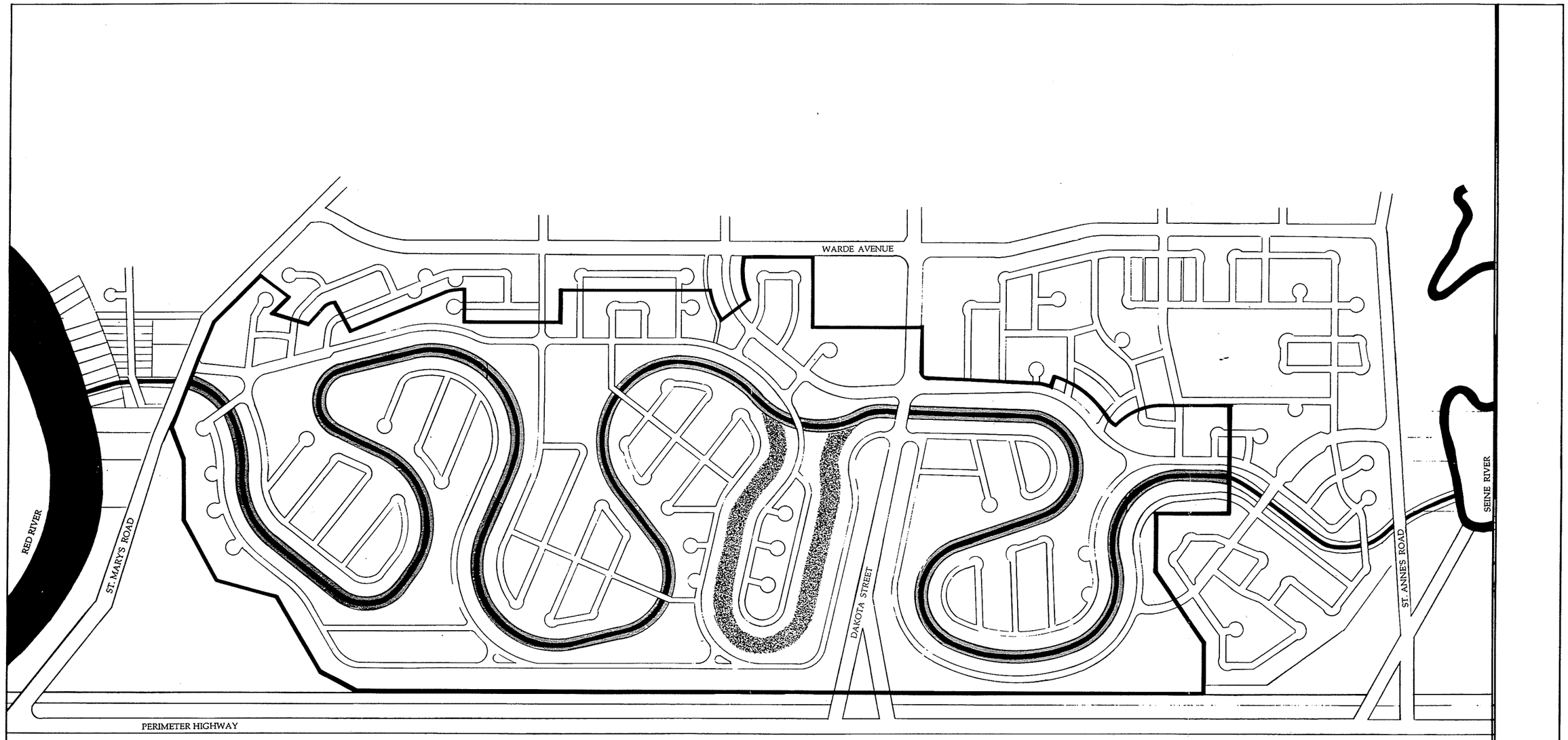
	SCHOOL SITES	SITE 1	3.39 a
		SITE 2	3.40 a
		SITE 3	3.33 a
		SITE 4	4.05 a
		SITE 5	3.28 a
	RIVER CORRIDOR PARK		51.85 a
	COMMUNITY PUBLIC PARKS		11.80 a
	RESIDENTIAL PARKS		11.45 a

MAP 11

SCHOOL GROUNDS AND PUBLIC PARK LOCATIONS

"RIVER PARK SOUTH" ALTERNATE DESIGN SOLUTION

SCALE 0 50 150 300

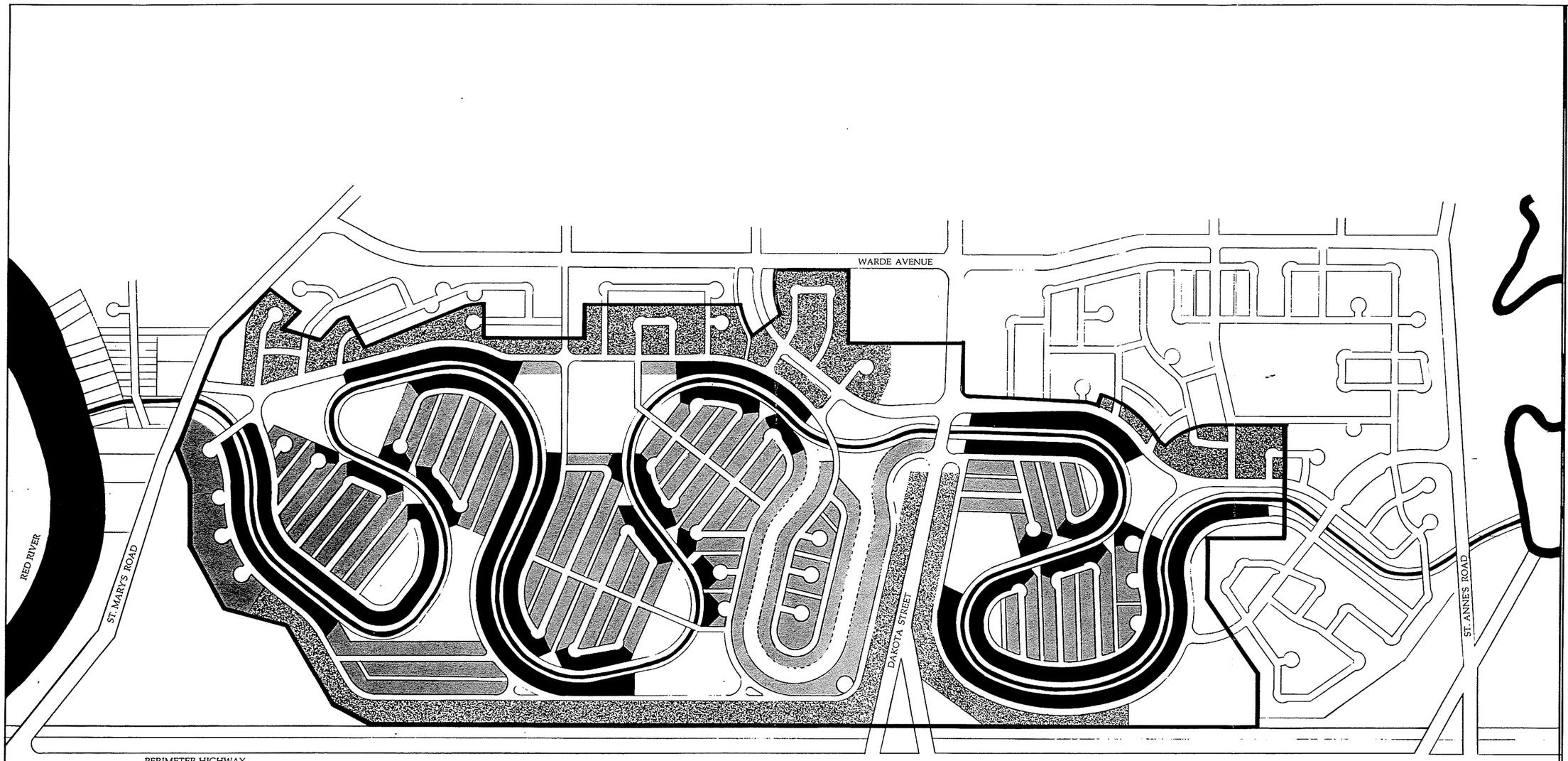


MAP 12

WATER STORAGE LEVELS

"RIVER PARK SOUTH" ALTERNATE DESIGN

SCALE 0 50 150 300



R1 - 5 WATERFRONT LOTS
($950.00 - $1000.00 PER FOOT FRONT)

R1 - 5 REGULAR LOTS
($850.00 - $900.00 PER FOOT FRONT)

R1 - 4 REGULAR LOTS
($550.00 - $600.00 PER FOOT FRONT)

MAP 13

RESIDENTIAL LOT ZONING

"RIVER PARK SOUTH" ALTERNATE DESIGN SOLUTION

SCALE 0 50 150 300

6.6 SUMMARY

The alternate design strategy for "River Park South" presents one solution for stormwater management that addresses a series of new planning objectives. The introduction of a new planning strategy that addresses issues and objectives of a more diverse nature, has provided an opportunity to effect positive changes for the general public , community residents and the developer.

Technical advantages of the alternate planning strategy include:

i) an increase potential for ground water recharge;
ii) the introduction of a second man-made drainage system consistent with prairie vernacular;
iii) potential to reduce conditions conducive to aquatic weed growth in unwanted areas;
iv) a continuous flowing watercourse;
v) a permanent water overflow storage area.

Advantageous planning opportunities that will benefit the public in general include:

vi) the elimination of potential hazards such as submerged intake pipes and easily accessible shallow open shorelines;
vii) the potential to develop environmental education programs in the public park dispersed along the river corridor;
viii) reduction in costs for snow removal from the community;
ix) the diversification of shoreline conditions and aquatic environments along the river corridor;
x) the potential for longer fully developed public recreation trails along the entire river corridor;
xi) access to the river/recreation corridor for all community residents via public access parks.

The issues addressed in the river corridor design that impact directly on residents living next to the waterbody include:

xii) the territorial demarcation of public and private property through landscape terracing;
xiii) the development of passive recreation opportunities along the river corridors next to residential lots;
xiv) the addition of visually attractive landscape and wildlife features;
xv) the reduction in unpleasant odors and visually obtrusive algae and weed growth next to residential properties.

The advantageous planning opportunities that will benefit the developer include:

xvi) an increase in waterfrontage available for residential lot development;
xvii) a reduction in development cost due to the elimination of underground conduit pipes;
xviii) a unique planning strategy that offers new attractions and opportunities for community residents which the developer can market.

Within the 645 acre subdivision 81,545 lineal "foot frontage" of land has been allocated for residential lot development. It has been estimated that the subdivision design strategy may generate **$73,256,350.00** from residential lot sales according to conventional zoning categories. The developer can expect to receive approximately 20 -25% of this revenue (Qualico Homes, Jan. 1990), as the costs for purchase of land, large scale grading operations, landscaping of park areas, road construction, and installation of service lines must be factored into the return values from lot sales. From this generalized estimation, the developer may expect to receive: **$14,675,300.00 to $18,344,125.00** for lot sale revenues.

The layout plan and cross-sections of the proposed water channel presented in the description of this alternate design strategy offer only one suggestion for implementation of the new planning objectives. The specific design of the river corridor requires further program and site specific detail design.

7.0 DESIGN CONCEPT COMPARISON

7.1 INTRODUCTION

Two stormwater management systems have been presented for one sub-urban subdivision of "River Park South" in the City of Winnipeg. The existing subdivision plan integrated a combined conduit / retention lake system to manage stormwater runoff while the alternate subdivision plan integrated surface drainage swales and a river system to manage stormwater runoff.

Both drainage strategies are modern man-made interpretations of natural prairie drainage systems. The retention lake system mimics prairie potholes that temporarily hold stormwater until it slowly drains from the environment or is evaporated. The alternative stormwater management system is a modern interpretation of a prairie river system that meanders extensively to collect stormwater that is not naturally absorbed by the prairie clay soils.

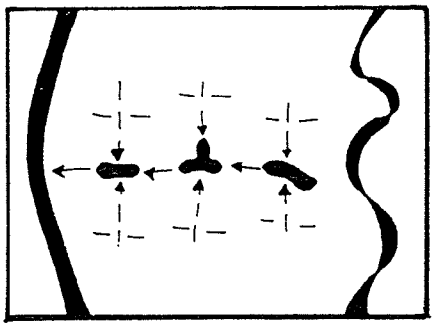
Although the storage capacity for both stormwater retention systems remains equal, the engineering design approach and functional operation of each system is divergent.

Several concerns about the impact of present stormwater retention lakes in the urban environment detailed through the residents survey indicate that "the current state of the art utilizes facilities which are controversial in regards to their engineering design and their influence on the form of cities" (Sarah Micheals, 1983).

The concerns addressed in this study include: existing design guidelines that predetermine design solutions, safety, territorial ambiguity, maintenance, recreation, visual interest along the shoreline, and economics. The discussion of these issues has provided direction for the evolution of the alternate stormwater management system presented in this study.

The design alternatives have been compared to assess the differences of their function and presence in the residential subdivision.

7.2 DRAINAGE STRATEGY



EXISTING

The total storage capacity of the three lakes is 3,843,000 cubic feet.

The combined lake /conduit system has three retention lakes fed stormwater runoff by an underground system of conduit pipes.

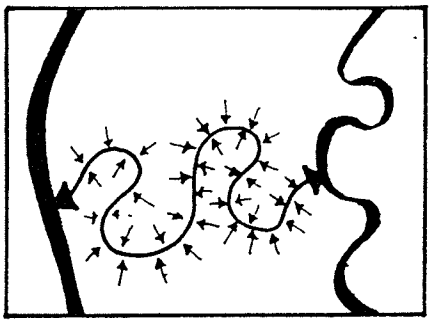
Large scale grading will be required to construct the retention lakes.

Detail grading will be required to direct surface drainage to the collection system of conduit pipes.

The conduit collection system removes stormwater expediently giving residents a "dry" surface environment as soon as possible.

Conduit pipe installation may cost $2,200,000.00

The lakes are visually individual units, connected by a parkspace corridor. Vehicular and pedestrian corridors transverse the parkspace that connects the lakes.



PROPOSED

The total storage capacity of the river system is 3,843,000 cubic feet.

Overflow water storage and winter snow storage will be integrated into a public park area that will drain into the river corridor reducing costs for snow removal.

The proposed river corridor will be the spine of functional drainage activities, passive recreation activities and wildlife habitat.

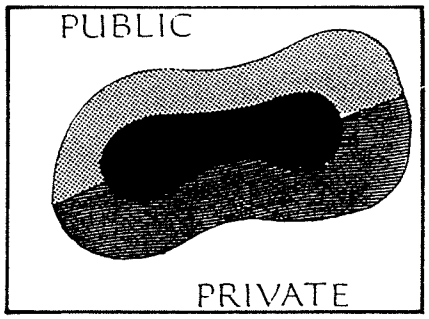
Stormwater runoff travels above ground to the river outlets increasing the opportunity for ground water recharge.

Large scale grading will be required to construct the river corridor.

Detailed grading will be required to develop surface drainage swales, channels and rivulets.

Pedestrian and vehicular bridges will be required to maintain a constant water and pedestrian flow through the site.

7.3 PUBLIC AND PRIVATE SHORELINE OWNERSHIP



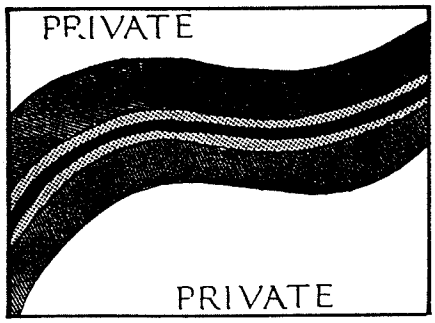
EXISTING

Approximately 50% of the lake shore is developed in private residential lots and 50% is developed as public parkspace.

The developer is restricted to selling residential lots along 50% of the lakeshore.

Resale value of the lots may range from:**$52,828,050.00 to $60,533,900.00**
Developer profit value may range from:
$11,337,000.00 to $14,170,000.00

Unbalanced access to the publiclake shore is created as residents living in the subdivision are funneled through access parks onto the public side of the lake.



PROPOSED

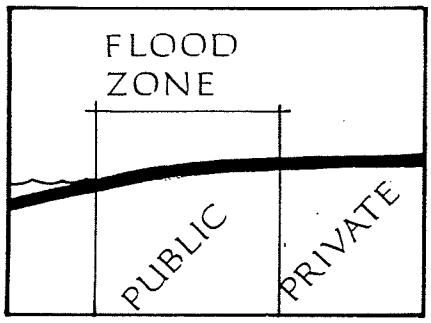
The entire river shoreline will be a public recreation corridor with residential lots developed behind the park on an upper terrace.

Waterfront lots will have a greater variety of orientations and views of the river corridor.

Resale value of the of lots may range from:
$70,931,850.00 to $75,821,150.00
Developer profit value may range from:
$14,675,300.00 to $18,344,125.00

Park access routes have been introduced in the rear of each lot connecting the individual homeowner to the river corridor. Access points are in effect dispersed throughout the entire subdivision.

7.4 SHORELINE PROFILE



EXISTING

standardized long shallow sloping shoreline graded at 7:1 around the entire lake.

EFFECTS ON SAFETY

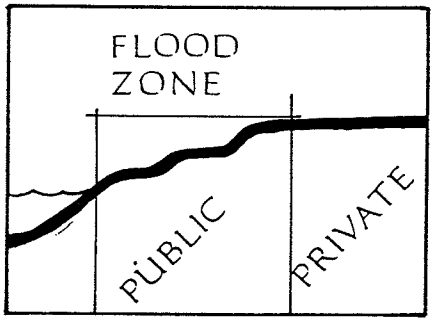
EXISTING CONDITION

Shallow shoreline slopes encourage unwanted aquatic weed growth around the entire lake which may tangle around childrens' legs in the water.

Chemicals are used to eradicate the plant growth which make the water dangerous for primary contact.

Children who decide to enter the water against the rules may be pulled under by the currents of outflow pipes at the lake bottom.

The shoreline profile is open and easily accessible to small children. Conditions are similar to a beach environment: open, inviting and no visible plant growth on the shoreline. Easy access may entice young children into the water.



PROPOSED

A variable riverbank shoreline profile to complement the variety of uses occurring on the waters' edge.

This may include steeper,shaded banks along most of the corridor and shallow shorelines where aquatic plant growth is desirable for wildlife habitat, in public park areas.

EFFECTS ON SAFETY

PROPOSED CONDITIONS

The shoreline profile is contoured into terraced bank conditions more similar to natural river shoreline conditions.

Watercourse safety programs will encourage residents to respect the man-made watercourse as a river.

Entry into the water will require work to climb over and around the landscape barriers.

There will be no intake pipes at the bottom of the river retention impoundment.

The use of chemicals will be reduced due to new environmental conditions that reduce aquatic plant growth.

EFFECTS ON LONG TERM MAINTENANCE

EXISTING

The extended unshaded shallow water conditions around the periphery of the lake increase the surface area where sunlight can penetrate and encourage aquatic vegetation to flourish.

Chemicals used to treat the water collect and build up in the water body.

Stagnant water may produce unpleasant odors.

Weed harvesting is not undertaken as the machinery does not operate along shallow slopes.

EFFECTS ON TERRITORIAL AMBIGUITY

EXISTING

The ground surface flows from private back yard to public park space with no ground surface differentiation or delineation between the two.

Along the residential shoreline there is a 4 foot flood fringe zone that is public property. The public access that is available at the rear of private lots is uncomfortable for the private homeowners.

Residents at either end of the private shoreline edge have encountered the burden of trying to restrict access onto the private shoreline. This has been accomplished by erecting fences to the shoreline.

Territorial battles are constantly a problem for lakeside residents who perceive the lakeshore next to their own as private property.

EFFECTS ON LONG TERM MAINTENANCE

PROPOSED

Steeper bank conditions will reduce the ideal shallow water conditions aquatic weeds grow in.

Shade trees along the bank will reduce the possibility of sunlight penetration required for aquatic weed growth.

Shade trees will also reduce water temperatures and the potential for algae bloom.

Recirculating flush system of the river corridor will eliminate stagnant water that encourages algae bloom.

EFFECTS ON TERRITORIAL AMBIGUITY

PROPOSED

Public and private territory will be delineated partially by introduction of riverbank terracing . Private property will be located on upper terracesThe rivercourse and public recreation corridor will be located on a lower terrace. A visual and physical differentiation will be developed.

8.0 SUMMARY

8.1 ISSUES ADDRESSED

This study has addressed the general issue of stormwater management in subdivision planning in the prairie environment. The planning concepts presently employed in retention lake stormwater management systems have been compared to the planning objectives employed in a river drainage corridor for the same purpose.

The study has reviewed the City of Winnipeg's current retention lake design guidelines to determine how they impact on the environmental /social structure of the community. Further definition of the impact of retention lakes in the community was determined through the residents' survey.

The environmental conditions and issues of concern addressed in the discussion included: safety of the water impoundment, maintenance of the waterbody, definition of public and private property, visual attractiveness of the water environment, development of recreation amenities, and security of private property.

These issues, in conjunction with:

i) the objective to develop an alternative stormwater management strategy that may provide an increase in ground water recharge; and
ii) the objective to introduce a stormwater drainage system consistent with prairie form and process,

have been addressed in the formation of a new planning objectives for stormwater drainage in the residential subdivision. With the direction of these new planning objectives an alternative strategic plan incorporating a meandering river corridor and surface drainage swales, was devised for the study site.

The two drainage strategies reviewed in this study were evaluated and compared in three areas:

First the functional requirement of the stormwater storage systems was determined. The drainage systems were compared by evaluating:

i) how the required storage capacity of the impoundment system was achieved;
ii) how the system was integrated into the subdivision plan to maximize its use for stormwater collection and marketing of residential lots; and
iii) how the general shape, size and edge profile was designed to addressed the associated planning objectives.

Secondly the environmental conditions created by constructing the retention lakes to current design standards in the existing plan were compared with the environmental conditions created by constructing the river corridor to new design objectives in the alternate plan.

Finally the question of economics was considered on a very general level. The potential return value for residential lot sales was calculated for both the subdivision design strategies. The values presented are not inclusive of construction costs and are subject to marketing analysis of the value of residential lots.

Several suggestions evolving from this comparative study may be valuable for the developer to consider in future subdivision planning. Those include:

i) Introduction of environmental parkspace (that includes wildlife habitat) to complement the traditional openspace in subdivisions;
ii) Introduction of a continuous stormwater impoundment watercourse;
iii) Integration of passive recreation activities into the community next to private residences and active recreation amenities in larger public parks on the site;
iv) Introduction of waterbody profiles that reduce unwanted aquatic weed growth, algae bloom, and stagnant water which add to maintenance problems;

v) Provision of a greater diversity in waterfront lots offering new orientations for viewing and options for development;
vi) Provision of public access to the waterbody shoreline that does not infringe on homeowner privacy;
vii) Provision of better definition between private and public property along the watercourse through terracing of the landscape profile;
viii) Introduction of waterbody configuration and design conducive to long term maintenance programs that are sympathetic to the co-existence of wildlife habitat;
ix) Investment in security programs including outdoor lighting and neighborhood watch programs;
x) Investment of funds into the development of the unique river corridor.

These planning suggestions may begin to address current issues in landscape architectural planning of future water oriented subdivisions.

8.2 COMPUTER APPLICATION

The MacIntosh computer system in conjunction with Minicad 3. 15 , Thunderscan and Mac Write 1.00 were used in producing this report. Images were thunderscanned into the Minicad program and retraced on screen to produce maps series 1 through 7. Mac Write 1.00 was used to produce the text.

Minicad 3.15 has the ability to measure polygons and could have been used to measure and tabulate land use areas of the subdivision plan. This process was tested in the study and it was determined 25% acurracy was lost in the plan image. For this reason all land acreages were measured manually by planimeter.

Future integration of the computer in this planning /design process may involve the Mincad 2.0+ program and the laser scanning process. With the advanced technology of the scanning process and the added feature of the running spreadsheet function of Minicad 2.0+, the subdivision plan could be input to scale, and designed and measured for size concurrently as the layout plan is produced.

8.3 FURTHER STUDY

The strategic planning concept for stormwater management put forward by this study demonstrates that the general concept for stormwater management is a viable option that works functionally and is acceptable to community residents. The strategy requires further study in the following areas:

i) Landscape architectural study to determine the detail design layout of the river corridor, shoreline stabilization techniques, program specific requirements for wildlife habitat, and recreation amenity development;

ii) Engineering analysis to determine velocity of flow of the channel, erosion and deposition factors of the river curves, recirculation systems for the water, and water maintenance requirements;

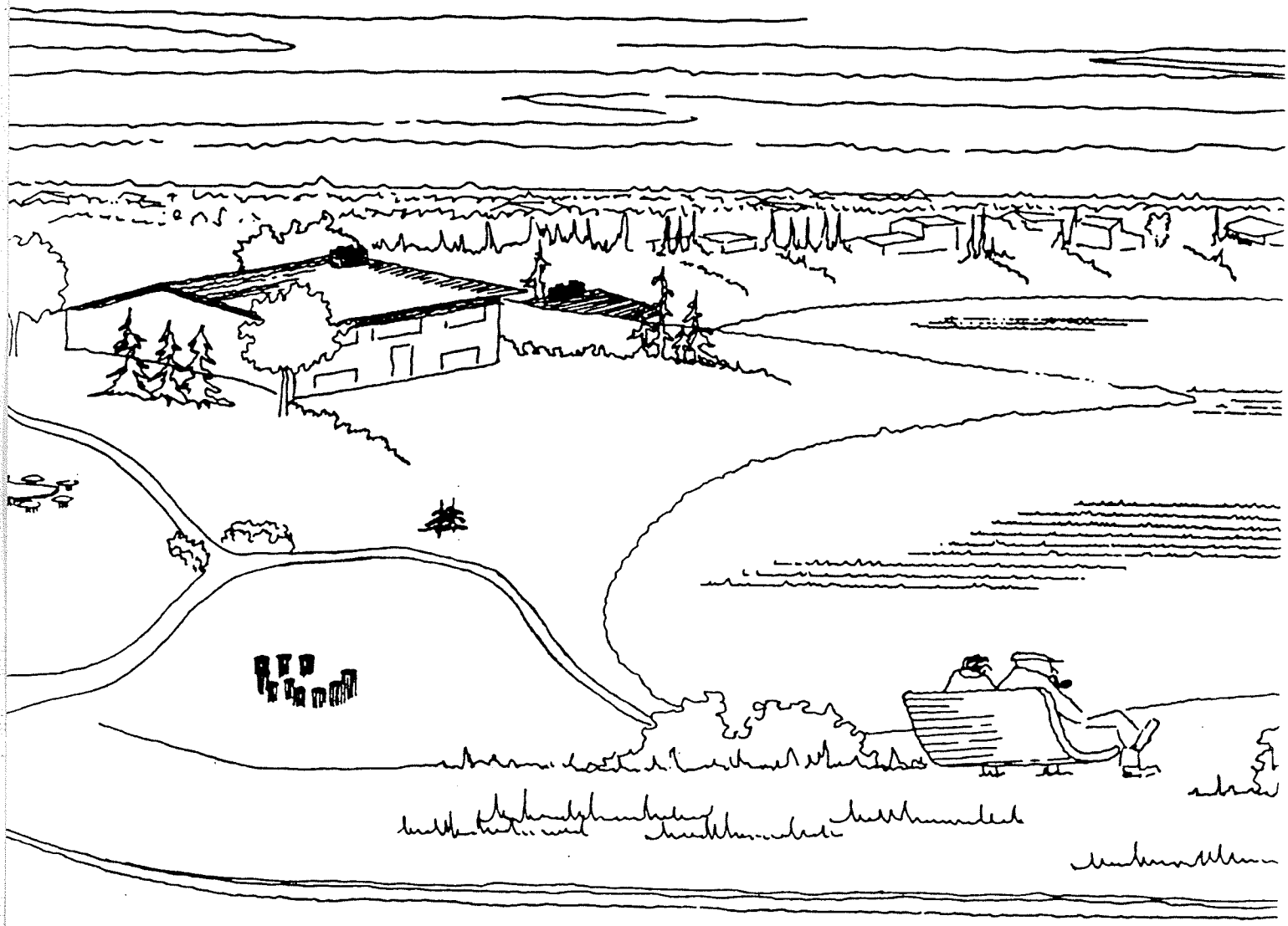
iii) Economic analysis to determine marketing potential for the subdivision, potential costs for development and projected profit margins for residential lot sales;

iv) Legal analysis to determine liability implications of safety measures and to outline by-laws to control the quality of development;

v) Educational and recreational analysis to determine the most appropriate programs to be implemented along the river/ recreation corridor.

APPENDIX 1

Stormwater Management By Use Of Impoundments



STORMWATER MANAGEMENT

BY

USE OF IMPOUNDMENTS

CITY OF WINNIPEG

WORKS AND OPERATIONS DEPARTMENT

WATERWORKS, WASTE AND DISPOSAL DIVISION

A. Penman,
Director.

- F O R E W O R D -

Numerous concepts have been developed for the control of stormwater, however, few have proven as reliable and attractive as a properly designed impoundment.

Impoundments are favored as an alternative to the closed conduit system because they are less costly to install and can be structured to incorporate the recreational and aesthetic amenities present at natural lakes. Further, this technique is particularly applicable to developments that are located a considerable distance from a receiving stream, where the cost of placing a closed conduit system would make development unviable.

The purpose of this report was to evaluate the impoundment concept as a stormwater management tool, and to provide guidelines for its implementation in the Winnipeg area.

We are indebted to the firms and persons who have provided information relating to this study and have cited their names under acknowledgements.

I N D E X

1. CONCLUSIONS AND RECOMMENDATIONS

A review of stormwater control systems in use within the City of Winnipeg and other centres has been conducted. It was determined that properly designed retention basins or artificial lakes can be an aesthetic amenity to the community particularly if integrated with linear parks and recreation areas.

Where a lake is planned for a development, it is essential that the planning of the subdivision layouts consider the lake as a focal point for the community. To ensure proper planning of the land use adjacent to the lake, the Environmental Planning and Parks and Recreation considerations must be basic inputs in the development of the lake facility. The optimum integration of the lake with other community passive and active green areas will require assessment on an individual system basis. In general, approximately half the shoreline perimeter should be available for public access where parks and recreation considerations do not require the entire lake shoreline to be publicly owned.

The following recommendations were adopted by Council at its meeting on June 25, 1975.

(i) that the impoundment area be defined as all lands around the perimeter of the lakeshore up to the high water line plus the area described in paragraph (ii);

(ii) that a minimum of 50% of the lakeshore perimeter and a minimum lakeshore area equivalent to 100 feet in depth measured from the normal water line along that minimum length of the perimeter be reserved for public access and use and included in the impoundment area;

(iii) that any private lot line adjacent to an impoundment area be established at the estimated normal water line and an agreement entered into with the City recorded by caveat prohibiting any structure except any minor structures permitted by the Commissioner of Works and Operations below the high water line and prohibiting any structure except a temporary structure approved by the said Commissioner of Works and Operations within two vertical feet above the high water line;

(iv) that in determining the area of land to be dedicated to the City or the sum of money to be paid in lieu thereof no portion of the impoundment area, as defined to include the lands reserved for public access and use, shall be included;

It was further recommended that:

(v) when a storm water impoundment area is created within a subdivision the owner of the land shall be required to enter into an agreement with the City under either Section 600 (1) (zoning agreement) or Section 637(57) (subdivision agreement). That agreement shall be registered by way of caveat against all lots through which the dyke of the impoundment area runs. The agreement shall preclude the owner of those lots from time to time from in any way reducing the elevation of the dyke and shall provide a release and indemnity from that owner to the City in respect of any loss to persons or property arising out of any removal or lowering of that dyke by the owner contrary to the agreement.

(vi) that the placement of buildings, structures and material within any area designated as being under the jurisdiction of the Rivers and Streams Act receive approval from the Authority..

DESIGN CONSIDERATIONS

To ensure proper operation and safety of impoundments, the following engineering guidelines are recommended:

(i) that impoundment systems be of the permanent lake type having not less than five (5) acres of water surface;

(ii) that impoundments have a minimum water depth of four (4) feet and side slopes of 7:1 for safety, and that all impoundment slopes between the normal and high water levels be sodded and that the area in the vicinity of the normal waters edge be suitably protected.

(iii) that where residential and park areas abut any impoundment the design for water rise be four (4) feet with a maximum of six (6) feet where open space only abuts.

(iv) that a supplementary water supply be incorporated to assure minimum water levels during extended dry periods.

(v) that impoundments anticipated to be stocked with fish have a water depth of six (6) feet or more.

2. INTRODUCTION

The concept of managing stormwater to date has been to "direct" such waters as quickly as possible to the river system by use of open channels and large diameter closed conduit systems.

The limitations of the open channel system, along with escalating costs of placing large diameter conduits, has prompted a review of alternate control methods, among which is "on-site" detention or storage. Under this concept, local stormwater is directed to impoundments where it is retained for ultimate release to the regional drainage system, by pumping or gravity flow, using smaller and less expensive conduits in both instances.

Stormwater management schemes have been implemented by various developers in the Winnipeg area, largely on the basis of economics, with varied emphasis on the recreational, aesthetic, and the standard of protection provided.

Since the responsibility for the maintenance, appearance and operation of the retention system is ultimately passed onto the City, it is only logical that the City provide some general guidelines and standards for these systems.

It is therefore intended to review each impoundment on an individual basis, giving appropriate consideration to the capital, operating and maintenance costs as compared to the conventional system.

The purpose of this report is to examine the ramifications of this concept, particularly as it relates to new land developments, so that guidelines may be developed and implemented.

3. IMPOUNDMENTS - Present Status in the Winnipeg Area

(i) Transcona Community - Utilizes a low level and a high level two pond, dry bottom system for controlling stormwaters. Drainage waters are directed into the low level pond by gravity and pumped into the high level pond or the surface drainage when the need arises. This ponding system is designed for stormwater control only and is fenced to prevent access.

THE WINNIPEG MINT

(ii) Southdale Lakes - St. Boniface Community -

A five-lake impoundment complex which occupies about thirty (30) acres, having a water surface of approximately twenty (20) acres. Some four acres are reserved to provide public access to the lakes. All excess waters collected are discharged to the local storm sewer via gravity. The design incorporated into these lakes allows for a bi-annual water turnover under normal climatic conditions.

The grassed slopes surrounding these ponds add to the beauty of the lakes.

(iii) Canada Mint - St. Boniface Community - Will utilize a permanent lake and moat combination to store storm and plant cooling water. Excess water will be directed to the local storm sewer. Approximately one-third of the total area will be water surface surrounded by shallow sloped grassed areas, thereby making an attractive complex.

(iv) Crestview Development - St. James-Assiniboia Community - Stormwater is directed into a three-pond system of the shallow water design. Any waters exceeding one and a half feet in depth are discharged by gravity flow. Ponds are drained completely for winter, thereby allowing a mud bottom to be exposed.

(v) Baldry Creek - Fort Garry Community - A linear ponding system consisting of two lakes located in a natural creek. Discharge is by gravity into downstream portion of existing creek. Grassed areas adjacent to water are equal in width to water surface, thereby providing an attractive setting.

4. TYPES OF IMPOUNDMENTS

There are two basic types of impoundments, those having a permanent lake and those having a dry bottom. The formation of impounding systems varies from linear to rectangular, depending largely upon the topography of the area.

The shape employed by industrial and municipal applications are usually rectangular, whereas the shapes used by land developers have irregular shapes which simulate a natural lake, thereby enhancing the appearance.

5. MAINTENANCE AND OPERATION OF IMPOUNDMENTS

The aesthetics of an impoundment area can only be achieved if the various components such as pumps, fountains, grassed slopes and shore line are not neglected. Adequate maintenance must be assured in the following areas to gain public acceptance.

(i) Algae and Plant Control - Ponds are subject to algae and plant development.

Nutrient-rich stormwater propagates plankton and emergent plants. However, such growths can be eradicated by use of an algicide such as copper sulphate when fish are not present, or by use of a selective algicide not harmful to aquatic life. A design incorporating at least bi-annual turnover will achieve sufficient movement of water to avoid stagnancy. Further, wave action is more pronounced on a deep body of water which makes it difficult for plants to attach themselves in the littoral zone. Plant and algae control has not been a problem in the Winnipeg installations.

(ii) Mosquito Control - The control of mosquitoes in permanent ponds of sufficient depth can be accomplished by stocking with fish which feed on the larvae. Alternatively, mosquitoes can be controlled by chemical applications or their development retarded by reducing stagnancy through continued agitation. The development of mosquitoes is much more predominant in open semi-dry drainage systems than in permanent impoundments.

(iii) Sediment and Debris - Stormwater impoundments serve as very effective settling basins by virtue of velocity reduction which, over a period of years, may result in some sediment build-up. If the build-up is large enough the material can be removed. As this sediment is composed mostly of earth and sand particles, it is suitable as fill.

(iv) Pumps and Related Equipment - Where installed the maintenance of pumps, valves, pipes and screens is an essential aspect of impoundments. Special equipment, such as fountains, sprinklers and temporary drainage equipment will require frequent servicing.

To assure that the water level can be maintained and stagnation reduced within the impoundments, a water supply, such as a well, should be incorporated along with the necessary pumping apparatus.

(v) Safety - Any body of water can be potentially dangerous. With slopes of 7-10:1 extending at least 30 feet into the water, the hazards of impoundments are less than the 135 miles of river and creek shore within the Winnipeg area. Hazardous areas, such as inlet and outlet structures, should be restricted and appropriate signs posted.

(vi) Grass and Trees - To maintain the aesthetics of an impoundment facility, it is necessary to cut the grass, trim trees and shrubs, paint benches and shelters. These maintenance costs must be considered in evaluating this concept.

6. INCIDENTAL BENEFITS OF IMPOUNDING SYSTEMS

(a) Recreation - The forms of recreation taking place at a wet bottom impoundment system will depend on its size, location and layout. Water-oriented sports, such as canoeing, fishing and sailing require a fairly large impoundment system. Linear lakes are more suitable for such activities than the smaller rectangular format. Cycling and hiking paths which require greater distance considerations are also more suitable to the linear waterways.

Winter sports, such as skating, open air curling, hockey and tobogganing, require a relatively small area and can be conducted within small impoundment areas. Skiing and snowshoeing require distance and are, therefore, more applicable to linearly-structured systems.

(b) Water Use - Where retention ponds are structured upon industrial or commercial sites, the waters can be used for cooling of processing equipment, as will be done by the Canada Mint, or for use in decorative fountains.

Water collected within public impoundment systems should not be used for irrigation or other purposes.

(c) Land Appreciation - Properties located adjacent to impoundment systems, as with natural lake and river property, will appreciate in value.

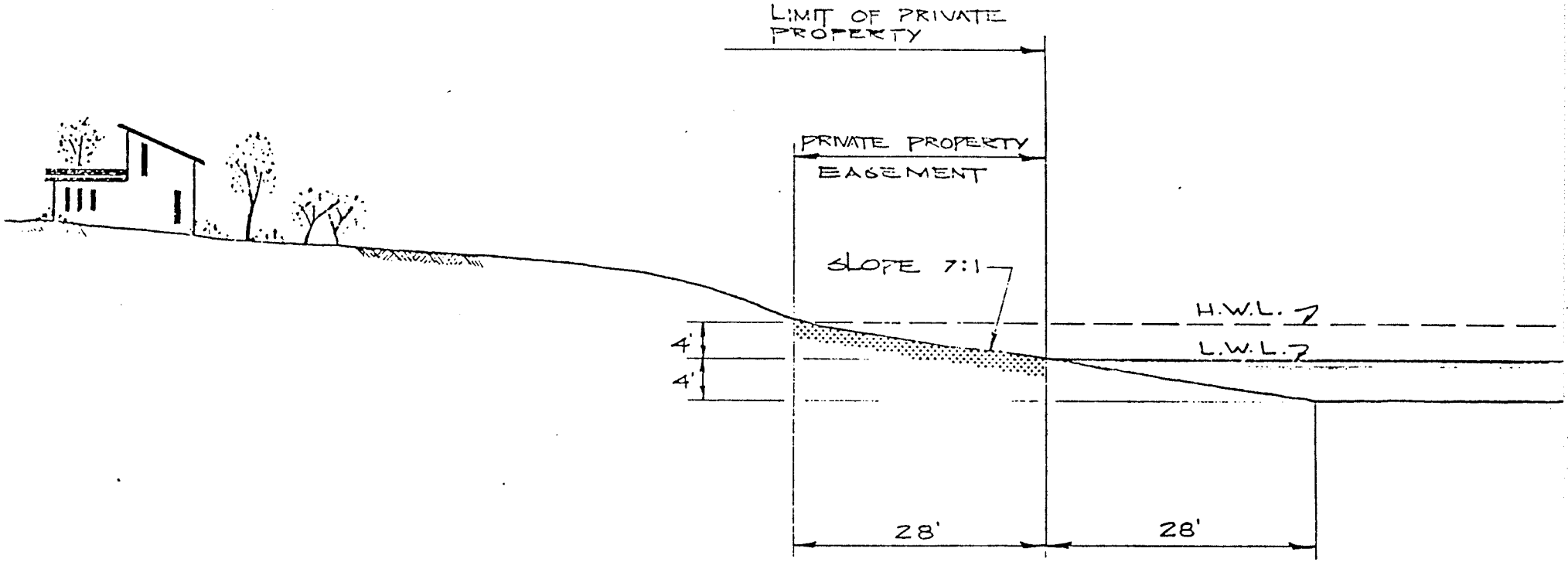
(d) Aesthetics - Spaciousness is possibly the greatest contributor to aesthetics. A properly structured, well designed impoundment system enhances the residential scene by providing visual relief from structures, as is reflected in the value of the lots abutting such sites.

7. DESIGN OF IMPOUNDMENTS

(i) Slopes, Grades - The slopes found in impounding systems within the Winnipeg area vary between 4:1 and 10:1. Slopes that are steeper than 4 horizontal to 1 vertical will cause difficulties in grass cutting operations, and are subject to greater erosion than the gentle slopes, thereby increasing the maintenance costs.

Steep sloped ponds are not as aesthetically pleasing and in the long term, slope failure is likely. Further, unfenced steep slopes become a hazard to small children. Ponds having gentle slopes of 7:1 cause no problem of this type and should, therefore, be the minimum used. Above the high water level the slopes should be flatter, particularly where residential development will be permitted so as to give a flat and adequate rear yard.

(ii) Layout - The configuration used in impounding systems will be dictated largely by the topography within the area. Existence of swampy areas, swales and creeks will influence the layout substantially. It appears that linearly structured impoundments such as can be structured on creeks, will have greater recreational potential. Areas subjected to temporary inundation should be grassed, as no damage will result, even though flooded up to one week.



CROSS SECTION OF IMPOUNDMENT

SCALE: N.T.S.

(iii) Locations - Large areas, such as railway yards, airports and industrial or commercial sites, are logical impoundment areas, by virtue of their size and their influence on adjacent land use. Public access to such sites may be restricted and, therefore, these could be utilized for purposes such as float plane base, boat testing facility or as a water reservoir for fire fighting during the summer months.

Impoundments structured within residential areas should be as central as possible, and preferably along the thoroughfares. This would provide the necessary access to such sites and, further, bring the public within walking distance of the recreational facilities that may be located within the park area.

(iv) Depth Configuration - The water depth within a wet impoundment system is important from the aspects of algae development, aquifer contamination, water turnover, fish stocking, sedimentation and drainage.

To prevent excessive algae development, the A.P.W.A. draft report on "On-Site Detention Systems" recommends a water depth of at least four (4) feet. Excessive depth, on the other hand, will increase construction and sediment removal costs, and further, may result in aquifer contamination and bank instability. A water depth of six (6) feet in the major portion of the lake is sufficient to permit fish to be stocked and survival assured, even during winter months when an ice cover of two to three feet may be present. Further, greater depth also retards algal development because light penetration due to turbidity is restricted to the upper levels, thereby limiting growths in the lower strata.

(v) Storage Design - The normal stormwater collection system is designed to carry a 5 year return storm. However, the design criteria for stormwater impoundments systems are presently under review and will be presented in a separate report. To assure protection of local residential properties, the storm design frequency for impoundments must be considerably greater, so as to accommodate the additional volume generated during extended periods of rain and thereby preventing the surcharging of the collection system.

(vi) Landscaping - To retard soil erosion, all slopes must be grassed by sodding and that the area in the vicinity of the normal waters edge protected by a suitable material. The City should be responsible for the landscaping up to the high water level. All other areas, excepting parks fronting on impoundments, would be at the expense of the developer. Sodding of all areas should commence as soon as practicable after final grading has been completed. No trees should be planted in the area subjected to inundation.

(vii) Water Elevations - The lake level elevations should be such as to permit a normal rise of four (4) feet, with an additional two (2) foot free board to accommodate excessively heavy or prolonged rains. The normal rise for an impoundment surrounded by park area could be designed for six (6) feet as no damage would occur.

No permanent structure should be placed adjacent to any impoundment at an elevation within six (6) feet of the normal water level. Minor structures should be placed only by approval from the appropriate authority.

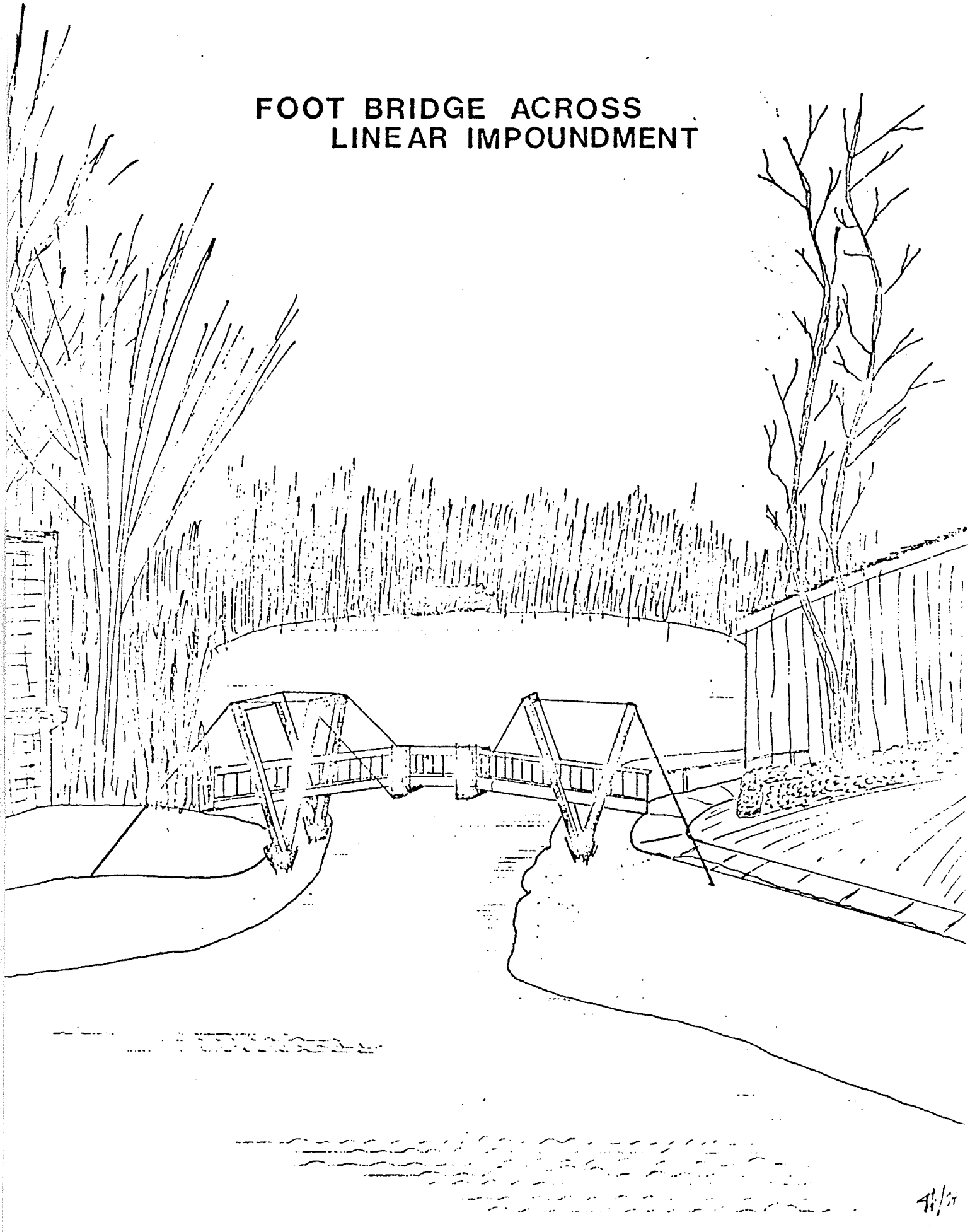
8. LAND USE ADJACENT TO IMPOUNDMENTS

(k) Linear Impoundments - Where creeks, rivers and streams are used as impoundment areas, a mixture of residential and parks appears to be the optimum. To provide a linear walkway or cycling path, it is necessary to reserve property on one side or the other. Such an arrangement should alternate with crossover bridges spaced at intervals to provide interconnection of the public areas. The public section would be acquired through developer dedication or purchase by the City.

(ii) Non-Linear Impoundments - Land adjacent to non-linear impoundments should be at least 50% public with a minimum lakeshore area equivalent to 100 feet in depth measured from the normal water line, with that minimum length of the perimeter to be reserved for public access and use and included as part of the impoundment area. Open space in excess of this would be acquired by the City through purchase or by dedication of the developer.

(iii) Restrictions - To assure that the aesthetics of an impoundment are maintained and property protected, it is necessary to regulate the placement of structures on adjacent slopes.

FOOT BRIDGE ACROSS LINEAR IMPOUNDMENT



All residential development agreements should, therefore, require that a Caveat will be registered in the name of the City, which prohibits the placement of any structure, including fences, flag poles and docks, or trees, shrubs and plants upon any portion of the slope that will be inundated by a four (4) foot rise in normal lake level, and further restrict the placement of any permanent structure within the area that would be inundated by an additional two (2) foot rise. Minor temporary structures should be placed only upon approval from the appropriate authority.

9. ECONOMICS OF IMPOUNDMENT SYSTEMS

The economics of an impoundment system must be evaluated on an individual basis. As developments occur farther from receiving streams, the use of impoundments will be favoured, as economics of using impoundment systems as opposed to the piping system are well documented.

10. LEGAL ASPECTS

Under Section 45(1) of the City of Winnipeg Act, the City has the authority to accept or purchase land within the City or another municipality, for the purpose of preventing flooding by surface or other waters. In general, the City regulates all matters dealing directly or incidentially with drainage of the City. Provincial approval is, however, required on changes being anticipated on streams regulated under the Provincial Waterways Act.

The Rivers and Streams Act regulates the placement of of buildings, structures and material within three hundred and fifty feet of the normal summer water level of the Red River, Assiniboine River, Seine River, Bunn's Creek and Sturgeon Creek. Approval of the authority must be received prior to commencing with construction within this designated area. The City is not liable for any damage caused, unless work is proven to have been done negligently. This applies to both private and public property. Advice on the wording used on signs should be sought from the Legal Department.

11. ANALYSIS OF LAND DEDICATION BY DEVELOPERS AS RELATING TO STORM WATER CONTROL

Under Section 637(23)(a) of the City of Winnipeg Act, the Council of the City may require that a land developer dedicate up to ten (10) percent of the land being developed, with such a dedication being for public purposes, other than highways.

Further to this, the owner of the subdivision shall enter into an agreement (Section 637(23)(e) with the City, whereby the expense in whole or part of all services fof such an area be the developers.

It appears logical that the cost of stormwater servicing should be shared on a prorated basis with the City. Costs would include all the land, excavation and control structures involved to provide a complete stormwater management scheme for the drainage basin.

On site retention by industrial and large commercial establishments should be implemented where the stormwater flow from such areas is interfering with the normal operation of the drainage system.

It should be noted that the 10% land dedication for open area should be based on the acreage of land remaining after the portion for the impoundment system has been deducted.

12. GENERAL DISCUSSION OF FINDINGS

The use of impoundment systems for stormwater management is a widely accepted technique which can be structured to provide a multi-purpose role and results in significant savings over conventional covered conduit systems. This technique is very applicable to areas of flat terrain where the hydraulic head is at a minimum.

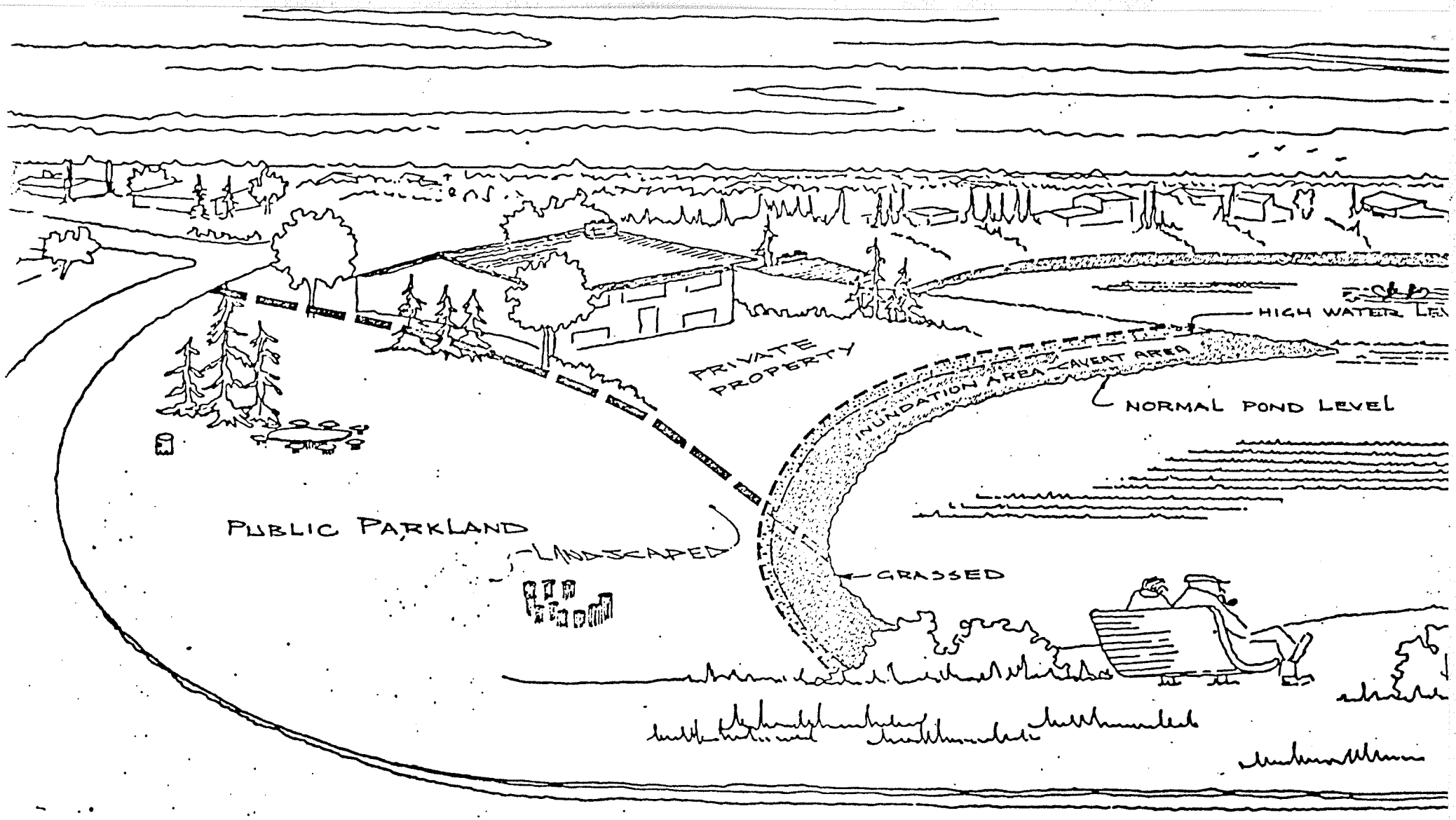
The continuous wet bottom (lake) impoundment systems lend themselves to better recreational and aesthetic development and are less costly to maintain than the dry bottom system. Recreational facilities such as volleyball and tennis courts, when structured on the bottom of dry ponds, are subject to siltation and must be cleaned prior to their use.

The use of natural watercourses in place of outfall sewers in conjunction with an impoundment system, results in substantial cost saving over the closed conduit system.

Creeks and streams can be used where sufficient flood plain area exists to structure an impoundment within its normal confines. The advantage of using creeks and streams is that a linear waterway can be placed which is recreationally and aesthetically attractive. The disadvantages, however, are some siltation build-up, which tends to reduce the hydraulic capacity, and continuous high water levels in portions of such waterways which may result in bank shifting.

The cost of all stormwater servicing should be shared on a prorated basis with the City. Costs would include the land and all necessary appurtenances so as to provide a complete stormwater management scheme.

Hopefully, the general guidelines in this report will prove impoundments as a viable stormwater management technique and an aesthetic benefit to the community as well.



Typical Impoundment Concept

- ACKNOWLEDGEMENTS -

UNDERWOOD McLELLAN & ASSOCIATES LTD.

W. L. WARDROP & ASSOCIATES LTD.

REID CROWTHER & PARTNERS LTD.

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LADCO COMPANY LTD.

CITY OF WINNIPEG - DEPARTMENTS OF -

PLANNING
PARKS
LEGAL
WORKS & OPERATIONS

Feb. 20, 1988

Dear Residents,

The retention lake in your community will be the focus of a research study conducted through the University of Manitoba, Department of Landscape Architecture. The field of Landscape Architecture is concerned with improving the living environment through design, including parks, playgrounds, and recreation spaces such as retention lakes to name a few.

We request that you answer the attached questionnaire that deals with the **retention lake** in your community. Specific questions will deal with the appearance of the lake, the safety, maintenance and recreational value of the lake. Your opinion on these topics is essential in determining how satisfied you are with the lake design and how future lake developments can be improved to better suit residents needs.

Your personal answers will be held in confidence and the compiled results of the survey will be circulated to all participants.

Please take the next 1/2 hour to fill out the survey and then return it into the original envelop. The survey will be picked up from your home in two days. If you will not be at home please leave it in your mail box or mail to the address listed at the end of the survey. If you have any questions or require clarification please call the number given below. Thanks for helping to make our community an enjoyable and healthy living environment.

HEATHER ANDERSON, B.R.S.
Telephone 261-8789
Enclosed Questionnaire

VISUAL SATISFACTION

The overall appearance of a retention lake is largely determined by a designer and a developer when the lake and subdivision are laid out. They decide where roads, sidewalks, parks and private lots are to be located. They also determine where trees should be planted, what the slope of the banks will be, how the shoreline will be treated, and where additional facilities such as playgrounds and fountains will be located. Your opinions on what would be appealing to new home buyers will be helpful. Please review the list of possible lakeside developments. Indicate how you feel each item will effect the visual appearance of the lake. Please use the following scal and circle your choice number.

LAKE FEATURE			RATING
1. A public park around the entire fringe of the lake, with a recreational trail through it leading to focal points of activity such as playgrounds, docks or lookout towers.	5.5	6.9	38.3
2. Private yards arounds the entire fringe of the lake, with fences that go from private side yard into the water separating the lakeshore into private parcels.	15.9	12.5	71.2
3. All private homes around the lake to be built on an upper terrace. Private back yards would terrace down to a public park and lake. There would be no fences between yards dividing the shoreline.	46.7	17.5	33.2
* Note please read 4 and 5 before answering 4.			
4. A fully landscaped park around the lake including shade trees, shrubs, trails, seating areas, grass areas, and no aquatic plant growth at all along the lakeshore.	46.5	9.7	35.5
5. A fully landscaped park around the lake including shade trees, shrubs, trails, seating areas, grass areas, and natural plant growth along the lakeshore such as bullrush and cattails.	3.7	7.6	50.7

6. Wildlife such as ducks and geese around the lake and on islands.	85.6	6.9	6.1
7. Visual attractions in the water such as fountain sprays and waterfalls.	79.6	11.8	7.5
8. Chain link fence six feet high around the entire lake.	2.6	2.0	8.7
9. Public activity areas along the lakeshore such as			
playground with playstructure	39.8	11.8	43.7
viewing/lookout tower	39.7	16.7	36.2
boardwalks or docks for fishing & suntanning	34.8	13.7	44.6
footbridges to central islands	58.6	10.4	22.9
10. Retention lakes with additional watercourses or rivers that would link the lakes together.	70.5	17.5	9.6

If you have any comments about what you do want to or don't want to see on or around the lakeshore please explain. Feel free to comment on the back of this page.

MAINTENANCE

General maintenance of retention lake (undertaken by the City of Winnipeg) includes cutting grass along the lakeshore, controlling algae growth in shallow water (usually by adding chemicals to the water), and removing plant growth such as bullrushes and reeds.

There are a variety of ways to keep the lakes free of algae and plant growth besides the chemical methods currently used by the City. Since most aquatic plant growth occurs in the first 6 to 18 inches of water, one solution to reducing plant growth may be to redesign the lakeshore and reduce the area of shallow water. (Please note that all of the options listed below will help to reduce plant growth, and many of them can be used in combination with one another.) Please review the following maintenance and design options and indicate your level of agreement with each method using the following scale.

1	2	3	4	5
strongly disagree	disagree	impartial	agree	strongly agree

Maintenance Option				
1.	Design the lake edge to step down into the water to reduce the area of shallow water and contain the plant growth to specific areas.	34.1	2.0	44.6
2.	Design the lake edge to have rock, boulder, or gravel cover over the lake bottom in shallow water.	65.6	1.6	1.8
3.	Design the lake to accommodate waterfowl and fish. The wildlife would require plant growth for food and cover.	53.5	22.3	13.1
4.	Cut aquatic plants such as cattails and bullrushes with a weed harvester. (A type of lawn mower used in the water). Cut plants can be used for compost and forgarden fertilizers.	43.2	31.4	29.2
5.	Apply chemicals and pesticides to the lake to kill all plant and algae growth.	18.7	14.6	65.6

Please comment on any concerns you have about lake maintenance and note on the back of this page if you have any suggestions on how to maintain the lake.

RECREATION

Opportunities for recreational activities around retention lakes have not been fully developed in the past. Part of the problem has been related to ownership of land surrounding the lake. Is it public or private? Currently 50% of lake shore is dedicated to public ownership and the other 50% has private lots along the shoreline. Development of continuous recreation trails around the lake cannot be achieved and private landowners have had difficulty keeping the public off their private lawns. These problems can be solved through changes in the design of lake and positioning of private lots along the shore.

In order to achieve success in recreation planning designers must understand how community residents would like to have the lakeshore used. There are two options.

1. The lakeshore should be divided into parcels and owned by the lakeside residents. Each lot owner would own the property right down to the water. Individuals would use their lakeshore for private recreation such as suntanning, gardening, play area, or lawn areas. Individual treatment of the shoreline may include fencing the property to the waters' edge. There would be no public access around the lakeshore.

2. The entire lakeshore should be designed as a community park and include community recreation activities such as jogging/skiing trails, play areas and quiet seating areas. The community park would be given specific separation from adjacent private property through a change in level (grade), trees and shrubs and/or fencing. Community recreation activities would be determined according to community wants and desires.

Please check one of the following statements.

27.2 I agree with recreation option statement number 1

46.1 I agree with recreation option statement number 2

26.5 I agree with neither of the two statements.

Please check the statement that corresponds to your relationship with the retention lake in your community.

41.9 My property is located right on the lakeshore and goes down to the waters' edg e

5.5 My property fronts onto a retention lake, but there is public park between my property and the lake.

52.4 There is a retention lake in my community but my property does not front onto it. My house is approximately _____ feet away
_____ meters away

Please indicate how you feel about the development the following recreation activities around the retention lake in your community. Use the following scale.

1	2	3	4	5
greatly improved	improved	no effect	detract	greatly detract

RECREATION ACTIVITY	SCALE			RECREATION ACTIVITY	SCALE		
tot lot	29.2	24.4	39	benches/sitting area	71.9	10.4	13.8
junior playground	28.7	21.6	49.7	education programs	46	30.7	15.9
public beach	23.1	11.8	65.1	wildlife viewing area	52.3	25.1	18
public boating dock	17.7	9.7	72.6	general skating area	74	15.3	6.1
public fishing area	23	18.1	58.5	hockey area	21.3	17.4	46
windsurfing	32.7	28.6	32	toboggan hill	57.9	17.4	19.4
canoeing	39.7	29.4	10.3	viewing tower	38.3	21.6	35.5
rafting	34.1	29.3	29.2	skate boarding track	12.4	14.6	67.7
snowmobile route	1.4	2.7	88.7	bicycle trail	46	11.8	36.9
jogging trail	53.7	18.8	21.5	motor bike trail	4.7	2	88.7
x-country ski trail	52.3	23	16.6	no activities at all	15.2	27.9	43.9
SCALE	1 & 2	3	4 & 5		1 & 2	3	4 & 5

GENERAL STATEMENTS

Please respond to the following statements by checking in the space either agree x or disagree x

I would agree 51 or disagree 44 to retaining all natural plant growth around the lake for wildlife habitat.

I would agree 88 or disagree 11 to have designated wildlife areas along the public lakeshore or on central islands within the lake.

I would agree 50.3 or disagree 46.8 to changing the slope of the bank that is underwater to reduce unwanted plant growth.

I would agree 70.6 or disagree 26.5 to living next to a waterbody that resembles a natural river system such as the Seine or Assiniboine River.

I would 84.6 or would not 11.1 prefer to live next to the lake if there were lots available.

SAFETY

I would agree 68.5 or disagree 30.7 the gentle slope of the bank is inviting and provides easy access into the water for young children.

I would agree 72.7 or disagree 25.1 the "DON'T SWIM" signs posted around the lake are useful in keeping children out of the water.

I would agree 76.2 or disagree 21.6 that safety could be designed into the lake by accepting the fact children want to explore their surroundings and making the lake a safe, controlled play environment.

I would agree 7.6 or disagree 90.6 that a six foot chain link fence around the entire lake would provide a safe environment by keeping kids out of the lake.

I would agree 90.2 or disagree 8.3 that a six foot chain link fence around the entire lake would prvide a challenge for kids to climb over and therefore does not provide a safe environment, particularily when a child is in need of help.

I would agree 54.5 or disagree 34.2 changing the lake edge from a continuous slope into the water to terraced steps into the water would be unsafe and should not be done.

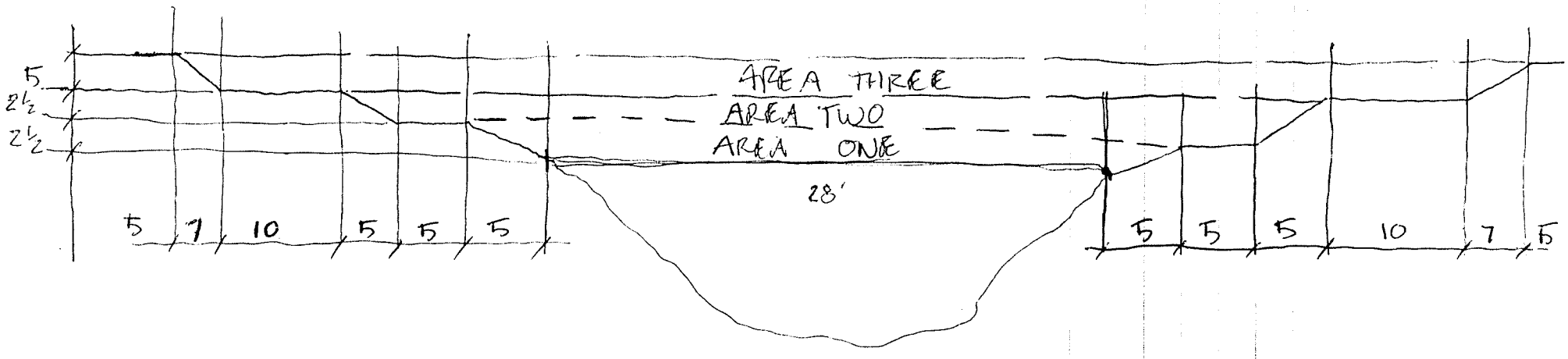
I would agree 32.8 or disagree 55.2 changing the lake edge from a continuous slope into the water to terraced steps into the water would be safe and poses no safety hazards.

Please feel free to comment on any of the questions or issues raised in this questionaire.

Thank you for your time and effort in responding to this survey. Please replace the survey into the envelope, it will be picked up from your house in two days. If you will not be home please place it in your mailbox or mail it to:

Edwards Research Study
309-990 Markham Road
Winnipeg, Manitoba
R3T 2M2

The results of this study will be circulated to all participants.



AREA ONE

STORAGE CAPACITY.

$= b + 2\sqrt{c^2+d^2}$

$= 28 + 2\sqrt{5^2+2.5^2}$

$= 28 + 2\sqrt{25+6.25}$

$= 28 + 2\sqrt{31.25}$

$= 28 + 2 \times 5.6$

$= 28 + 11.2$

$= 39$ cfs.

AREA TWO

$= b + 2\sqrt{c^2+d^2}$

$= 48 + 2\sqrt{31.25}$

$= 48 + 11.2$

$= 59.2$ cfs.

AREA THREE

$= b + 2\sqrt{c^2+d^2}$

$= 78 + 2\sqrt{5^2+5^2}$

$= 78 + 2\sqrt{50}$

$= 78 + 2 \times 7.07$

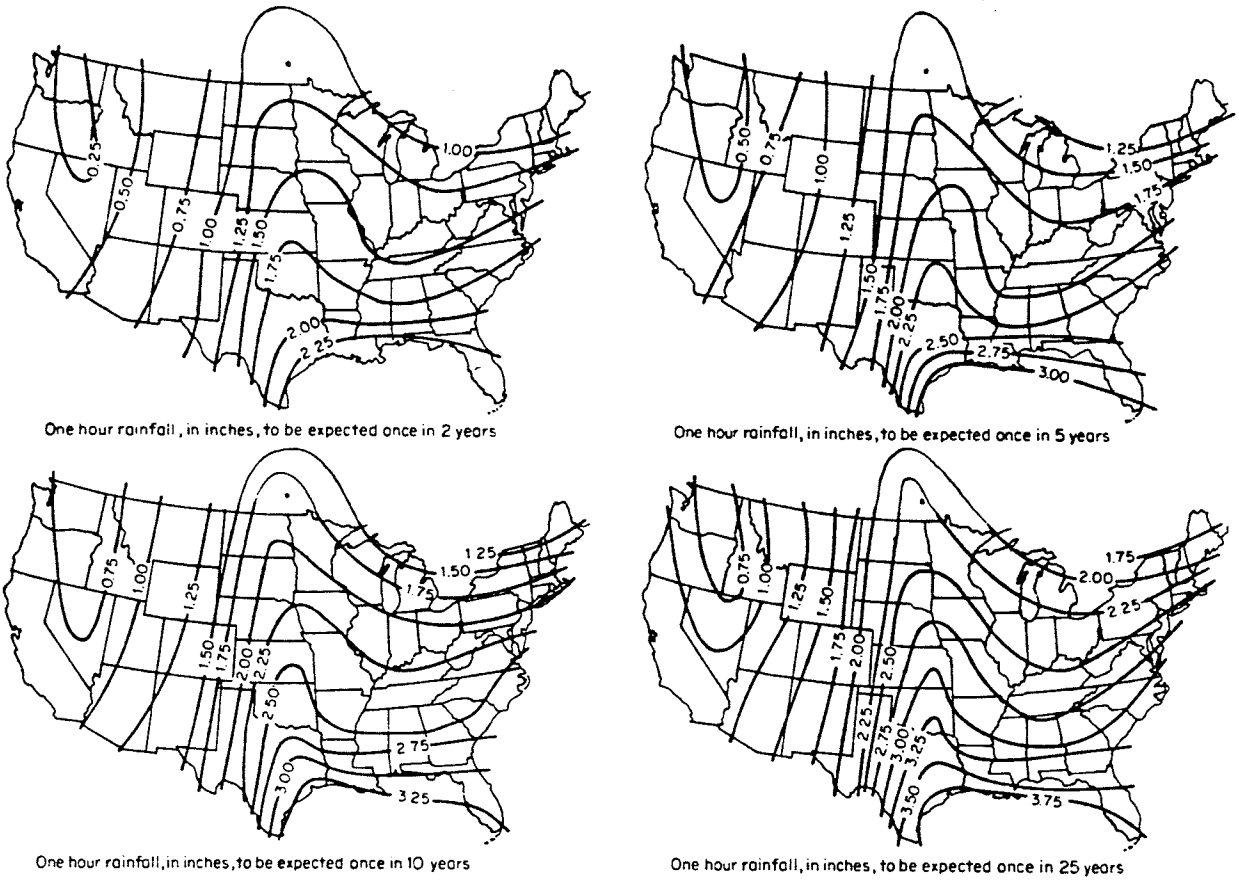
$= 78 + 14.14$

$= 92.14$

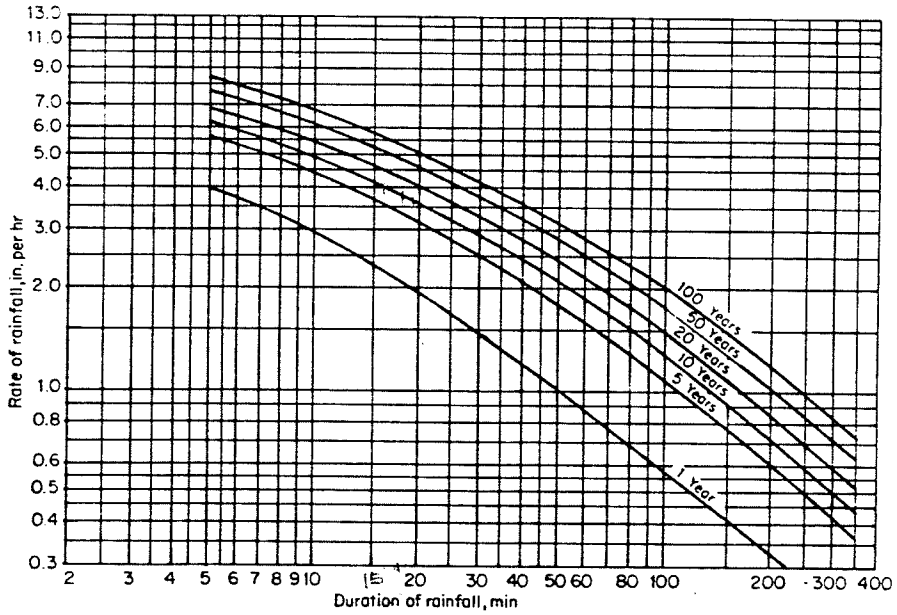
AREA ONE	39
TWO	59.2
THREE	92.14
	190.34.

APPENDIX 3.

APPENDIX 4.



Rainfall-intensity probability. (*Adapted from D. L. Yarnell, USDA Misc. Publ. 204.*)



Typical probability curves for rainfall in the North Central United States.

ESTIMATED COST OF CONDUIT PIPES **APPENDIX 5**

Correspondence from: Don Mulder
I.D. Engineering Canada Inc.
Professional Engineers

Date: January 8, 1988

Current pipe installation construction costs for 1988 in common backfill situations are approximately as follows:

Pipe Diameter (mm)	Cost $/m
250	50.00
300	55.00
375	70.00
450	90.00
525	100.00
600	120.00
750	155.00
900	200.00
1050	270.00
1200	350.00
1350	450.00
1650	600.00

APPENDIX 5

CONDUIT PIPE TABULATION & COST ESTIMATE

PIPE SIZE Ø	LINEAL METERS	COST/ METER	TOTAL
250	289	50.00	14450.00
300	2205	55.00	121275.00
375	4150	70.00	290500.00
450	2737	90.00	246330.00
525	1544	100.00	154400.00
600	1136	120.00	136320.00
750	2154	155.00	333870.00
900	1058	200.00	211600.00
1050	481	270.00	129870.00
1200	610	350.00	213500.00
1350	610	450.00	274500.00
1650	35	600.00	21000.00

TOTAL COST $ 2165615.00

ESTIMATED RETURN VALUES OF RESIDENTIAL LOTS
FOOT FRONT FOR THE DEVELOPER

Personal correspondence with Arch Honigman
B.A., M.C.P., M.C.I.P.
Land Development
Planner

Date: Jan. 1987

30 Speers Rd.
Winnipeg, MB

Zoning catagories and general description found in River Park South

"R1-5"	Single family district 50' lot width, 5000 sq. ft. lot area
"R1-5" Lake	Single family district 50' lot width, 5000 sq. ft. lot area
"R1-4"	Single family district 40' lot width, 4000 sq. ft. lot area interior lot
"R-PL"	Single family district small lots 20' lot width with a back lane 30' lot width without a back lane 2500 sq. ft lot area
"PR"	Parks & Recreation District
"R3B-1"	Multi family dwelling 33-35 units per acre
"C2"	Commercial

Each zoning catagory has an approximate land value per foot front. Foot front measure is estimated by measuring the lot width approximately 1/3 back or 40' from the road.

Approximate land values for 1987:

Zoning Group	Value Per Foot Front
R1-5 Lake	950.00-1000.00
R1-5	850.00-900.00
R1-4	600.00-650.00
R-PL	550.00-600.00
R3B-1	135,000.00 per acre
C2	150,000.00 per acre

NOTE: River Park South Subdivision layout incorporates all zoning catagories except "C2".

For calculation purposes the catagories of R1-4, R-PL & R3B-1 have been collapsed and represented as R1-4 zoning. In cost estimation all R1-4 zoned areas have been allocated the land value of $600.00 and $650.00 per foot front. Values given for potential lot sales in the original subdivision layout will be artificially high due to this generalization.

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