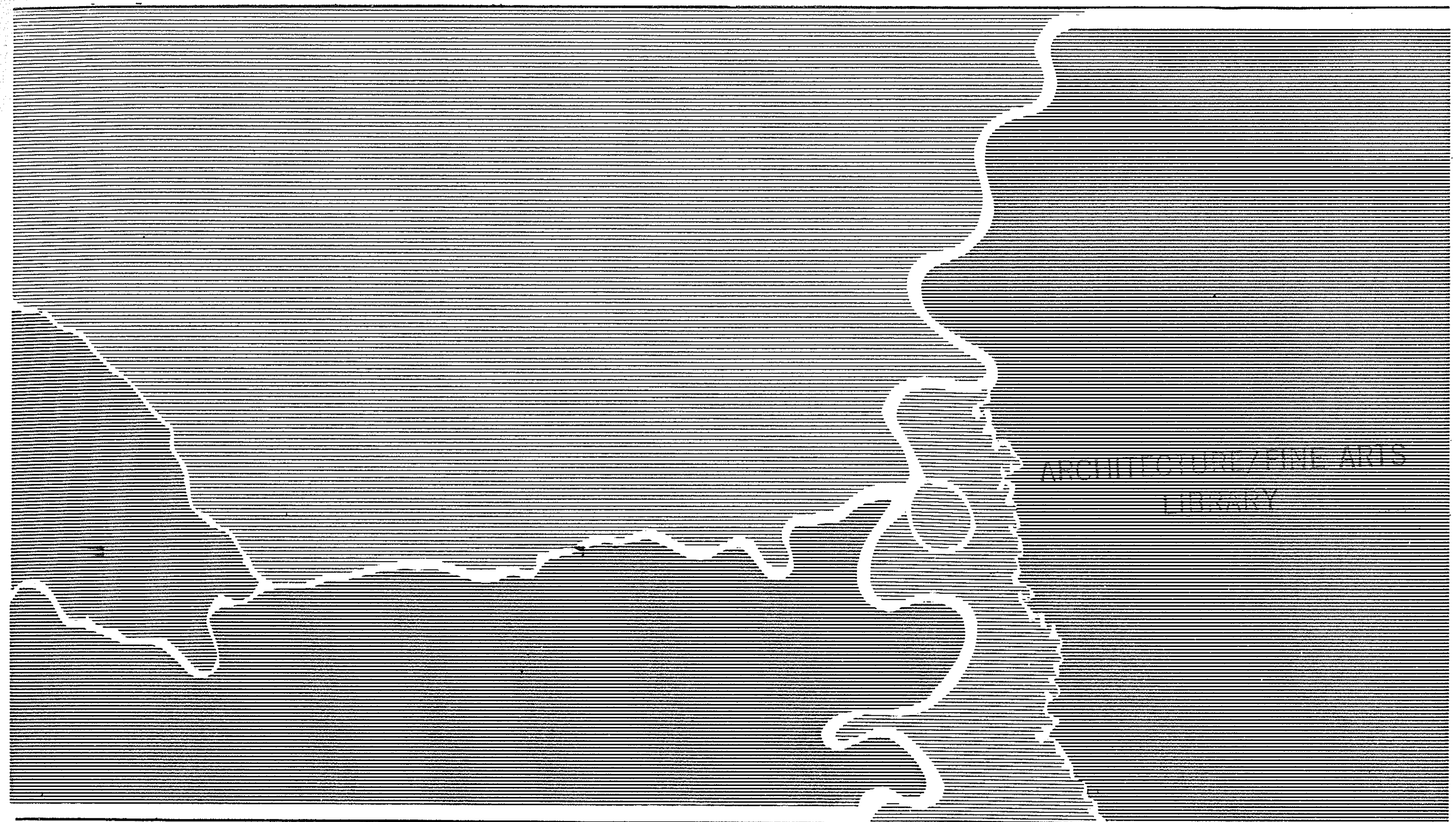

The

SURFACE WATERS of WINNIPEG

RIVERS, STREAMS, PONDS and WETLANDS 1874—1984

THE CYCLICAL HISTORY OF URBAN LAND DRAINAGE

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Rivers, Streams, Ponds and Wetlands · 1874 — 1984

THE CYCLICAL HISTORY OF URBAN LAND DRAINAGE

by

Robert Michael W. Graham

A Practicum submitted in partial
fulfillment of the requirements for
the Degree, Master of Landscape Architecture

Department of Landscape Architecture
University of Manitoba
Winnipeg, Manitoba, Canada
1984

ACKNOWLEDGEMENT

In recognition of their support and enthusiasm, I wish to thank the members of my committee; Garry Hilderman, Assistant Professor, Department of Landscape Architecture, University of Manitoba; Dr. Robert Newbury of the Freshwater Institute, and E.B. McLachlan, Assistant Professor, Department of Landscape Architecture, University of Manitoba. In particular I wish to acknowledge Garry Hilderman for the original idea which forms the core of this study.

I am further indebted to a number of individuals for their generous assistance with various facets of this study, among them; Tim Ross, Map Archivist, for the Provincial Archives of Manitoba, without whose very generous help this study would not have been possible; Nils Christensen, of the Manitoba Soil Survey, for his expert air photo interpretation of the path of Colony Creek and Dr. Larry Stene, Department of Geography, University of Manitoba, for his interpretation of the beheaded Seine River.

I would also like to acknowledge the Faculty of Graduate Studies for the financial support through the University of Manitoba Graduate Fellowship.

Finally I wish to thank Gloria Leslie Greeniaus for her implicit support and William Rock Jr., Chairman, Department of Landscape Architecture, University of Toronto, for the initial encouragement.

This historical study is dedicated to Rebecca, who is the future.

ABSTRACT

The modern day City of Winnipeg is situated on the poorly drained floor of pro-glacial Lake Agassiz, one of the flattest regions on earth. Within the area now bounded by the Perimeter Highway sixteen major streams and at least twenty small coulees once emptied into the Assiniboine and Red Rivers. Behind the levees of these rivers large areas of marsh existed providing detention storage of surface waters. The overflow from these wetlands fed many of the streams. The first settlers in the region mimicked the natural drainage regime by damming the waters of the streams to drive grist mills. Later agricultural settlers, occupying the uninhabited but marginally drained lands behind the levees began to drain the wetlands. During the explosive growth period of the City (1880-1910) the drainage regime was radically altered and an expensive and inadequate conduit system was substituted in its place. Serious flooding episodes have occurred from the first alterations up to the present day. In an attempt to solve the flooding problems, overcome the expense of conduit systems and add amenity, a series of stormwater retention ponds was introduced by private developers in 1965. Functually these impoundments imitate the original hydraulic relationship between the ponds, wetlands and streams of the native landscape. Approximately one hundred years after the elimination of the natural drainage regime, Plan Winnipeg 1981 calls for the preservation of all natural watercourses in recognition of their high value for storm drainage and recreational amenity. Of the original thirty-six streams and coulees only nine exist today. All wetland storage areas have been eliminated. This practicum traces the historical progression of land drainage in the City of Winnipeg, summarizes the design criteria for future urban stormwater management, and outlines the present condition and rehabilitation potential of the historic water features.

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CONTENTS

LIST OF FIGURES

Chapter 1

INTRODUCTION

1.1 WATER, TIME AND THE CYCLES OF CHANGE

A relationship has been perceived by man to exist between water and time since the beginning of civilization. In particular, flowing waters, rivers and streams, have evoked in man an awareness of time and its transiency. The movement of water over time is cyclical in nature and is termed the hydrological cycle. Water passing from the land to the rivers to the oceans is evaporated into the air, forms clouds, and falls again as rain or snow upon the land. It is the rate of movement in this cycle that is of concern to man and of vital concern to his settlements.

This study concerns itself with the surface waters of Winnipeg over approximately a one hundred year time span during which a cyclical movement can be observed in the treatment of land drainage. It is my hypothesis that the nature of the drainage regime was not fully understood by its' first settlers or by the engineers who laid the groundwork for the alterations that we live with today. In fairness it must be acknowledged that Canada was a "new" land and that the settlements that occurred, and their subsequent growth, were severely hampered by a lack of precipitation records and inadequate regional data. In the course of one hundred years however, we have come to understand the nature of the landscape and even begun, hesitantly, to replicate or approximate its drainage processes.

The Prairie is a land of subtleties and extremes; a vast geometry of sky and earth (Stegner 1953), clouds, sky, grass and, more problematically, water. The average annual rainfall in Winnipeg is about 15.22" per year with a range of from 8.14" in 1939 to 24.39" in 1878 (Labelle, 1966). That is a potential variation of approximately 16". Summer storms are brief and violent and it is not uncommon for 2" to fall in one area in under an hour. The highest amount of rain recorded in Winnipeg was 10.26" in a 24-hour period. On unpaved and level ground, storm water percolates downwards until saturation of the soil occurs, at which point it begins to collect and run directly across the land surface into a network of drainage runways, stream channels and rivers. On the lacustrine clay floor of pro-glacial Lake Agassiz in the Winnipeg region, the land rises for the first ten miles on either side of the

Red River at a rate of only about 2 or 3' per mile. In combination, these simple facts contribute to the central problem of settlement at the northwestern edge of the Tall Grass Prairie, at the junction of two rivers whose waters are capable of rising 40' above summer average. The history of urban settlement in Winnipeg from 1816 to the present day has been a gradual, painful, and only partial coming to terms with these realities. In the process, a unique landscape was largely obliterated and the natural drainage regime of the area profoundly altered. I believe there are lessons to be learned from a close examination of the native Winnipeg landscape and its drainage regime.

Within the region now bounded by the Perimeter Highway, at least thirty-six streams and coulees at one time emptied into the Assiniboine and Red Rivers providing a natural drainage network for the region. In addition, at low water, there were innumerable small springs emptying into the bed of the Red River (Ruttan, 1896). Lake Manitoba, some 25' above the City of Winnipeg's elevation, lies to the northwest and it was from this direction that the streams exiting on the north side of the Assiniboine and the west side of the Red originated. Those exiting into the Red on the east bank originated in the highlands of the southeast.

The numerous streams of the area were highly valued by the first settlers. Historian W. L. Morton in an essay entitled, "The Significance of Site in the Settlement of the American and Canadian Wests", developed two major premises that relate to those streams. Firstly, "....that the settlement of the West was, in a large measure, a competition for site", and secondly, ".....that the absolute significance of site is most pronounced in primitive society and becomes progressively less so as society grows more complex" (Morton, 1950). The development of the City of Winnipeg from the Selkirk Settlement to the present day and the obliteration of the natural drainage features is an excellent case study for Morton's thesis.

The grist mills of the Red River Colony were powered by the dammed waters of Catfish Creek (now Omands), Inksters Creek (now Selkirk), Macleods Creek and Sturgeon Creek and others not yet positively identified. These mills were subject to the intermittant nature of the streams and operated most effectively when the dams built up a sufficient head of water during the spring freshet. They were often at a standstill later in the season or were washed out by summer stormwaters (Kaye, 81). Early maps of the City clearly indicate these streams and their coulees (Parr, 1874; McPhillips, 1883). The oblique angle air photographs taken of the City in 1927 however indicate that by that date most of the stream courses had been obliterated or were remnant only. As late as the 1970's, lands abutting Macleods Creek in East Kildonan, formerly the site of a Selkirk Settlement grist mill, disappeared beneath a high rise apartment complex over the helpless objections of the City of Winnipeg's Water and Waste Departments. There is still no adequate legislation to protect such streams. Wetland depressions, of which the Oxbow of the Red in St. Boniface and the Elmwood Lowlands are but two examples, met a similar fate and were drained or filled in.

A number of factors may be cited for the gradual disappearance of these important features. Wetlands on the prairies have historically been regarded as wasteland and would have been drained for agricultural purposes or filled for development. The streams were seasonal and intermittant in nature. A stream bed on the prairie may lie at low water for several months or even years before suddenly overflowing its banks in a freshet or storm. The rapid and at times explosive nature of urban growth in Winnipeg between 1882 and 1913, in the absence of any specific legislation to protect streamways, also led to their disappearance. The Charter of the Winnipeg Parks Board of 1893, called for the establishment of green spaces. Although the Winnipeg Parks Board was heavily dependent on advice from the Minneapolis Parks Board and the precedent of their Parks Act, they made no mention of streams or provision for their protection by the establishment of linear parkways along their courses as was the case in Minneapolis. A huge loss to the City, but in hindsight, understandable in the light of the control that businessmen and developers in that era of Boosterism exerted on the city in its early years (Artibise, 1975). Originally wooded, the coulees of many of these creeks and streams had long since been stripped of their trees leaving their banks susceptible to unsightly erosion, which would also have contributed to their disregard.

With the coulees, streams and wetlands went many of the unique qualities that characterized the landscape of the Red River Plain. There was no visionary like Olmsted to speak for those values on the prairie as he had spoken for the Fens in Boston. The plains were too raw, too new, too often seen as a blank page, or "rich prairie wastes" (Hind, 1858) upon which it was man's destiny and right to inscribe his visions of the future. With these features also went the possiblity of a unique cityscape that celebrated its surface waters - the regions most problematic issue. Gutters, stormsewers, and ditches replace the streams and coulees, stormwater retention ponds mimic the marshes, and ponding in parking lots temporarily replicates the wet meadows.

This study will address the historical evolution of land drainage in Winnipeg and the fate of its surface waters. I will seek to show that a unique prairie landscape was, and is still treated with scant regard for the nature of the land and, in the early years, with little comprehension of the region's hydraulic regime. Although the potential for an urban form responsive to the native landscapes surface waters was ignored in favor of a conduit system that necessitated a rigid and uniform urban structure, possibilities now exist for a refined approach to land drainage due to the adoption by the City of a dual drainage policy.

In undertaking this historical survey it was my intention to uncover, as far as existing records permit, the process and sequencing of the alteration of the native landscape in the development of Winnipeg from the Selkirk Settlement to the present day. No study of this nature has ever been undertaken that traces the development of land drainage in the area that became the modern day City of Winnipeg. My chief interest in this study has been the interaction of man with the hydraulic regime of the Winnipeg landscape. This study will seek to show that the "new" land drainage concepts adopted by the City out of necessity in the 1970's essentially mimic the region's original hydraulic regime. In this regard McHarg's statement that a knowledge of nature's processes is indispensable for the wise use of the land by man sheds, in hindsight, considerable light on this history.

> If one accepts the simple proposition that nature is the arena of life and that a modicum of knowledge of her processes is indispensable for survival and rather more for existence, health and delight, it is amazing how many apparently difficult problems present ready solution. Let us accept the proposition that nature is process, that it is interacting, that it responds to laws, representing values and opportunities for human use with certain limitations and even prohibitions to certain uses. (McHarg, 1969).

In just over one hundred years the City of Winnipeg has come full circle, "from pothole to pothole" (Hilderman, 1981). There were, however, significant losses with long term effects along the way. Viewed in a larger context, these losses will be seen to be much larger than merely aesthetic. In summation, stormwater design concepts for future land drainage development will be outlined. An overview of the significant drainage features of the native landscape as they exist in 1984, and their potential for rehabilitation or commemoration, is presented in conclusion.

1.2 LEVELS OF ACCURACY: THE SURFACE WATERS, 1874

In order to most accurately document the nature of the native landscape prior to 1874 and its transformation over time, I have depended entirely on primary source material, beginning with the Fidler Survey of 1816 and ending with the Manitoba Soil Survey of 1953. In assigning names to the streams I have used those ascribed to them by Sinclair, 1874. With the exception of Catfish Creek (Fidler, 1816), which is today termed Omands Creek, a search of the historical literature reveals that invariably names for the streams were derived from the owners of the lot through which they exited into the rivers. As changes in ownership occurred over time I have, for reasons of simplicity, chosen the names as of 1874.

A number of discrepancies arise from cross-referencing of the various maps during the period 1816-1888 due to the particular terms of reference of each survey. Fidler's Plan of the Settlement on Red River as it was June 1816, (Figure 3), was undertaken for Lord Selkirk and is the first extensive survey of the region that was to become Winnipeg. A number of features identified later in the century are missing from this map. Three streams that exited into the Assiniboine River west of the Forks, and three streams that exited on the east side of the Red River north of the Forks are missing. This survey was undertaken to delineate the limits of the Selkirk Settlement in detail, and the surrounding area was, therefore, treated less exactly.

The Map of Red River Settlement post 1826 with Lord Selkirk's signature and attributed to Fidler's successor George Taylor, excludes three streams exiting into the Assiniboine; includes Colony but excludes Browns and Logans (Figure 4). This may have been only an interim map because Taylor's Plan of the Red River surveyed in 1836, 37, and 38 is more complete and indicates a more thorough reconnaissance (Figure 5). Although a number of smaller streams are missing from the north side of the Assiniboine River west of the Forks this map is the most accurate of the region until the Dominion Land Surveys of 1873-74. For the first time the beheaded channel of the former Seine River appears as do all the streams exiting on the east side of the Red River north of the Forks. H.Y. Hind's Plan of the Selkirk Settlement, on the map of part of the Red River Valley, 1857, excludes Browns and Logans but indicates a creek running out of what is today Elmwood Cemetery in East Kildonan where Taylor had outlined the former channel of the Seine River (Figure 6). What are we to make of these discrepancies? They may relate in part to the limitations of the terms of reference of the surveys, they may be drafting errors or be attributable to the intermittant nature of many of the streams themselves. Hind's stream in Elmwood may have existed for some years after the great flood of 1852 as the swamp indicated by Taylor slowly drained to the Red River.

We owe the most complete information of the native landscape to the Dominion Land Surveyors Duncan Sinclair, George McPhillips, and their assistants, who undertook the River Lot Surveys of the Parishes in 1873-74. Notebooks from the survey indicate that the primary purpose of this survey was to delineate the exact boundaries of the old river lots and the boundary between those lots and the outer two miles of hay privilege abutting the new sectional survey. This was necessary to prepare for the anticipated influx of agricultural settlers into the West. No survey was undertaken of the inner portion of these lots that extended in perpendicular fashion two miles back from the Red and Assiniboine Rivers. These were private properties and the Rebellion of 1867 had been precipitated by just such an incursion. The notebooks reveal that the surveyors, in the majority of cases, walked from station-to-station along the rivers. To this we owe our knowledge of almost all outlets onto the Red, Assiniboine and Seine Rivers and our almost total lack of knowledge of the landscape inland for a distance of two miles. Thus no accurate topographical information exists about the lands in their native state, north of the Assiniboine or west of the Red River above the Forks (Figure 7).

The conjectured connection between Colony Creek at its exit west of the Hudson's Bay lands and Colony Creek as it passed through Township II, Range 2R, Section 14 S.E. 1/4 just north of the Parish of St. James rests on the serpentine configuration just south of the boundary between the River lots and the Outer Two Miles (Figure 8). Such a serpentine line appears nowhere else on the River Lot Survey Maps of 1874. The hypothesis that this is in fact the underfit bed of Colony Creek is supported by testimony of Joseph Doupe D.L.S. before the Winnipeg City Council May 27, 1878. No certified graphic representation of the complete path of Colony Creek exists today, if indeed it ever did. However, Fidler (1817) indicates an extensive zone of willows, a diagnostic tree of streams and drainage runways, in the path that Colony Creek would, presumably, have taken as it drained towards the Assiniboine River (Figure 3).

The River Lot Survey Notebooks vary greatly in level of detail. McPhillips' Notebook No. 543 is clearly the work of a meticulous craftsman and to it we owe our detailed information of the Oxbow of the Red which contained Goulets Drain, one of the early alterations of the drainage pattern (Figure 9). This survey also records the impoundment and re-channelling of Inksters Creek by John Inkster (Figures 10, 11, 12).

Sinclair's Plan of River lots in the Parishes of St. John, St. James, and St. Boniface (1874) prepared from these Survey Notebooks, omits Browns and Logans Creeks. This may relate to the dry years of the early 1870's or to the superimposition of the street layout of John D. Parr's Plan of the City of Winnipeg 1874 (Figure 8). Both creeks appear prominently on Parr's Plan 1874 and George McPhillips' Map of the City of Winnipeg 1877. A scaling from these two plans indicate the coulees of the two streams to have been between 50 and 75' wide so they would have been hard to miss. H. N. Ruttan's Survey of the Assiniboine River from Armstrongs Point to Headingly, completed in 1888, provided a further level of detail on the relationship between marshlands, coulees and streams.

Concerning the alterations to the landscape's drainage regime after 1880 there are many gaps. In the case of land drainage ditches there is only one extant map published by J. F. Ruttan and Co. in 1883 although a number of ditches appear in the Survey Notebooks (Figures 13 and 14). A number of ditches, some specified as Government Drains, others labelled only drains, appear on this map. From the location of these drains, marshlands and standing water problems can be inferred for specific areas. As regards the original City of Winnipeg Sewer System of T. H. Parr and E. S. Chesbrough, there are only two maps extant. A map of the sewers 1885, superimposed on George McPhillips' Map of the City 1881, indicating the original layout of the system resides, uncatalogued, in a barrel in the Archives of the City of Winnipeg, along with both H. N. Ruttan's exquisitely rendered Plan of the Assiniboine River 1888, and the original Map of Sewer Districts (circa 1885) as laid out by T. H. Parr and E. S. Chesbrough. A map of the sewer districts and outlets superimposed on McPhillips' Map of Winnipeg 1905 is to be found in the Archives of the Province of Manitoba. No exact date exists for the latter although it represents the system as completed by approximately 1914. Such maps were, presumably, updated periodically and the earlier versions discarded. This appears also to be the case with the Manitoba Department of Natural Resources, Water Resources Branch, who have no records of drainage works earlier than the 1950's. During the course of this century Provincial Water Resources have been under the jurisdiction of a number of different departments which may account for the lack of material on the historical progression of land drainage. The fact that the area that is now termed Winnipeg existed as separate municipalities or cities until amalgamation in 1970 can also be cited for the loss of records.

The Reconnaissance Soil Survey of Winnipeg Map Sheet Area 1953 yields only general information about the region now lying within the Perimeter Highway due to the extent of urban development existing at the time of the survey. Within that constraint, the areas of hydromorphic soils are outlined enabling a general picture of the areas subject to regular ponding (Figure 15).

The City of Winnipeg Survey Department undertook topographical surveys of the inner City as early as 1914. One early example, updated to 1948 and drawn to one foot contour intervals, exists which gives a clear picture of the original subtle ridge and swale topography which still exists in the City despite extensive grading (Figure 16).

The 1927 air photographs have an indexing system that is virtually indecipherable, making it extremely difficult to trace alterations to the drainage regime. The City of Winnipeg's file of these photographs has been looted over the years, making it impossible to spot check many specific areas. Nevertheless traces of many of the original streams were observable in the photographs studied.

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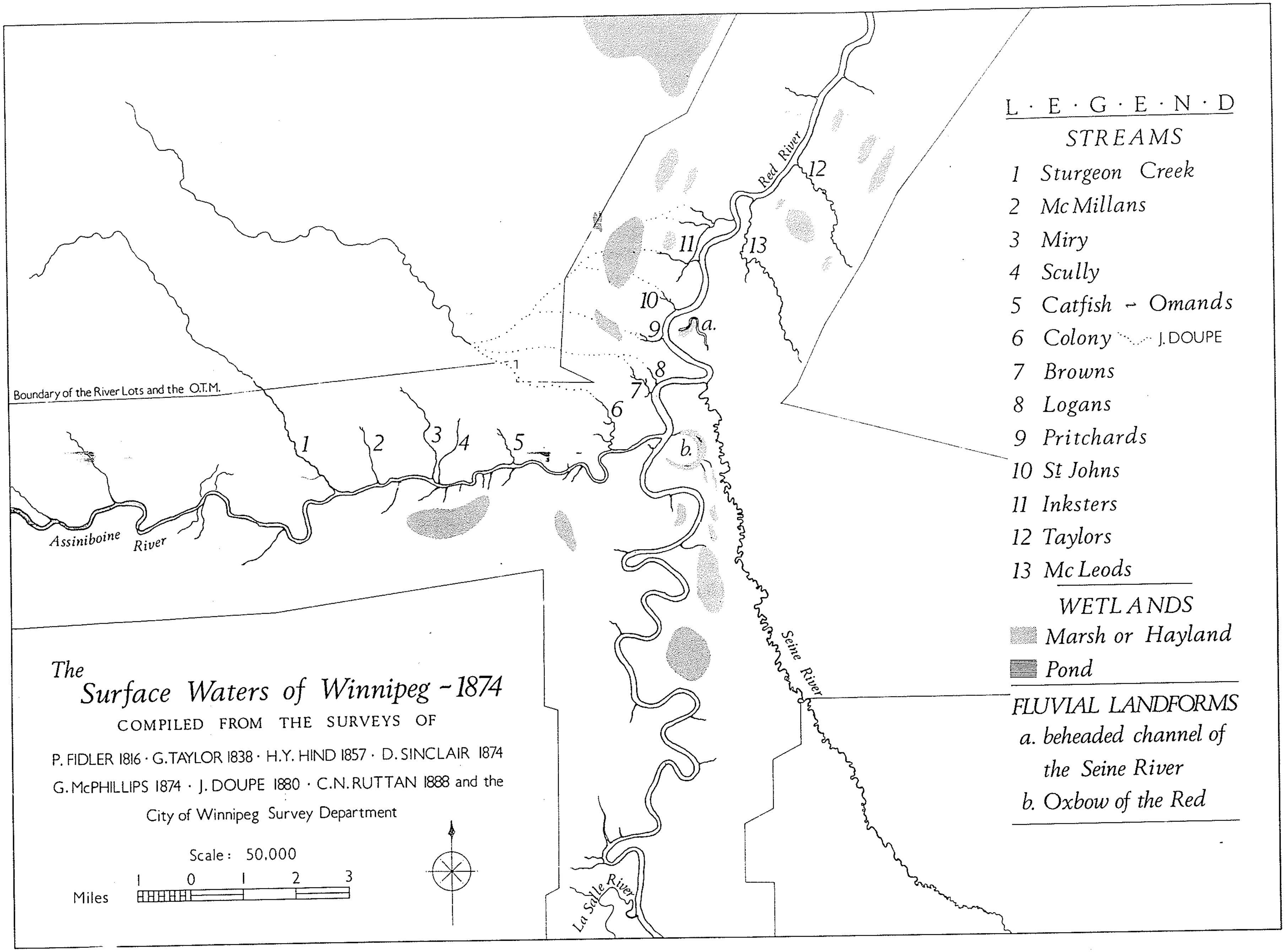

L·E·G·E·N·D
STREAMS
1 Sturgeon Creek
2 McMillans
3 Miry
4 Scully
5 Catfish - Omands
6 Colony J. DOUPE
7 Browns
8 Logans
9 Pritchards
10 St Johns
11 Inksters
12 Taylors
13 Mc Leods
WETLANDS
Marsh or Hayland
Pond
FLUVIAL LANDFORMS
a. beheaded channel of the Seine River
b. Oxbow of the Red
Red River
Seine River
La Salle River
Assiniboine River
Boundary of the River Lots and the O.T.M.
The Surface Waters of Winnipeg - 1874
COMPILED FROM THE SURVEYS OF
P. FIDLER 1816 · G.TAYLOR 1838 · H.Y. HIND 1857 · D. SINCLAIR 1874
G. McPHILLIPS 1874 · J. DOUPE 1880 · C.N. RUTTAN 1888 and the
City of Winnipeg Survey Department
Scale: 50,000
Miles
1 0 1 2 3

Figure 1

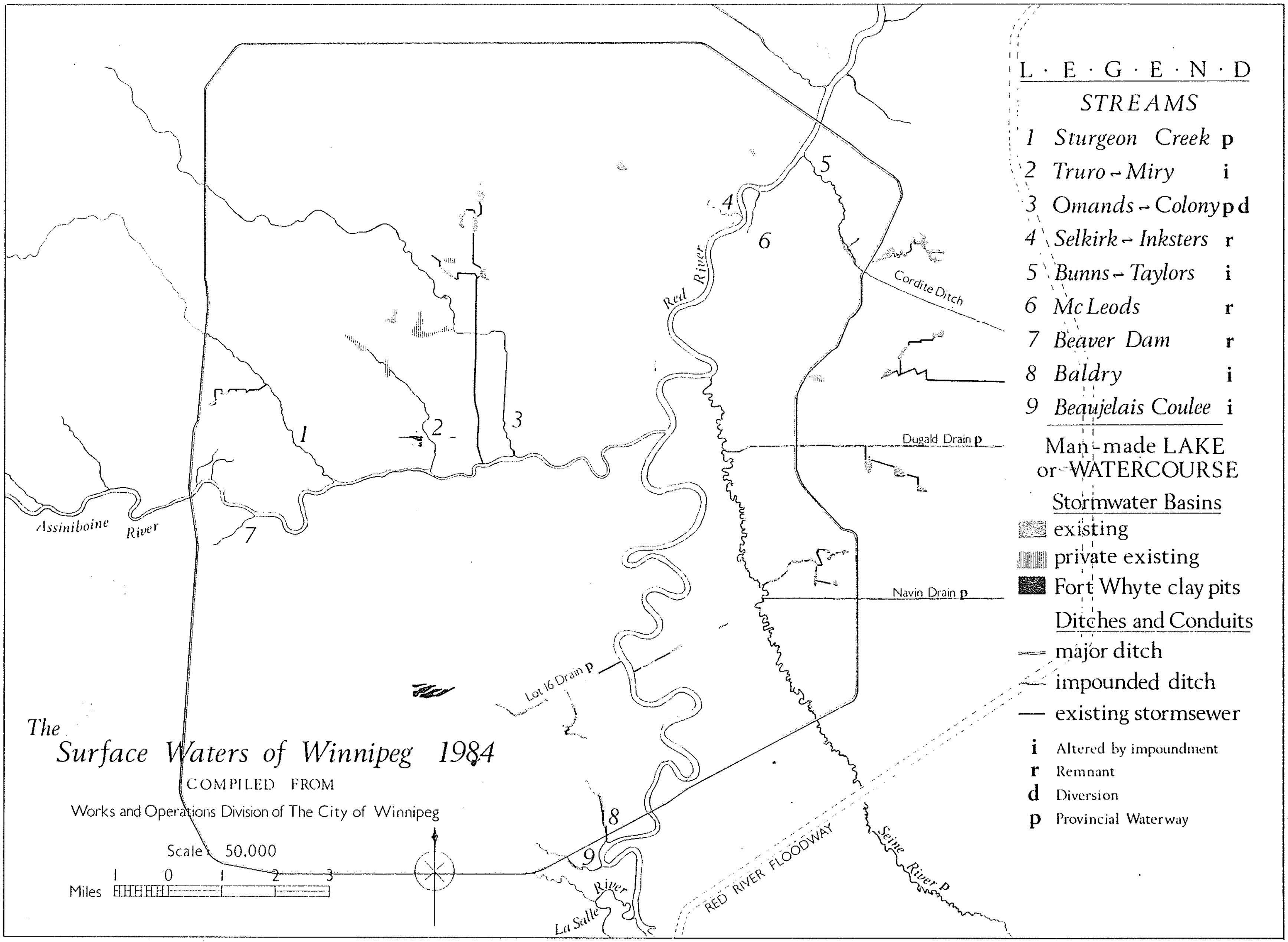

L · E · G · E · N · D
STREAMS
1 Sturgeon Creek p
2 Truro – Miry i
3 Omands – Colony p d
4 Selkirk – Inksters r
5 Bunns – Taylors i
6 McLeods r
7 Beaver Dam r
8 Baldry i
9 Beaujelais Coulee i
Man-made LAKE or WATERCOURSE
Stormwater Basins
existing
private existing
Fort Whyte clay pits
Ditches and Conduits
major ditch
impounded ditch
existing stormsewer
i Altered by impoundment
r Remnant
d Diversion
p Provincial Waterway
The Surface Waters of Winnipeg 1984
COMPILED FROM
Works and Operations Division of The City of Winnipeg
Scale 1: 50,000
Miles
Assiniboine River
Red River
Cordite Ditch
Dugald Drain p
Navin Drain p
Lot 16 Drain p
La Salle River
RED RIVER FLOODWAY
Seine River p

Figure 2

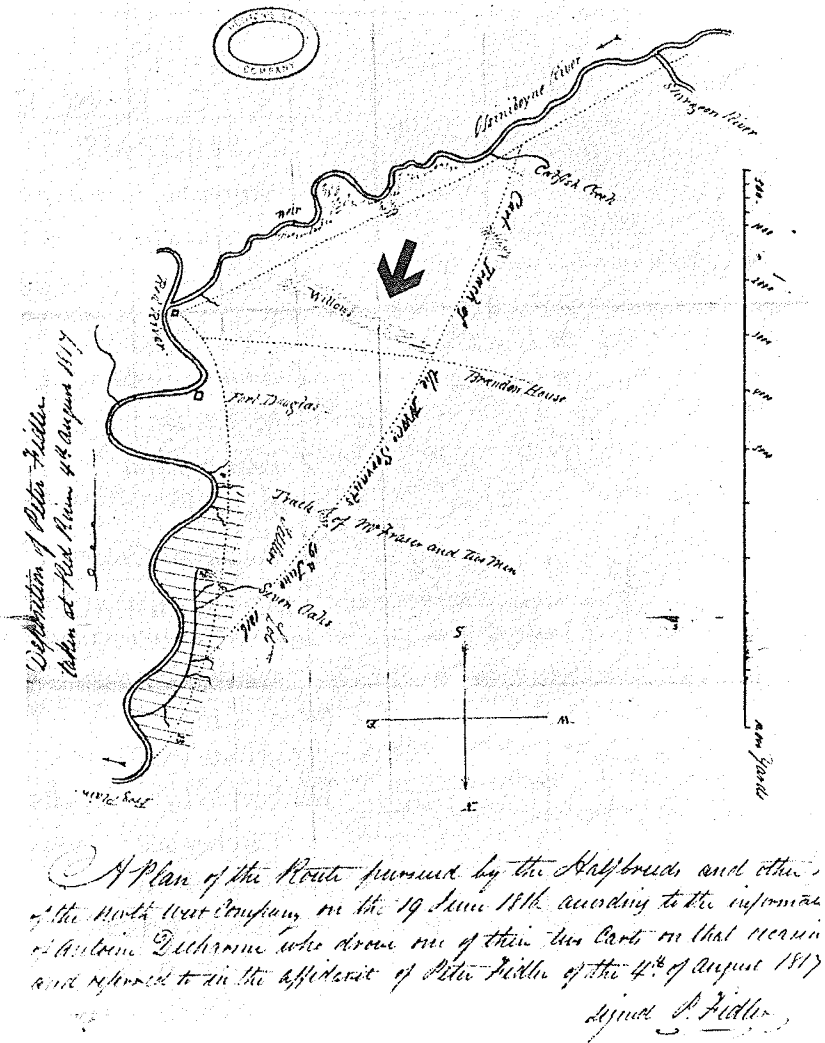


Figure 3 HBC Archives PAM

A Plan of the Route pursued by the half breeds and other servants of the North West Company on 19 June, 1816, by Peter Fidler. Note the zone of willows lying in the region of Colony Creek's drainage runways.

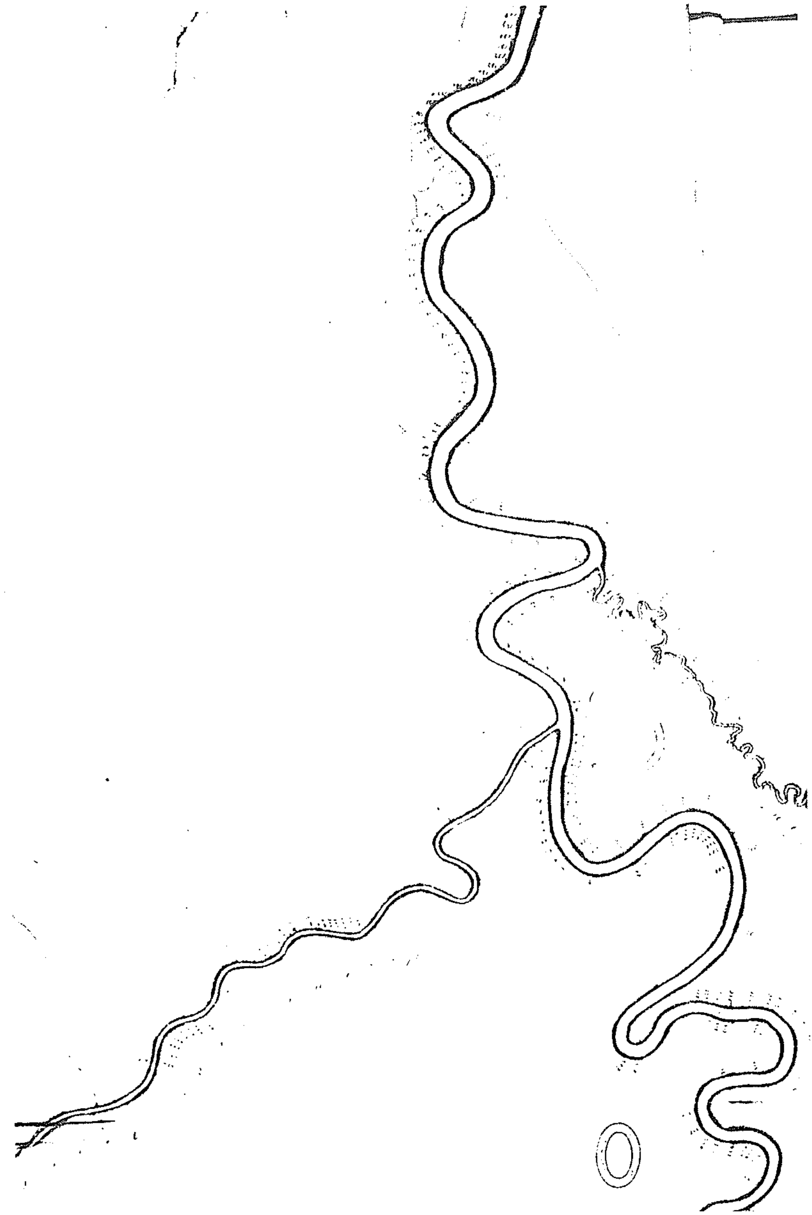


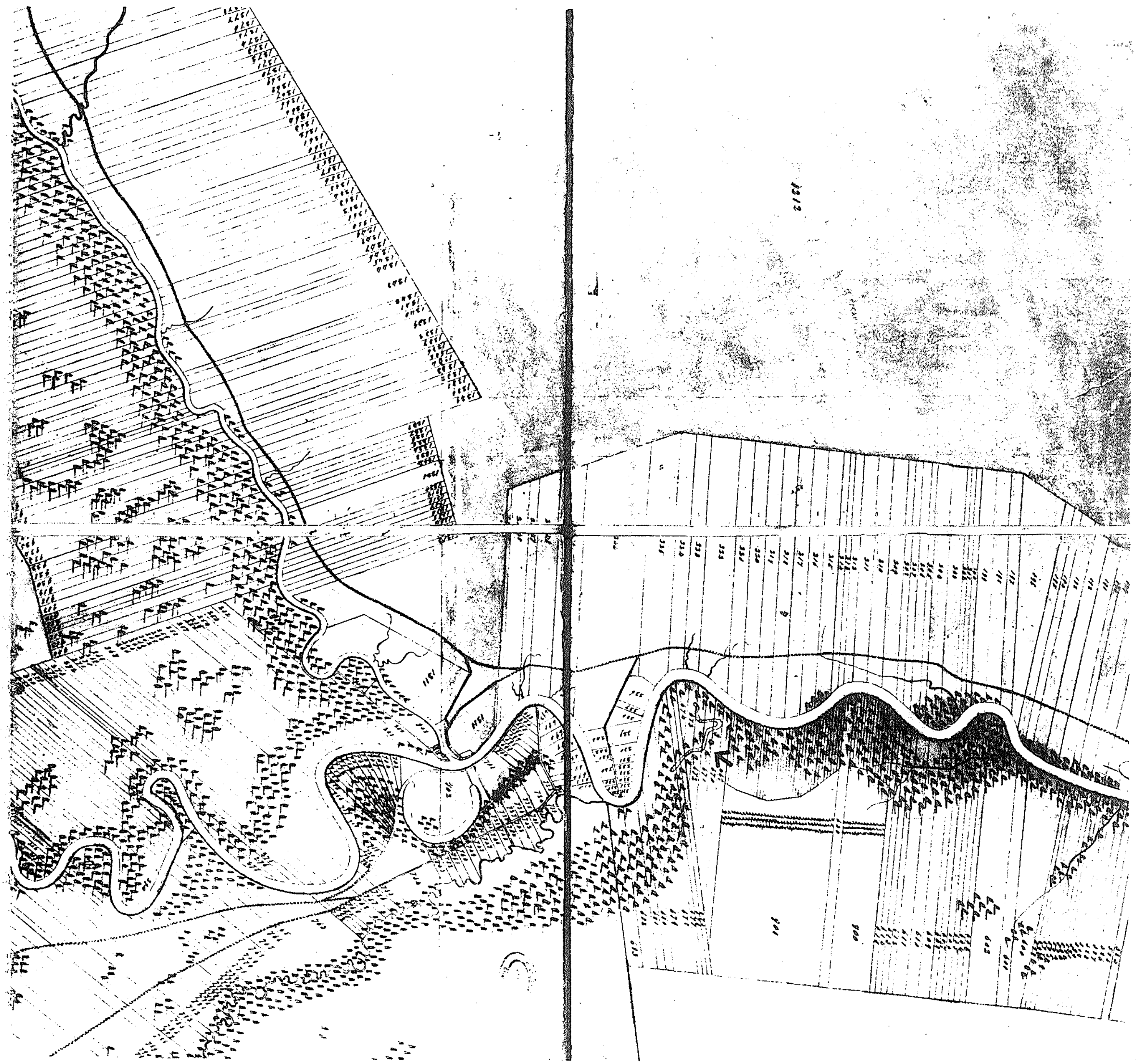
Figure 4 HBC Archives PAM

Portion of Map of Red River Settlement, signed by Lord Selkirk (attributed to George Taylor). Note the absence of Browns and Logans Creeks.

Figure 5

HBC Archives PAM

Portion of Plan of Red River Colony, surveyed in 1836, 37 & 38 by George Taylor. This is the most complete map of the water features until the Dominion Land Surveys 1873-75. Note the beheaded reach of the Seine River.



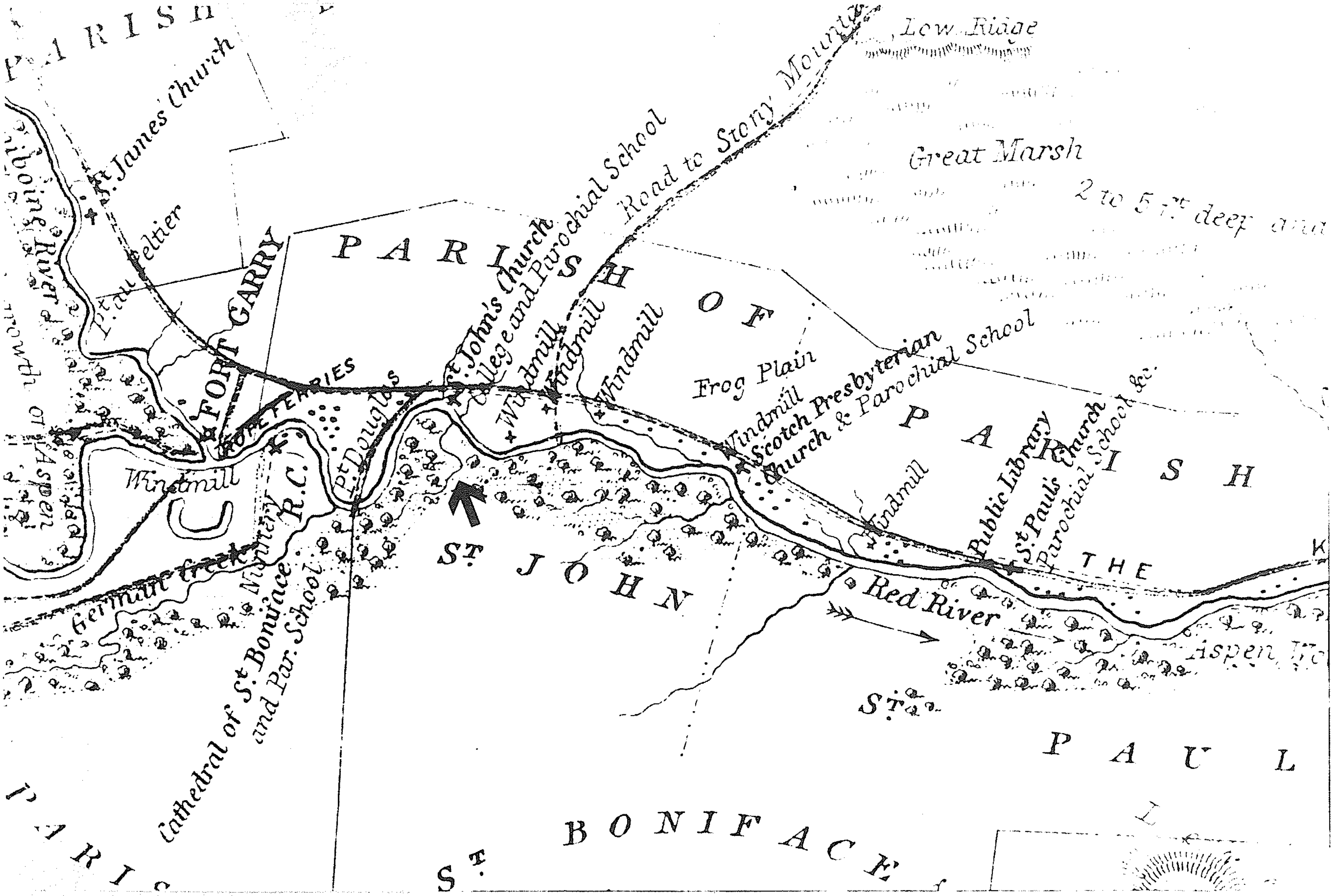


Figure 6
Portion of Plan of Selkirk Settlement, 1857 prepared for Report on the Exploration of the Country Between Lake Superior and the Red River Settlement, 1858. Note the stream exiting in what is today the West Elmwood district in East Kildonan. This stream (possibly the beheaded Seine) may have existed after the wet years of the late 1850's.

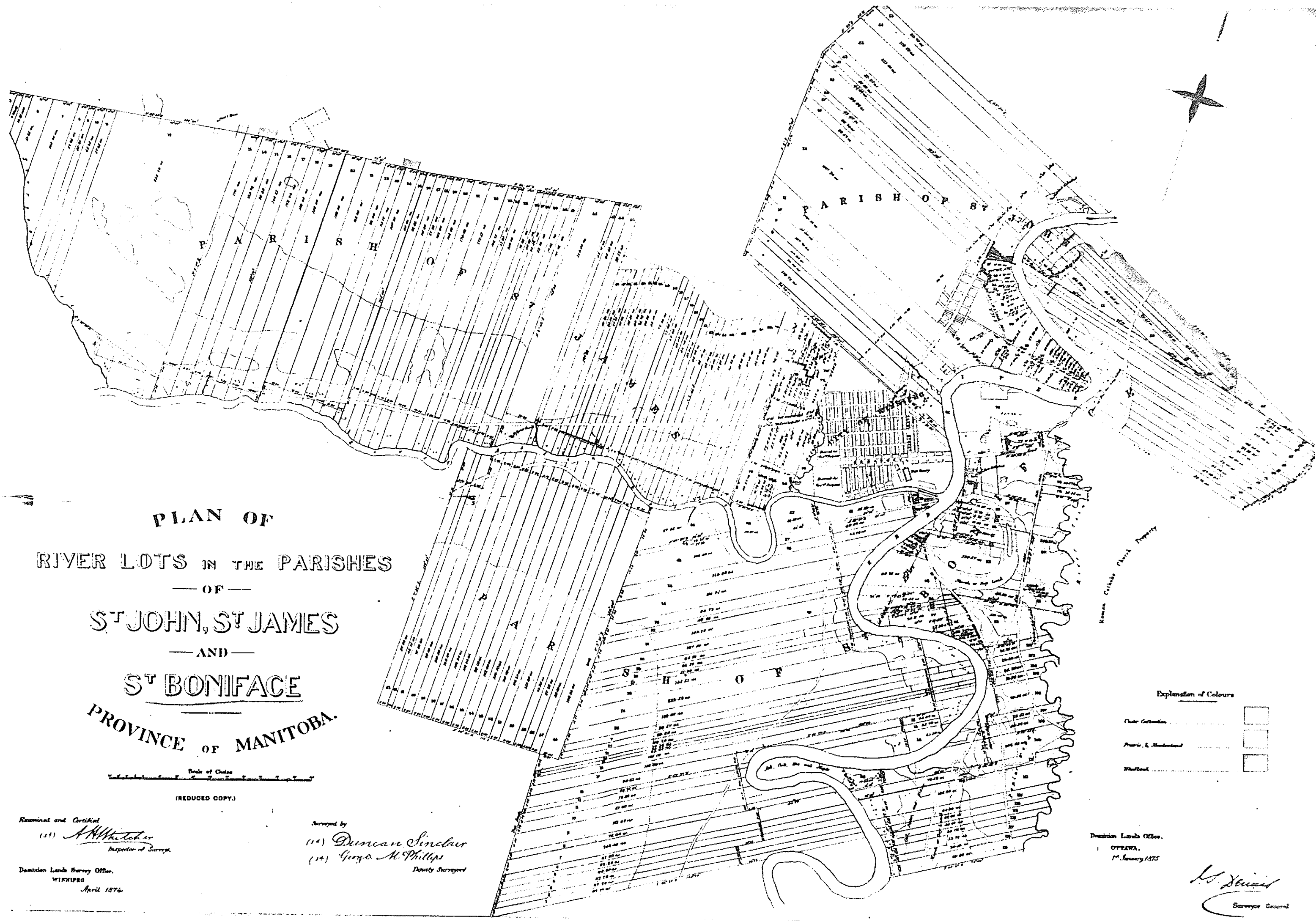
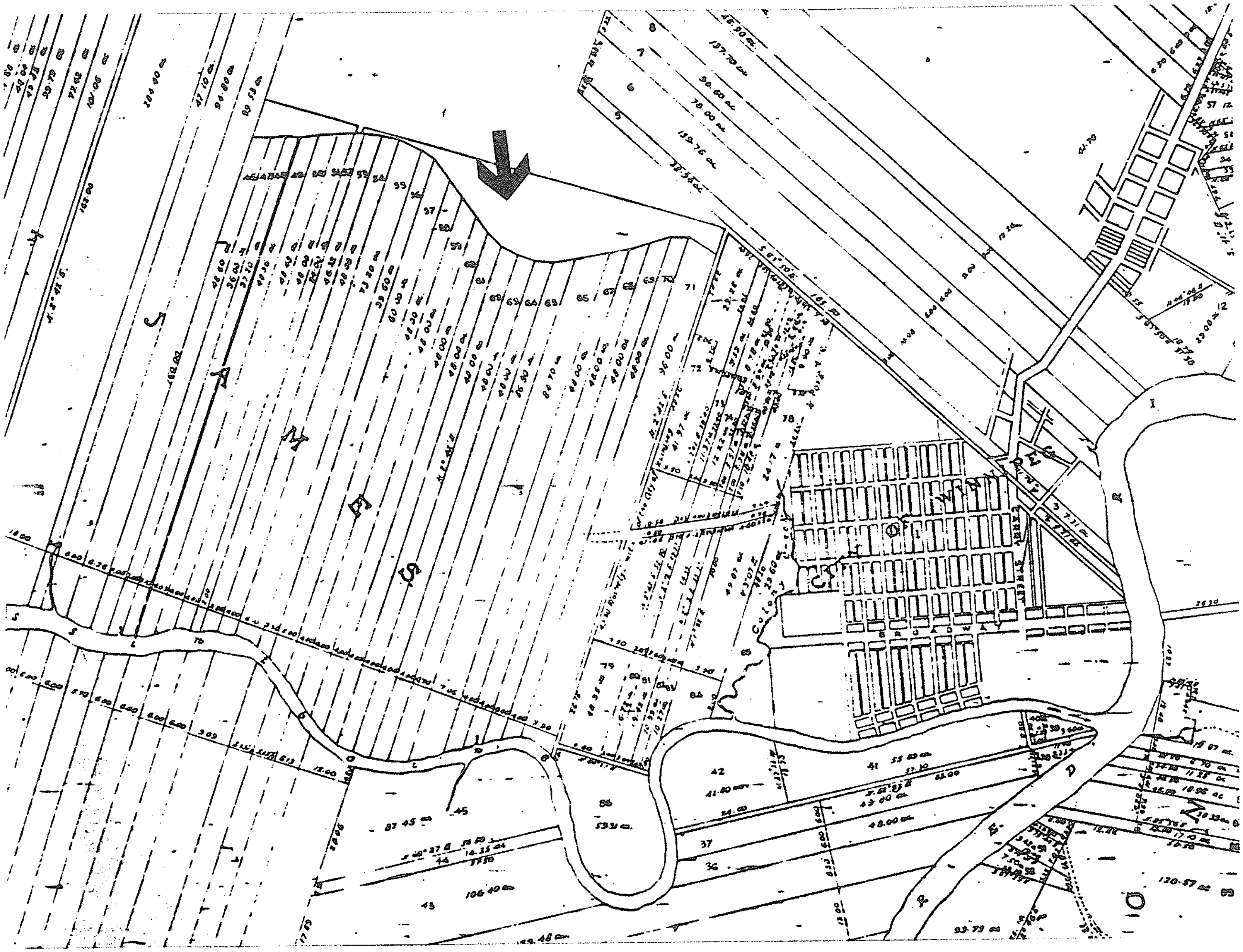


Figure 7

PAM

Note the absence of Browns and Logans Creeks in this plan, which is possibly due to the superimposition of Parr's Plan of the City of Winnipeg, 1874. The absence of Colony Creek northwest of the city can be attributed to the fact that this survey was undertaken to ascertain river lot boundaries and the boundary between the O.T.M. and the new sectional survey. Thus little information exists of the nature of the landscape within the inner two miles.



PAM

Figure 8
Detail of Sinclair's Plan of River Lots (Figure 7). Note the serpentine line in the vicinity of the drainage runway of Colony Creek and the stepped configuration of lots above the coulee of the creek proper. Such a serpentine line appears nowhere else among the many River Lot Plans nor does such a stepped configuration. This is probably due to the intermittent waters of Colony Creek.

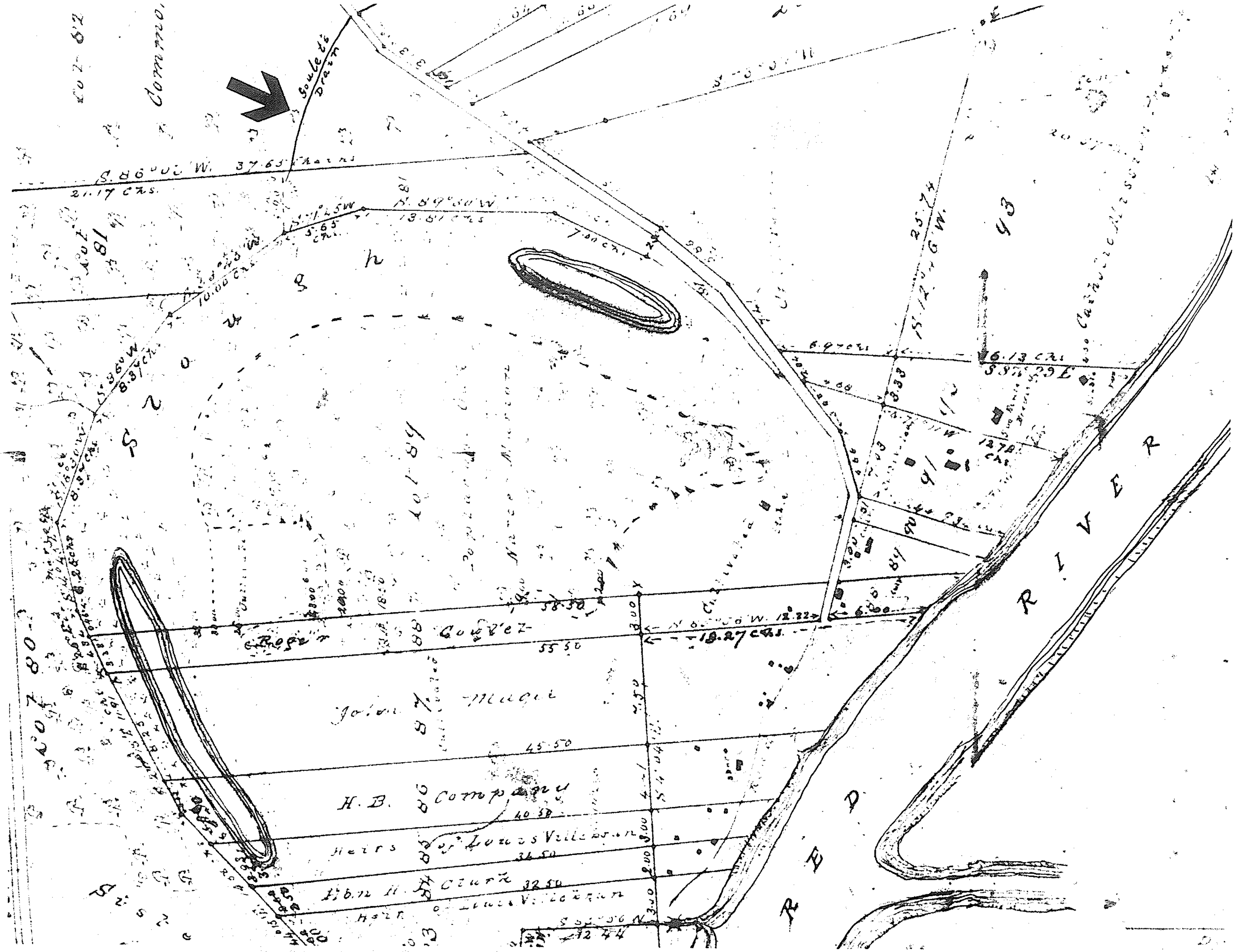


Figure 9 PAM

The Oxbow of the Red, surveyed by George McPhillips. Note Goulets Drain in the upper left hand corner. This ditch was one of the early alterations, for agricultural purposes, of the marshlands in St. Boniface.

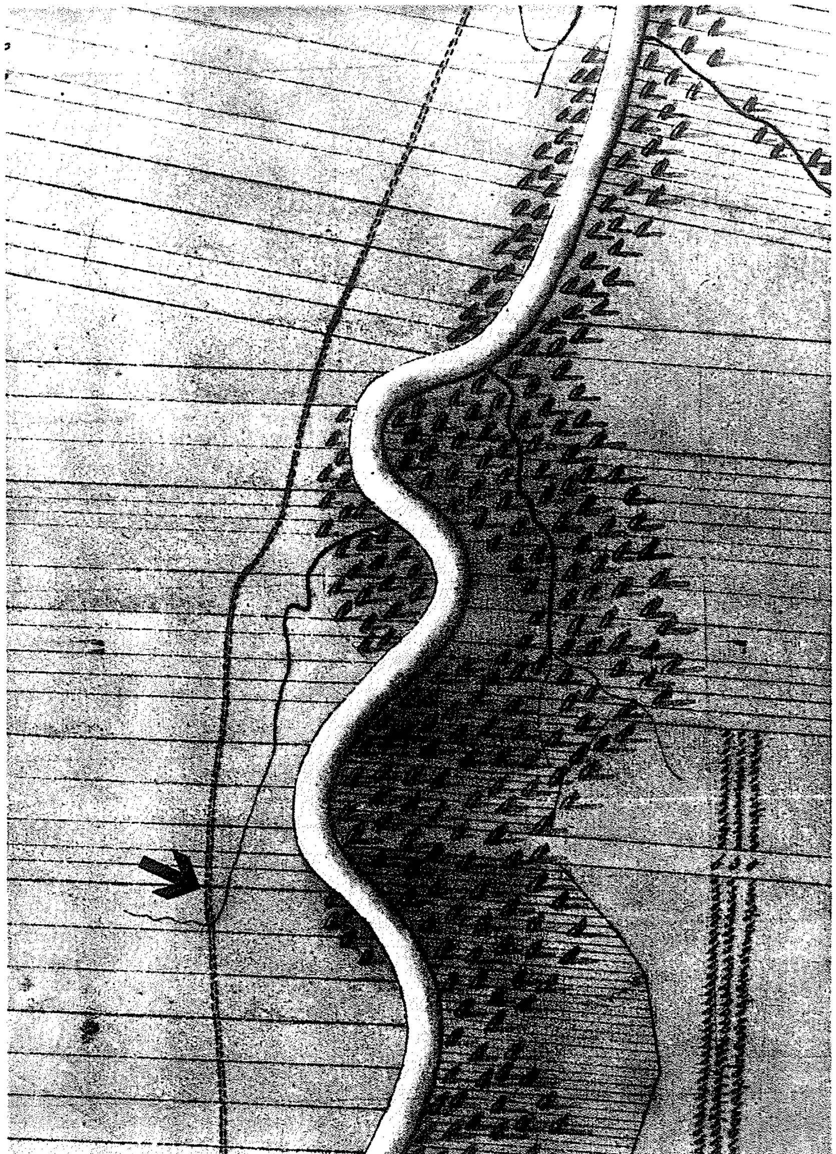


Figure 10 HBC Archives, PAM
Seven Oaks or Inksters Creek in the Parish of Kildonan (Detail Figure 5, George Taylor, 1838). This was the original configuration of Inksters Creek and tallies with Fidler's plan, 1817.

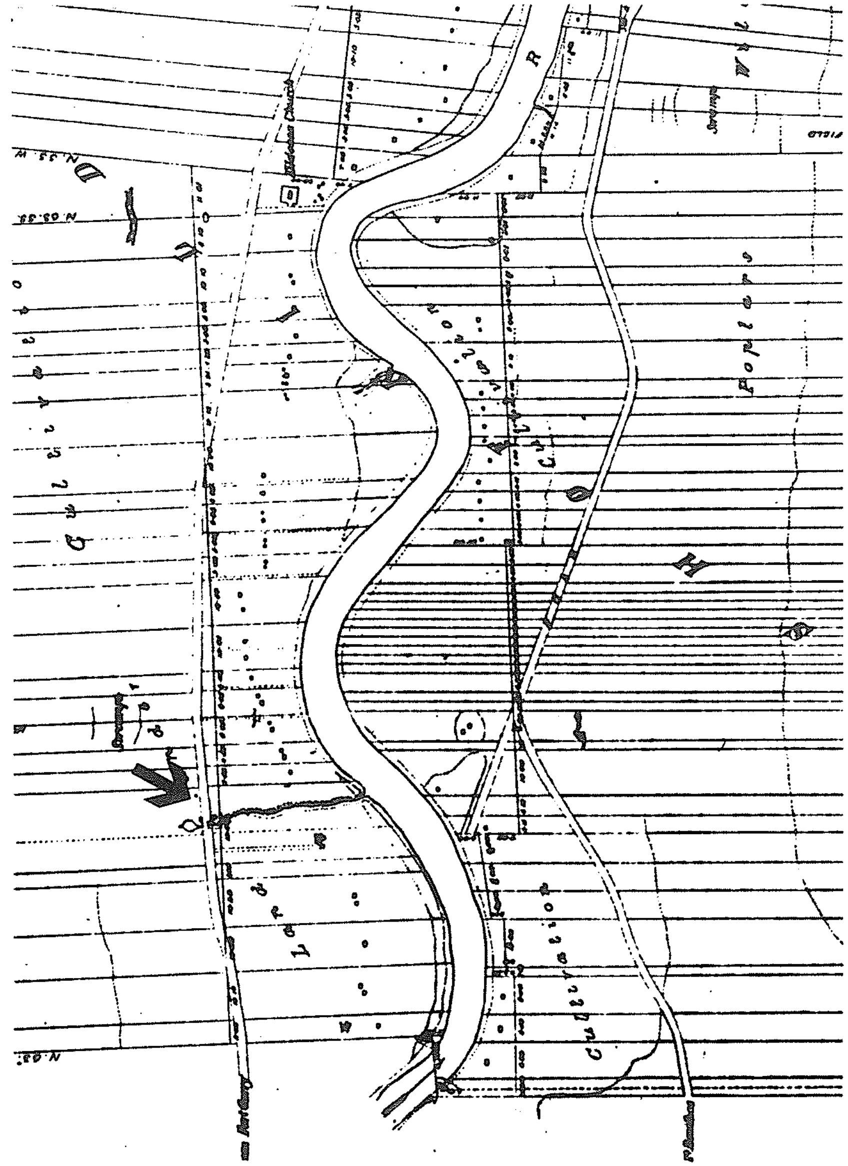


Figure 11 PAM
John Inkster's Mill Pond and Flume (Detail of Plan of River Lots in the Parish of Kildonan and St. Pauls). This mill pond existed in the region of the present day Seven Oaks monument and the flume to the Red River, was one of the earliest diversions.

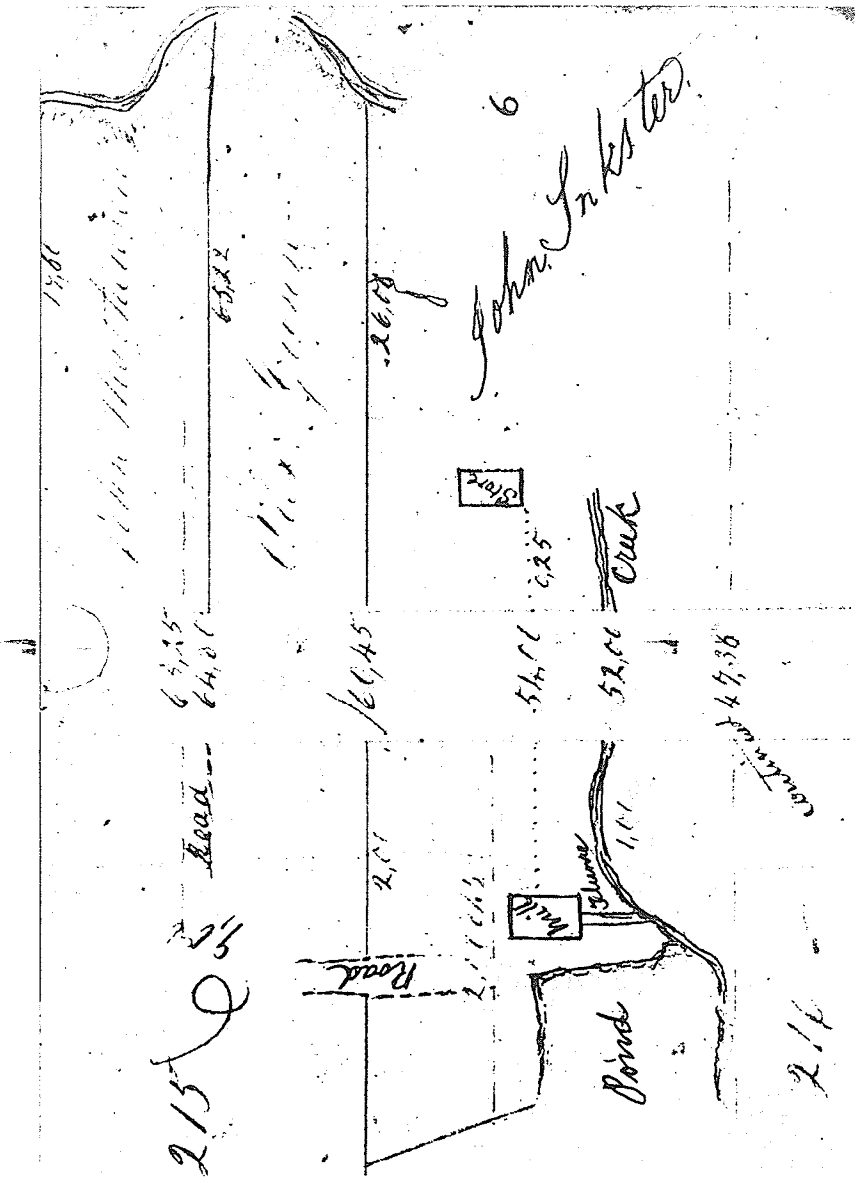


Figure 12 PAM
John Inskter's Mill Pond and Flume, page 139, Survey Notebook No. 535. The mill pond was fed by waters from the northwest. The Red River is at the top of this plan.

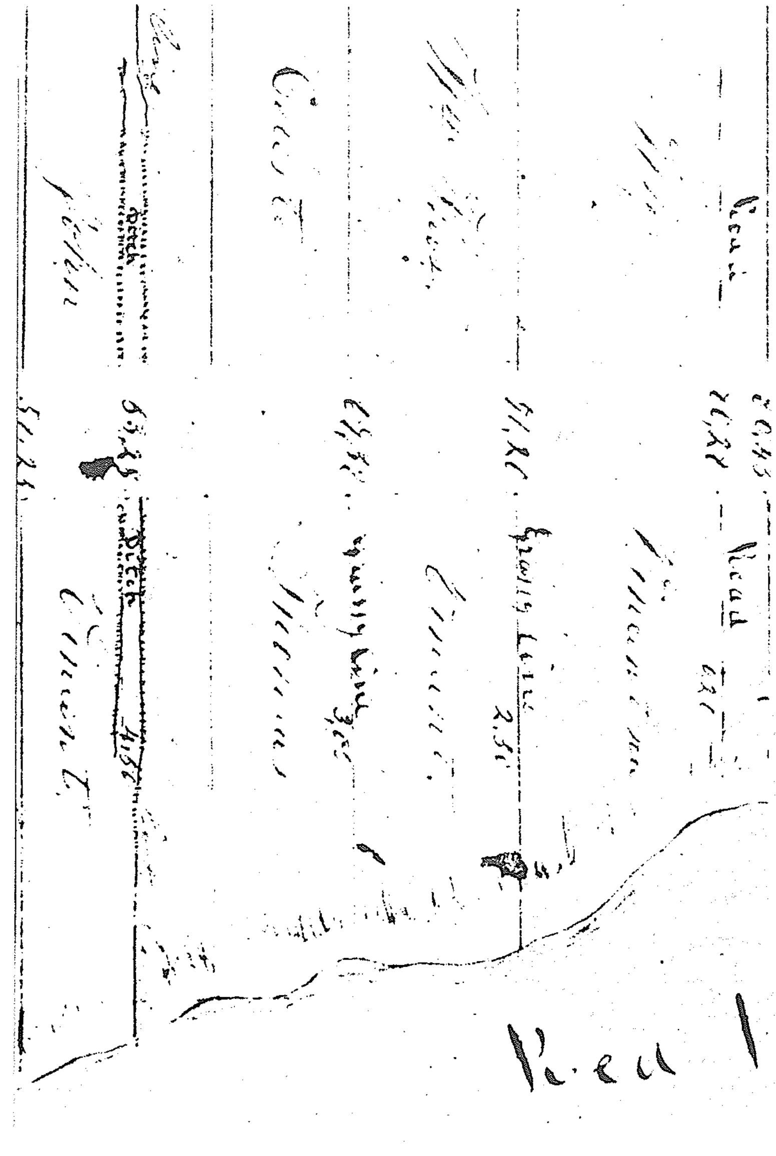


Figure 13 PAM
Early agricultural drain, page 152, Survey Notebook No. 535. This ditch in the Parish of St. Pauls, indicates that by 1873 agricultural drainage was already in existence. The ditch may have connected with an existing coulee which was common practice.

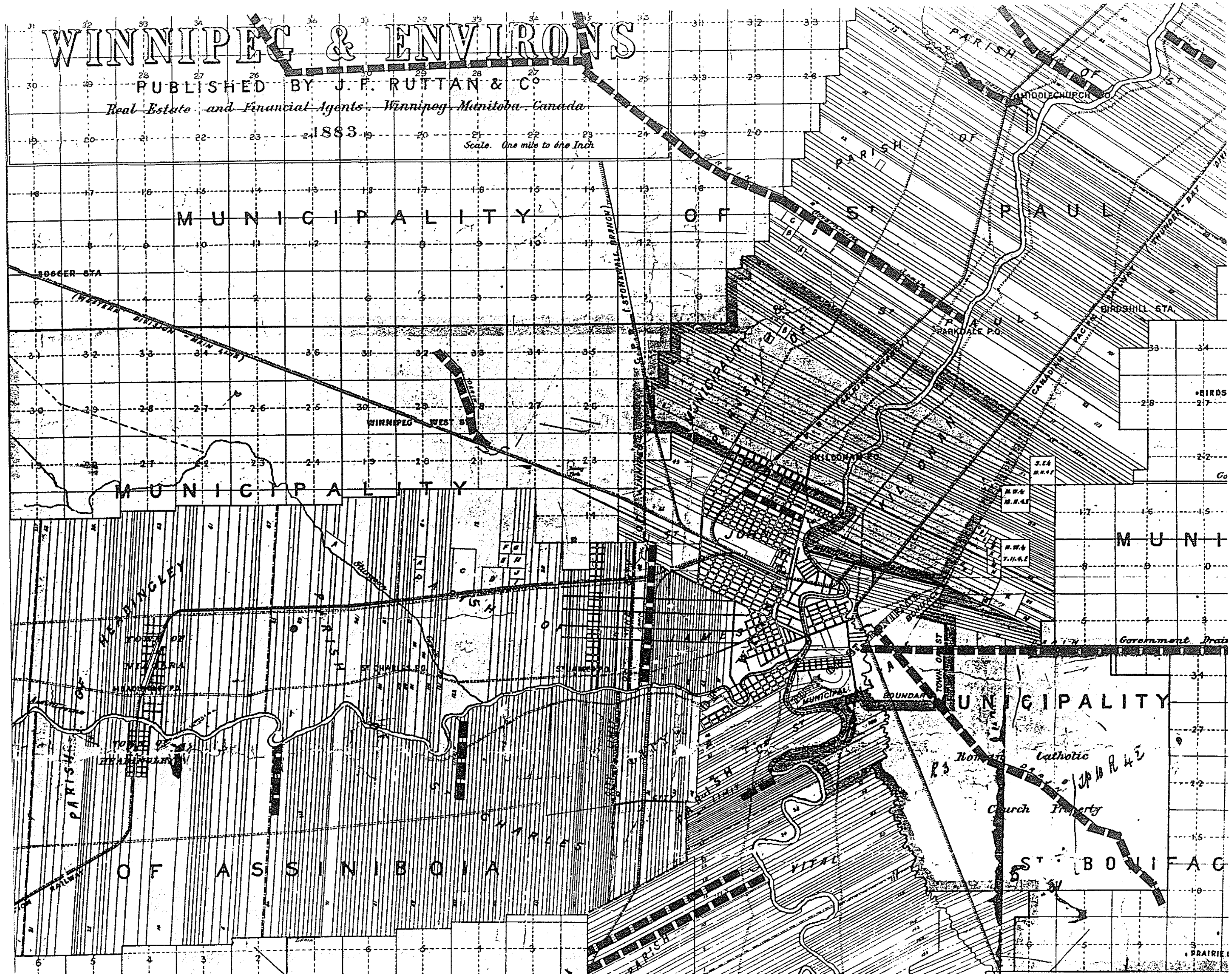


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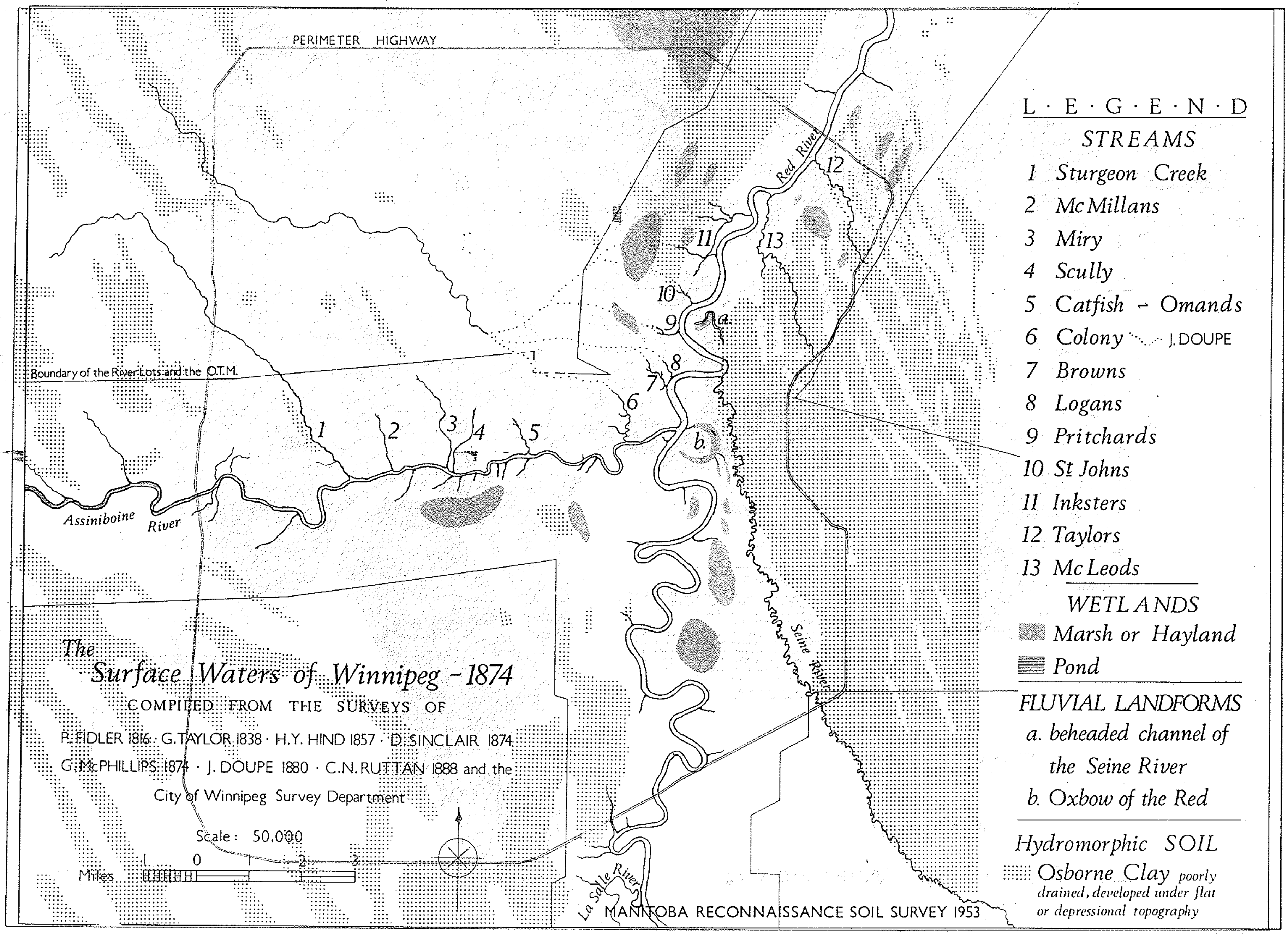
Figure 14 The superimposed dotted lines mark drains indicated on the colored original by red lines.


PERIMETER HIGHWAY
L · E · G · E · N · D
STREAMS
1 Sturgeon Creek
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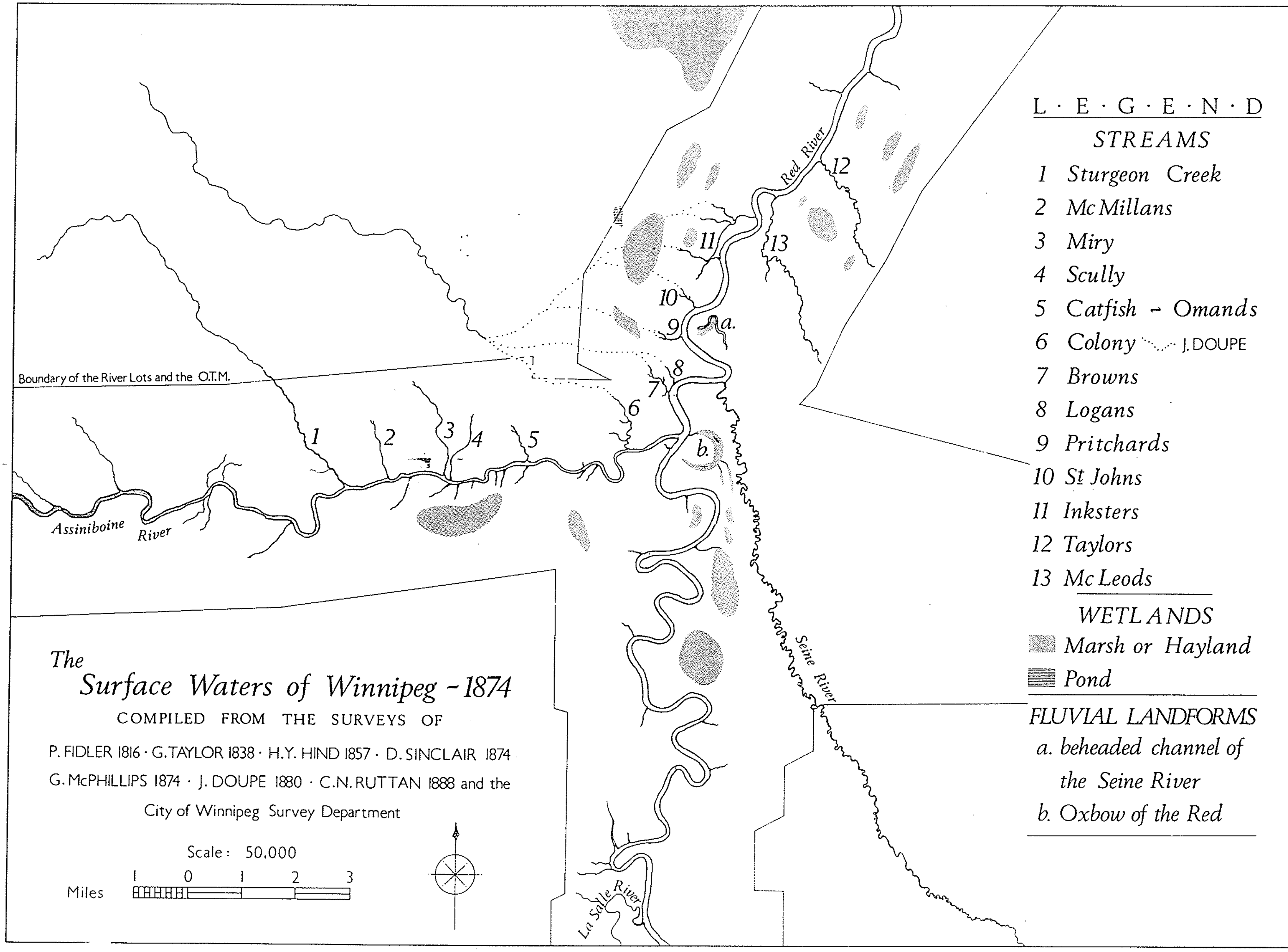
11 Inksters
12 Taylors
13 McLeods
WETLANDS
Marsh or Hayland
Pond
FLUVIAL LANDFORMS
a. beheaded channel of the Seine River
b. Oxbow of the Red
Hydromorphic SOIL
Osborne Clay poorly drained, developed under flat or depressional topography
Red River
Seine River
La Salle River
Assiniboine River
Boundary of the River Lots and the O.T.M.
The Surface Waters of Winnipeg – 1874
COMPILED FROM THE SURVEYS OF
P. FIDLER 1816 · G. TAYLOR 1838 · H.Y. HIND 1857 · D. SINCLAIR 1874
G. McPHILLIPS 1874 · J. DOUPE 1880 · C.N. RUTTAN 1888 and the
City of Winnipeg Survey Department
Scale: 50,000
Miles
MANITOBA RECONNAISSANCE SOIL SURVEY 1953

Figure 15


L · E · G · E · N · D
STREAMS
1 Sturgeon Creek
2 McMillans
3 Miry
4 Scully
5 Catfish - Omands
6 Colony J. DOUPE
7 Browns
8 Logans
9 Pritchards
10 St Johns
11 Inksters
12 Taylors
13 McLeods
WETLANDS
Marsh or Hayland
Pond
FLUVIAL LANDFORMS
a. beheaded channel of the Seine River
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Red River
Seine River
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City of Winnipeg Survey Department
Scale: 50,000
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1 0 1 2 3

Figure 15

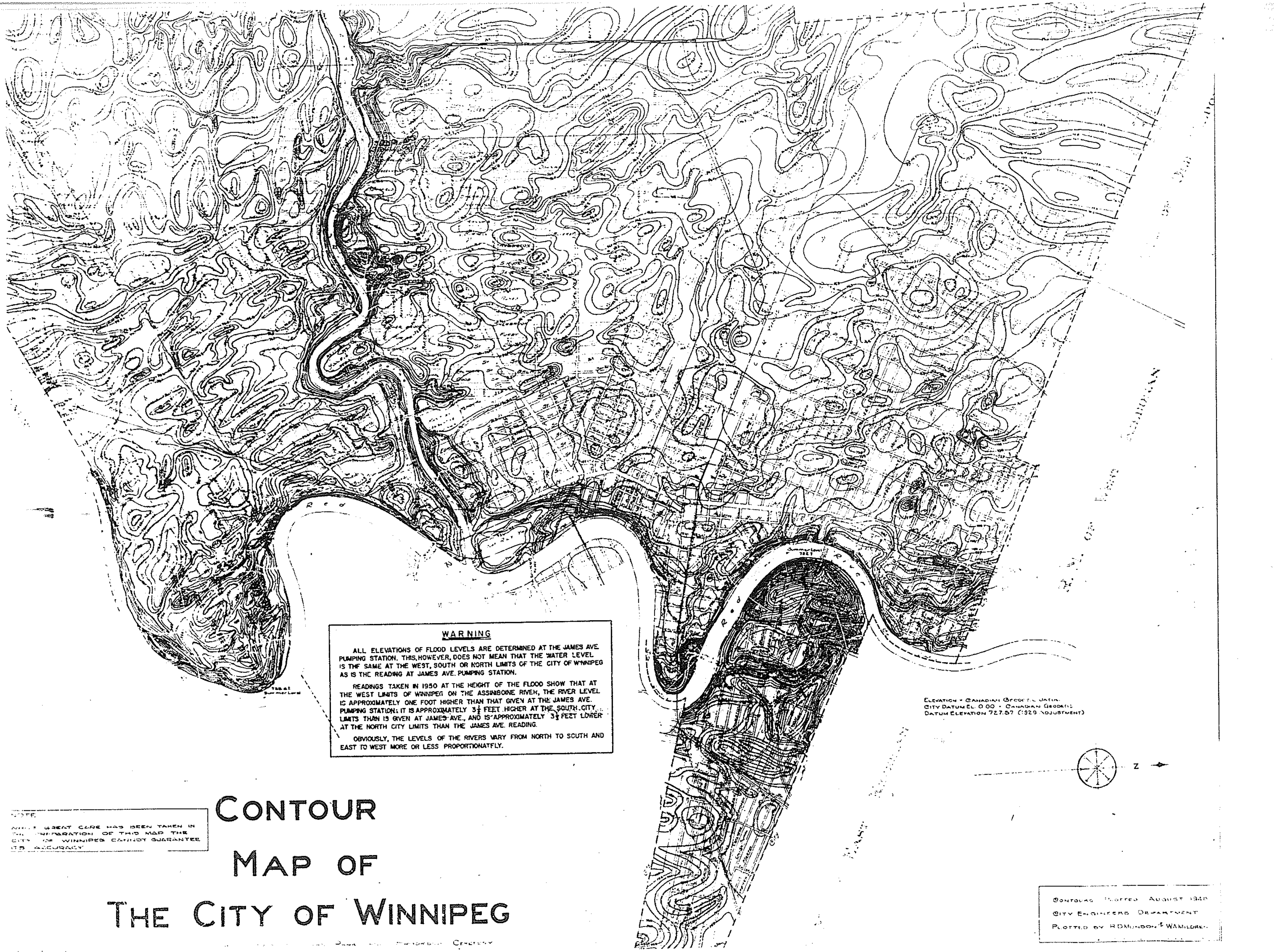


Figure 16

The base map, dating from the turn of the century, was updated in 1948. Note the subtle ridge and swale topography, still existing after extensive grading. The grain of the land runs northwest and southeast and is attributed to the recession of Lake Agassiz.

Chapter 2

THE NATIVE AND THE URBAN LANDSCAPE

2.1 INTRODUCTION

Historically, with few exceptions, in Europe and from the period of earliest settlement in North America, storm water management has been directed to removing precipitation and standing waters away from habited areas to the receiving body, ocean, lake or stream, as quickly as possible. In short, the rate and amount of runoff has been intentionally increased and magnified. To that end, streams have been re-channelled, straightened, lined or filled in, and converted to storm sewers. Since the natural easement of flow, of whatever degree, can only be denied with great effort, expensive stormwater conduit systems have resulted around the world. The detrimental effects of this conversion include increased peak flows, flooding, erosion, pollution and great economic expense, not to mention the loss of unique landscapes.

Seventy percent of the population of Canada now lives in urban areas. The result of this continuing process of urbanization is that drainage problems in newly developed and in older existing areas have been intensified. The stormwater drainage systems of the older Canadian cities, Halifax, Toronto, Montreal, Vancouver and Calgary all originated as combined sewer systems; conduits conveying both surface runoff and waste waters. Winnipeg is no exception to this general pattern and although its local flooding problems historically have been at times extreme, this problem is not common to Winnipeg alone. The problem has been exacerbated by the poorly drained clay plain upon which the City has grown and certain irrevocable engineering design decisions.

What is unique about the issue of land drainage in Winnipeg is that the current North American trend towards the use of temporary storage of stormwaters, adopted by the City of Winnipeg, replicates to a surprising degree, the hydrologic regime of the pre-settlement landscape. This landscape can be classified as the northern most extent of the Wet or True Prairie and was characterized by extensive marshes and periodic wetlands which were, in spring and wet seasons, drained by intermittant and immature streams. Thus temporary storage was provided in depressions and by the characteristically serpentine prairie streams and coulees which stored water due to bends, the frictional effects of vegetation and low gradients. Temporary storage in the present day is provided by man-made lakes slowly drained by conduit to a receiving stream, by maintaining natural stream conditions whenever possible, and allowing ponding on rooftops, in parking lots and in swales.

2.2 THE NATIVE LANDSCAPE

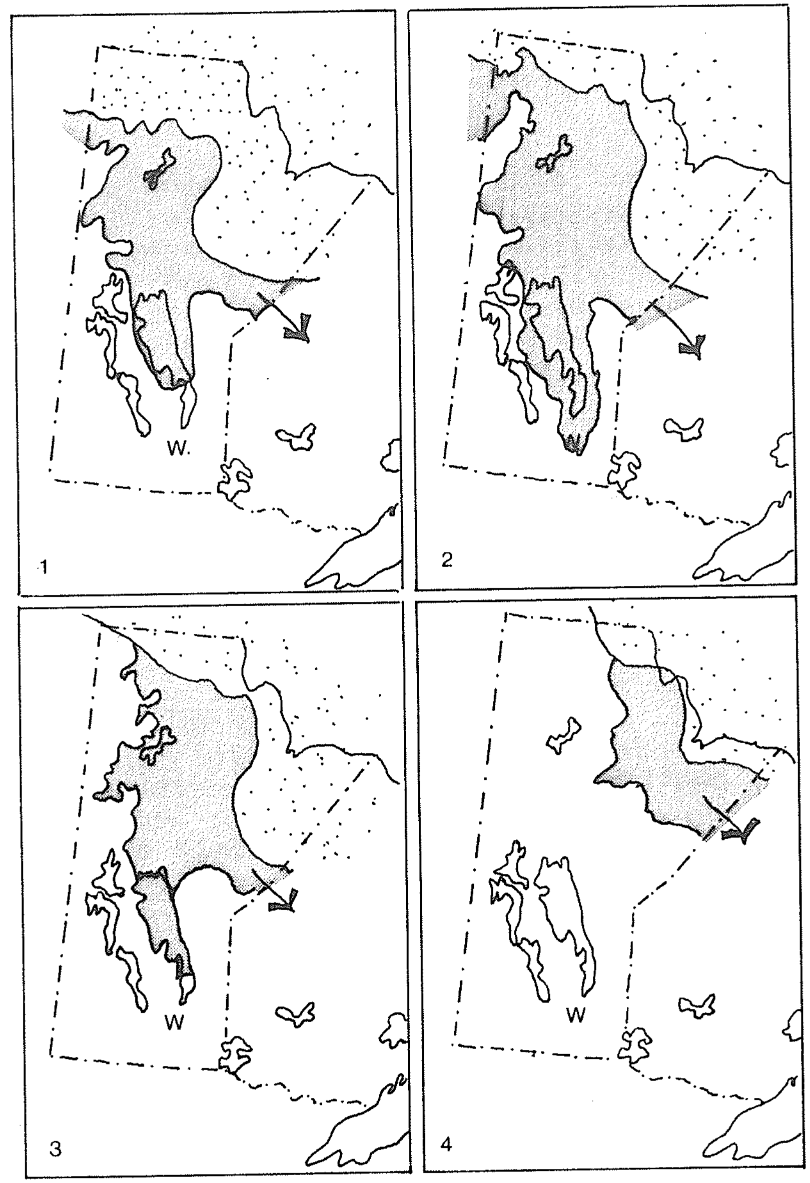
2.2.1 PRECIPITATION, RUNOFF AND TIME

In the transition from the native to an urban landscape the critical factor has been the alteration of the rate of runoff - the amount of time that elapses before stormwaters, draining overland, reach a collection point. In the native as in the urban landscape, runoff or streamflow is determined by the amount of rainfall excess. In the native landscape, rainfall excess is determined by climatic factors, the rate and intensity of precipitation, the infiltration capacity of soils, and the amount of surface storage allowed by topography (Morisawa, 1963). While the same is true of the urban landscape, the degree to which these factors, exclusive of climate, have been altered by man is critical to the rate of runoff and thus the design of land drainage systems. This chapter will discuss the factors that affect land drainage in the native landscape, and then summarize their alteration in the transition to an urban centre, with the intent of providing a conceptual background to the cyclical history of land drainage in Winnipeg.

2.2.2 TOPOGRAPHY

When the glaciers retreated northwards for the last time about 13,5000 B.P. they created a lake basin between the ice front, the Manitoba escarpment, and the heights of land to the east in north-western Ontario and to the south in Minnesota. Thus the pro-glacial Lake Agassiz was formed. In a complex series of advances and retreats of the ice margin, near the Winnipeg area much of the time, water-laid till was deposited directly on the bedrock surface over dense basal tills. This was followed by glaciolacustrine silty-clays and silts. (Teller, 1980).

The level topography in the Winnipeg area is the result of the deposition of these glaciolacustrine materials brought into Lake Agassiz by streams during its later stages. As the lake receded to the Central Lowlands, great quantities of sand and silt poured into its quiet waters. Lake currents distributed the material with the finer particles, the silts and clays being carried to the centre of the lake which is today the approximate centre of the Red River Valley and the location of the City of Winnipeg. The thickness of these water-laid sediments in Winnipeg range between 50 and 70' thick with the average being 40'.



After Dredge, G.S.C.

Figure 17

Recession of Lake Agassiz
The paths of the streams were determined by the grain of the land established by the various shorelines of the receding lake.

Micro-relief is evident today in the form of low clay ridges that impart a very slightly undulating appearance to the area. These low ridges run generally in a northwest to southeast direction and are conjectured to be the result of swash and undertow effects on the lacustrine materials at the intermittantly regressing shoreline (Ellis, 1953) (Figure 17). Even where topography appears flat, slight depressions that are only a few inches in depth below the general level are common. This micro-relief, in combination with the relatively impervious nature of the silts and clays, accounts for the alternating areas of intermittant marsh and prairie in the native landscape. The slightly undulating character of the landscape can be imputed from the areas of hydromorphic soils (Figure 15). A topographical survey of the City of Winnipeg dated 1948, with contours drawn to one foot intervals, indicates the micro-relief of the native landscape that still exists despite extensive urban development (Figure 16).

2.2.3 SOILS

The soils of the Winnipeg region lie within the Blackearth Zone and were developed on the fine clay deposits of the central plain of glacial Lake Agassiz. All these soils have, at one time or another, been under the influence of excessive moisture due to the level topography and the nature of the lacustrine clays themselves, which have high moisture retention values but are relatively impervious when saturated (Ellis, 1953). Local micro-relief has resulted in different drainage regimes and thus different soil types have developed with varying morphological features. Exclusive of the coarser, and therefore better drained soils associated with the flood plains and levees of the rivers and streams, the Red River clay, its associate the Osborne clay, and the Fort Garry clays underly the region now occupied by the City of Winnipeg. The single outstanding feature of all these soils is the fine texture of the parent clay and its low hydraulic conductivity (Render, 1983). Extensive ponding occurs in level areas and depressions in wet seasons or after a heavy rainfall (Ellis, 1953).

With regard to land drainage the primary factor is the infiltration capacity of the soil. Infiltration capacity is the rate at which water will be absorbed by a soil. It begins with a high initial value, decreases rapidly, then reaches a steady state. Rainfall exceeding the rate of infiltration flows off as surface runoff or is stored as standing water in topographic lows. Infiltration capacity of a given soil during a given rainstorm is determined by; soil texture, soil structure, vegetative cover, biologic structures, antecedent soil moisture, and conditions of the soil surface (Morisawa, 1968).

2.2.4 VEGETATION

Vegetation is an indicator of moisture and we owe much of our knowledge of the nature of the native vegetation, and thus the moisture regime, to the first explorers. In 1800 Alexander Henry wrote the following description of the river bottom forests:

> The South side of the Assiniboine, particularly near the forks, is a woody country, overgrown with poplars so thickly as scarcely to allow a man to pass on foot; this extends some miles West, when the wood is intersected by small meadows. The woody country continues South up Red River to Riviere la Sale. On the East side [of the Red] the land is low, overgrown with poplars and willows, frequently intersected by marshes, stagnant ponds, and small rivulets. The banks are covered on both sides with willows, which grow so thick and close as scarcely to admit going through; adjoining these is commonly a second bank of no great height. This is covered with very large wood such as liard, bois de blanc, elm, ash, and oak; some of these trees are of enormous size.

In 1812 Miles Macdonnel provided this description of the prairie lands abutting the flood plains west of the Red.

> After leaving the river bank [we] entered a fine plain as level as a bowling green covered

> with a fine sward of grass, knee high, here and there a clump of wood as if planted for ornament by the hand of man... The plain extended close to the Forks...

The native vegetation of the Red River plain in the Winnipeg region consisted of tall prairie grass (up to 3 metres in wet years), meadow-prairie grass, wet meadow grass, and marsh grass associations, which corresponded with the various degrees of natural drainage. Extensive river bottom forests lined the flood plains of the rivers and streams; oak communities occupied the higher locations adjacent to the flood plains and aspen parkland communities occupied the better drained sites of the clay plain (Figure 18).

2.2.4.1 VEGETATION AND RUNOFF

The presence or absence of vegetation, and its character profoundly alters the rate of runoff in a number of ways. Infiltration is promoted by leaf surfaces that intercept and slows the rate of rainfall. Leaf or grass litter absorbs moisture, and evapotranspiration by the plant returns soil moisture to the air.

2.2.4.2 EVAPOTRANSPIRATION

The character of vegetation has an important effect upon the height of the water table and thus on infiltration capacity. The more massive the vegetation, the more water it absorbs and transpires into the atmosphere; and this water is drawn either from the ground-water supply or from the soil before it penetrates to that level. The water table is characteristically depressed under groves of trees in otherwise open country; and the removal of trees in shallow basins often results in the appearance of swamps or ponds. Figure 16 indicates such a condition surveyed by Sinclair in 1874 just east of the Red River in what is today East Kildonan-Transcona.

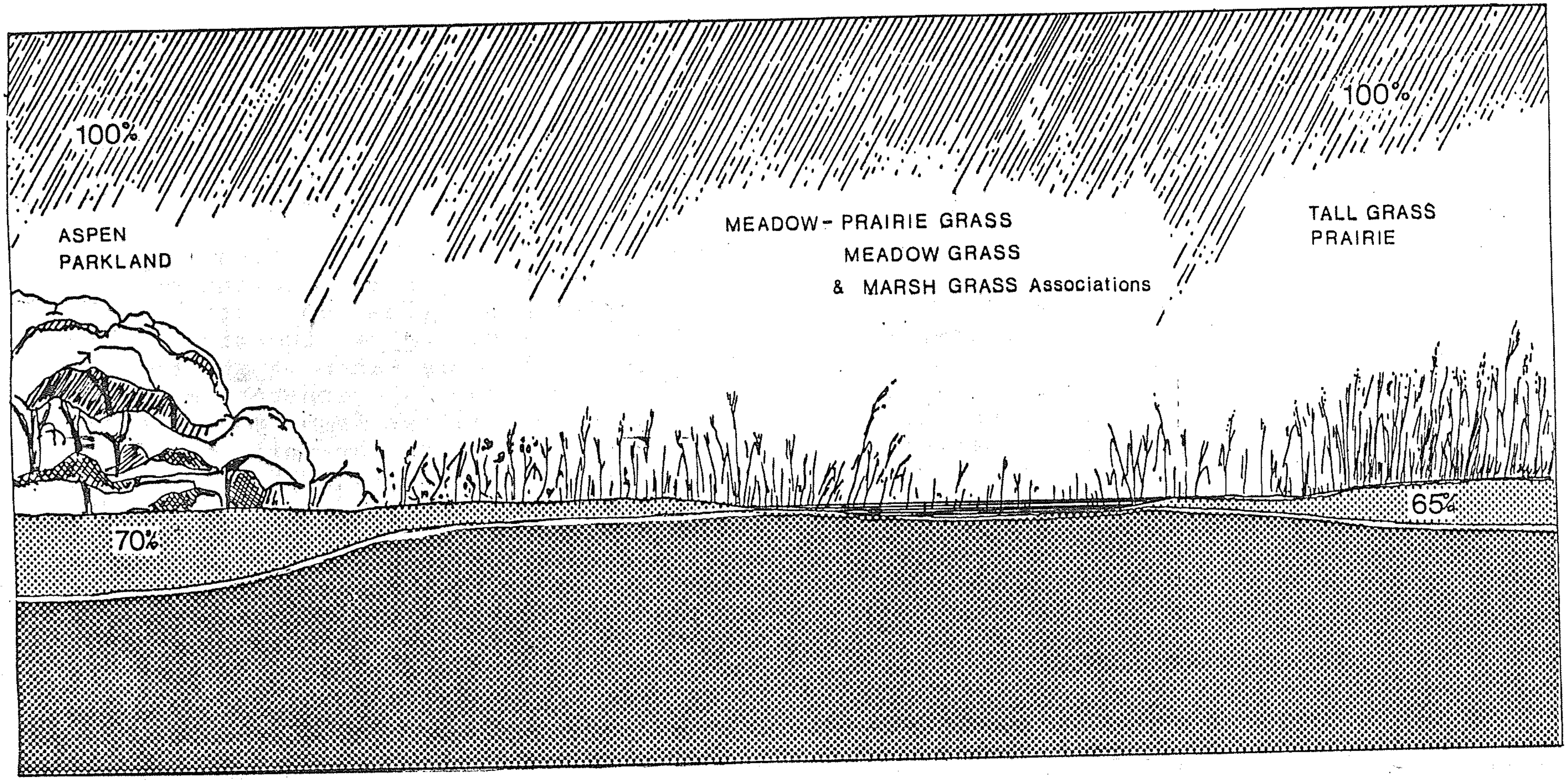
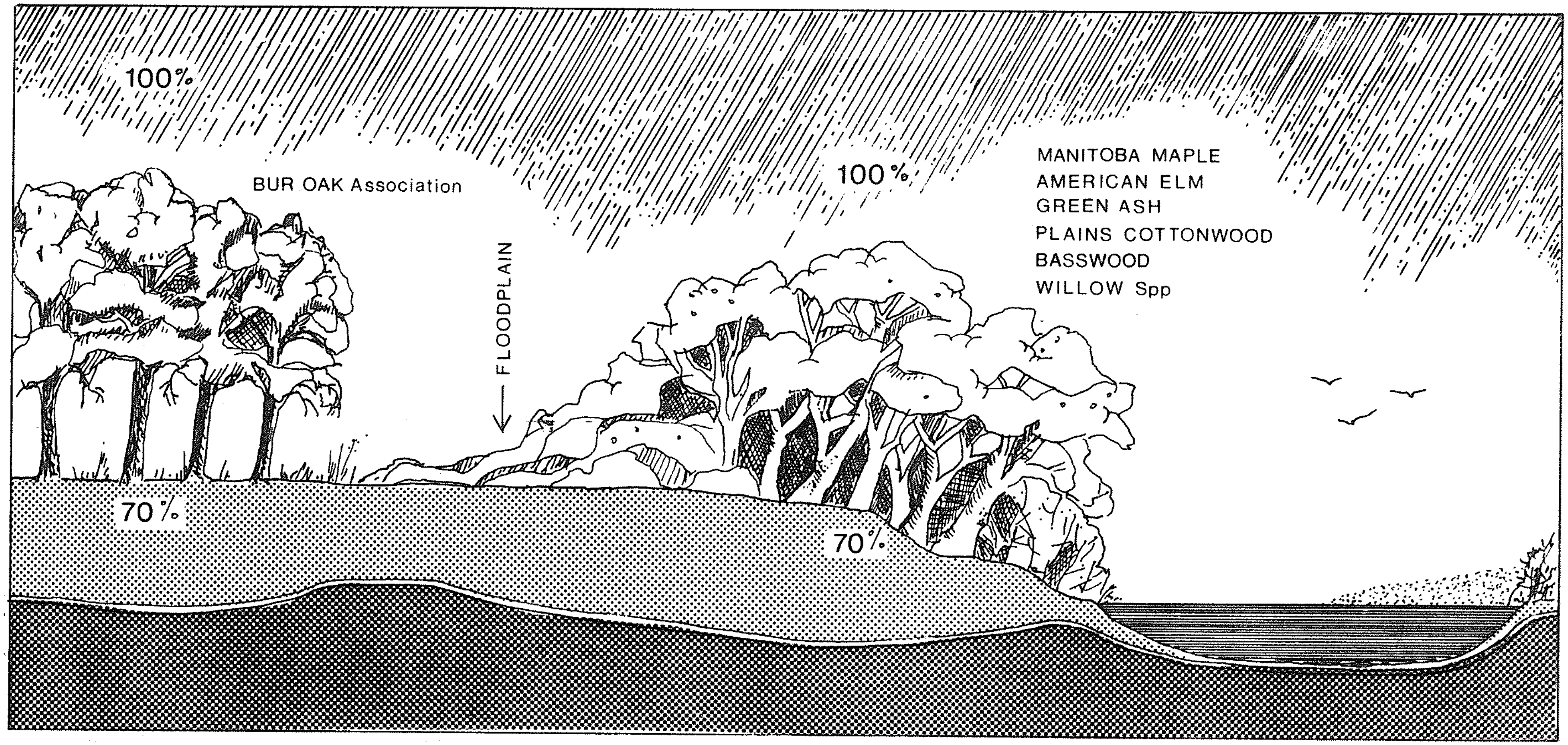


Figure 18
Vegetation in the Native Landscape
Interception values for the vegetation in the native landscape have been proven to account for low levels of precipitation runoff.


100%
BUR OAK Association
FLOODPLAIN
100%
MANITOBA MAPLE
AMERICAN ELM
GREEN ASH
PLAINS COTTONWOOD
BASSWOOD
WILLOW Spp
70%
70%

Evapotranspiration Values Trees

Species	Litres/Day	
Oak	125	(Daubenmire, 1947)
Maple	50	(Sullivan, 1977)
Elm	75	(Sullivan, 1977)
Ash	50	(Sullivan, 1977)
Willow	25	(Sullivan, 1977)

Note: Information regarding specific varieties of species in Manitoba unavailable.

Evapotranspiration by the marsh grass Phragmites communis, a typical species of marsh areas in the Winnipeg region, has been shown to almost double the effective precipitation for the period June 1 - September 10 (Phillips, 1976). This species is tolerant of a wide range of water regimes, with communities spreading into water as deep as 50 cm. and also growing well where the water table drops to 1 metre below the surface (Walker, 1965). Phragmites would therefore presumably have been very common in the Winnipeg region prior to settlement and land drainage. This supposition is supported by Hind (1859).

> It must be seen at sunset when, just as the huge ball of fire is dipping below the horizon, he throws a flood of red light... upon the illimitable waving green, the colors blending and separating with the gentle roll of the long grass, seemingly magnified... into the distant heaving swell of parti-colored sea...

Studies have indicated that runoff in the native landscape, except in wet years or during extreme events, can be assumed to have been very low. Dragoon (1969) examined the effect of prairie species on runoff by planting on small watersheds. Plant cover on the watershed planted resulted in a 90% reduction in surface runoff the second year after planting; after the third year little surface runoff resulted. In addition, interception by annual grass litter has been shown to range from 5 to 14% of precipitation values (Brandson et al, 1972). Runoff from marsh areas feeding intermittent streams would have been further reduced by vegetation as studies have shown that the the use of water by streamside phreatophytes (cattails, bullrushes), is so great that water can be consumed by the dense streamside vegetation, thus virtually eliminating flow downstream (Daubenmire, 1947).

2.2.5 CLIMATE

The climate of Winnipeg is, by virtue of its location, far from the moderating influences of the oceans, termed continental, and is characterized by wide ranges of annual, seasonal, day to day and diurnal temperatures.

The mean annual precipitation in Winnipeg is 20.49". Of that total, 76.8% or 15.22" may be considered as rain that falls on unfrozen ground between April and October. Between November and March, when mean monthly temperatures are below freezing, 4.86" of precipitation falls as snow or 23.2% of the total. These values, however, vary widely from season to season (Labelle, 1968).

Precipitation falling as snow accumulates above ground and sublimates or evaporates during dry cold days. However, during the spring thaw, any remaining snow melts and, as long as the ground is frozen, remains as surface water. In springs following wet years, or when the soil is moisture laden from late rains, spring runoff is exacerbated. In addition to these waters falling within the Winnipeg area, the region is also subject to invasion by foreign waters which flow as surface runoff from the adjacent higher lands to the west, south and east (Ellis, 1953). In the early years of Winnipeg, as will be shown, the accumulation of these waters had a profound effect on the City.

Of the 15.33" of precipitation falling as rain, in addition to extreme yearly variations, values also differ widely within a single season and within geographical areas in close proximity. Within a growing season, June, July and August are the wettest months accounting for 57% of the average rainfall and these are also the months of most frequent thunderstorms (Lipson, 1965 and Simpson, 1966). These thunderstorms are brief in duration and, on occasion, almost tropical in their intensity. Such rainstorms are responsible for large amounts of runoff and surface ponding, often falling with such violent intensity as to prohibit infiltration.

Data regarding or indicating statistical "return periods" for various intensities and duration of rainfall are vital to designers of land drainage systems. An event which is said, by statistical analysis, to have an 'x' year return period is the one which will occur once every 'x' years on the average over a long period of time. However, the accuracy of the estimate depends upon the length of the period for which accurate records are compiled and the number of occurrences during that time.

2.2.5.1 WET AND DRY CYCLES

In Winnipeg, many of the problems of urban land drainage from 1874 to the present day can be attributed to inadequate records due, in part, to the cyclical nature of the wet and dry periods. Located on the 50th parallel of latitude, Winnipeg is situated in the middle of the prevailing westerlies, a broad belt of westerly winds between latitudes 30 and 60 degrees north and south of the equator. Variations in the average path of these winds account for the difference in seasonal weather from year to year as well as large variations within each season. The Arctic Polar Continental air mass dominates in winter bringing cool dry air to the region. In summer, the dry warm Pacific Maritime Polar air mass predominates. However, periodically incursions of Maritime tropical air from the Gulf of Mexico reach the Winnipeg latitude - although mostly aloft. Such air is the source of most of the region's spring and summer rainfall. The instability of this air is responsible for the frequent occurrence of thunderstorms and heavy convectional showers.

The meeting of the warm, unstable maritime tropical air from the south and the cool polar air from the north forms a front which oscillates through a north-south zone that stretches across the Prairie Provinces. During summer if the

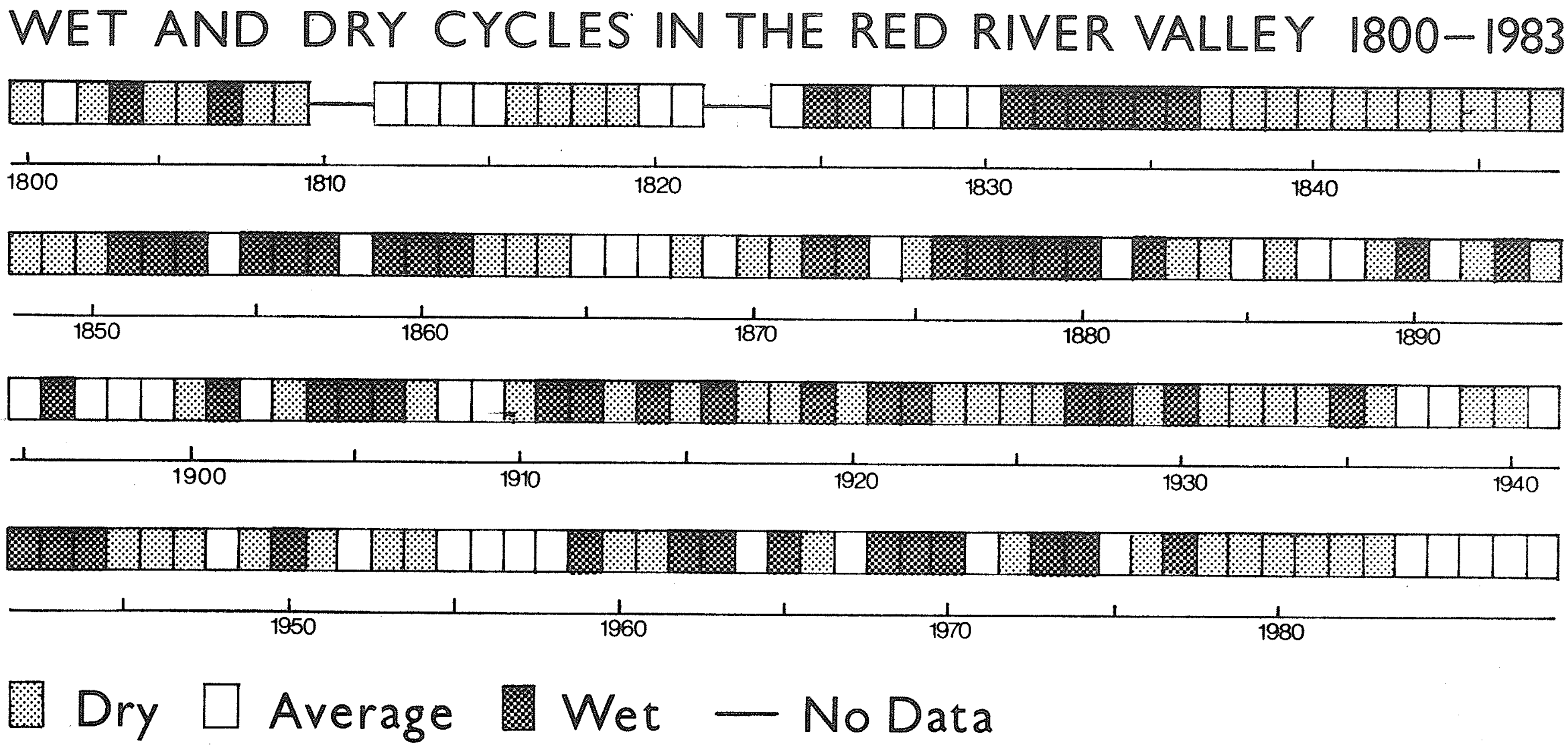


Figure 20

Updated from Allsopp, 1977

average position of the polar front is over southern Manitoba, more moisture than usual may be expected; if it is farther north, it may result in a dry summer. In Figure 20, meteorological information obtained from the Hudsons Bay Archives, settlers' diaries and journals, dendrochronological analysis, and lake level variations, has been combined with instrumental data recorded at Winnipeg 1872-1983 to derive a chronological sequence of agricultural weather for the period 1800-1983 in the Red River Valley of Southern Manitoba (Allsopp 1975). As can be observed, an "average" year occurs only 26% of the time. Forty percent of the weather can be typed as dry and 34% as wet.

2.2.6 THE STREAMS

The grain of the land in the Winnipeg region runs north-west to south-east and has been accounted for by the pattern of the shoreline of receding Lake Agassiz (Ellis, 1953). The course of the streams tributary to the Red and Assiniboine Rivers closely follow this ancient pattern as shown in the Surface Waters of Winnipeg, 1874.

Northwest Quadrant

Sturgeon, McMillans, Scully, Miry, Catfish, and Colony Creeks were located in this quadrant. The waters in this region enter the area from the higher lands of the Manitoba Escarpment and Lake Manitoba to the northwest. Due to the insufficient fall across the clay plain, many of these streams were unable to cut adequate channels. Sturgeon Creek was, and is, the largest and most mature of these original streams. However, Colony Creek is more typical of the rudimentary drainage pattern of this quadrant. Flowing in a southeasterly direction, its waters separated in the vicinity of Twp II, Range 2E, Section 14, S.E. 1/4 into three arms that sheet drained across the prairie (Doupe, 1878). These waters flowed southeast to exit into the Assiniboine through the Colony Creek outlet; east into Browns and Logans Creeks, and north to exit through Pritchards, St. Johns and Inksters Creeks (Doupe, 1878). Considerable ponding occurred as these waters flowed across the prairies, and marshes formed in wet years.

The Southwest Quadrant

No names were ascribed to the stream runaways or coulees in this quadrant with the exception of the La Salle River originating in the highlands to the southwest. Due to the flat topography and the prevailing clay texture of the surface deposits in this quadrant, the natural streams were ineffective in providing adequate drainage of the lands through which they passed (Ellis, 1953). This region was thus subject to the formation of extensive marshlands in depressional areas.

The Southeast and Southwest Quadrants

The Seine River and both Taylors (Bunns) and Macleods Creeks were located in this quadrant. These tributaries flowing into the Red from the east were more continuous and less erratic in nature than those from the west. The waters that fed these streams rise in the eastern forested region of the Lake Agassiz terraces and were also fed by water ponded in bogs and swamps.

2.2.7 THE NATURE OF THE STREAMS

On the prairies in general there was, and is, a wide variation in the discharge of the rivers and their tributaries. In dry seasons the flow of some of the streams was reduced to zero and floods were common in wet seasons. Streams may be broadly classed as ephemeral, intermittant or perennial (Morisawa, 1968).

2.2.7.1 INTERMITTANT STREAMS

These stream channels carry water part of the year and are dry the other part, but receive flow from the groundwater table when it is high enough. In 1894, before extensive groundwater pumping occurred, the potentiometric surface in the Upper Carbonate aquifer was 1 to 4' below ground level in North Winnipeg (Johnson, 1934). From this we can infer that those streams of the Northwest Quadrant (Sturgeon, McMillans, Miry, Catfish (Omands) and Colony) were fed by teluric flow. This deduction is reinforced by Hering (1896) who stated that there was a continuous flow of water from the west through crevices and fissures in the limestone bedrock into the Red River. The coulees of these streams in some places were in the vicinity of 50 to 60' wide, suggesting periodic large flows of water. The coulee of Colony Creek at the intersection of modern day Broadway and Osborne was 50' wide although the actual stream in April of 1874 was 3' wide (Doupe, 1874). Many of the smaller coulee outlets into the Red and Assiniboine that would have borne water only in spring or after a rain would also fall into this category.

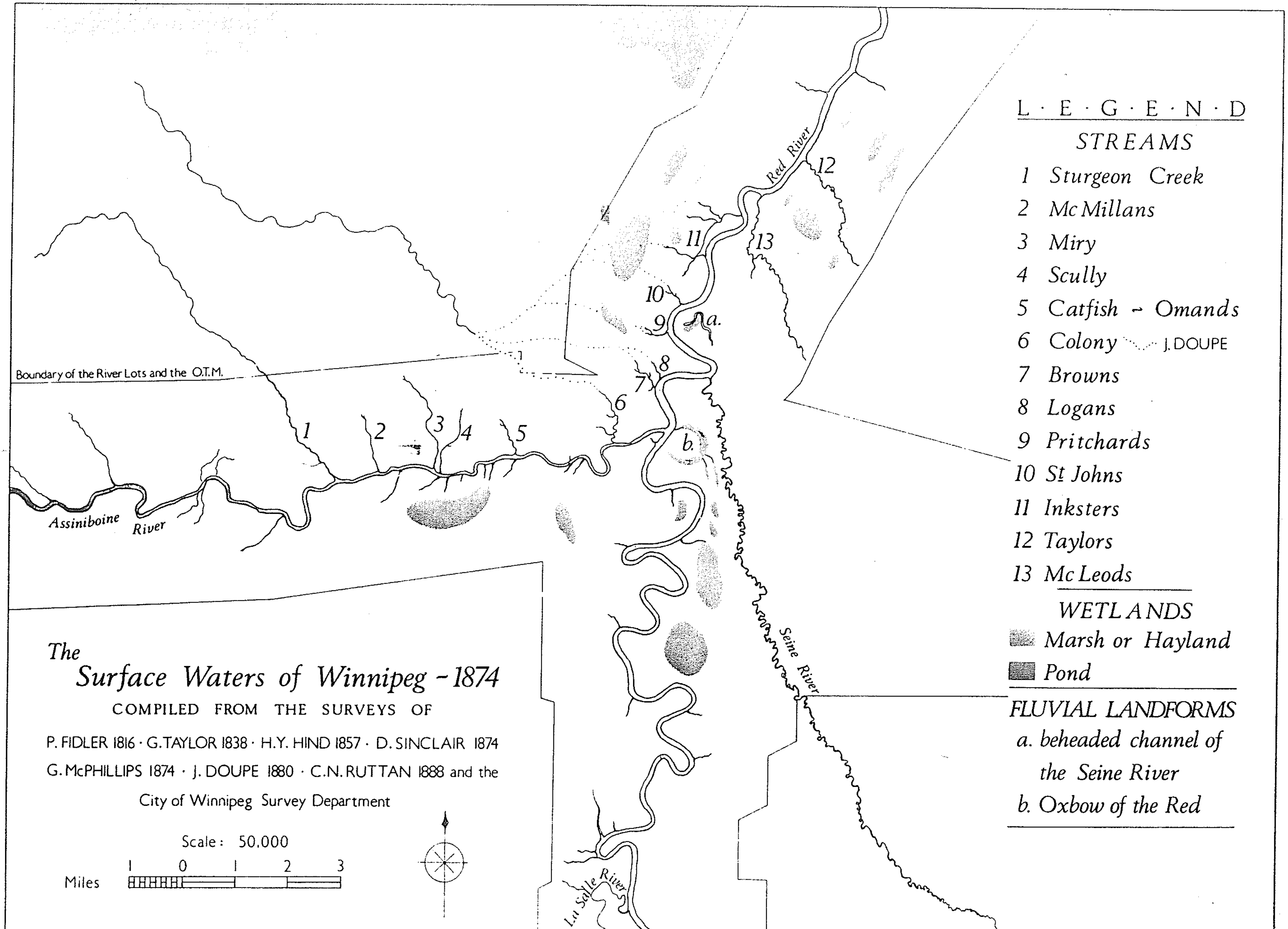
2.2.7.2 PERENNIAL STREAMS

These are streams that carry water the year round and are fed by a fairly stable groundwater flow. Only those streams entering the Red River from the highlands to the east and south can be said to have been perennial;the Seine, Taylors (Bunns), Macleods and the La Salle River. Sturgeon Creek, fed by waters from the northwest, is identified by Ellis (1953) as intermittent, however Fidler (1816) called the stream a river and the width of the valley it occupies would tend to indicate Sturgeon Creek as being perennial.

2.2.8 PONDS AND WETLANDS

Much of the landscape today occupied by the City of Winnipeg was either marsh land or intermittant wet meadow. Due to the plastic nature of the lacustrine clays, and the cyclical nature of the wet and dry seasons in the Red River Plain, these areas would have been continually expanding and contracting. In addition much of the area was regularly inundated by floodwaters of the Red and Assiniboine Rivers (Figure 21). These waters provided an additional source of supply for the wetland areas. These marshes and wetlands acted as areas of surface storage, releasing their overflow to the streams in times of wet weather and replenishing the ground water in dry seasons.

The areas of more or less permanent marsh are indicated in Figure 1, The Surface Waters of Winnipeg, 1874. The areas of hydromorphic soils (the Osborne


L·E·G·E·N·D
STREAMS
1 Sturgeon Creek
2 McMillans
3 Miry
4 Scully
5 Catfish – Omands
6 Colony ········ J. DOUPE
7 Browns
8 Logans
9 Pritchards
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City of Winnipeg Survey Department
Scale: 50,000
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Figure 21

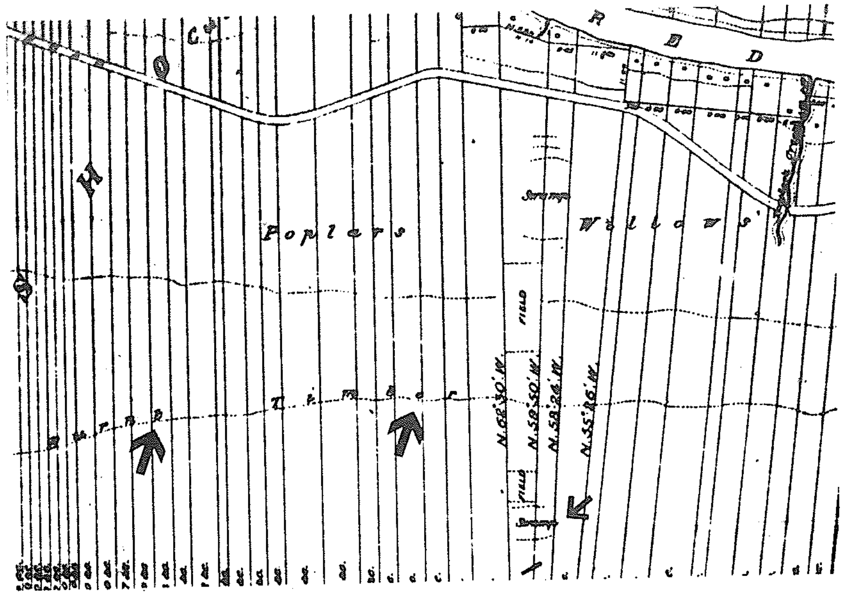

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Figure 19
Edge of Burnt Wood and Swamps East of Red River. (Detail Plan of River Lots in the Parishes of Kildonan and St. Pauls, 1874). Swamps have been attributed to the rise in water table after the death of trees.

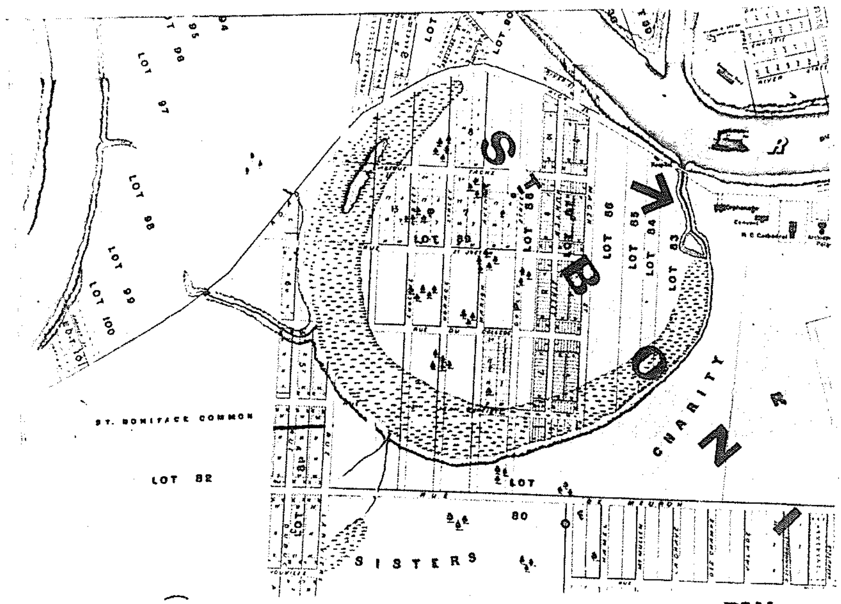

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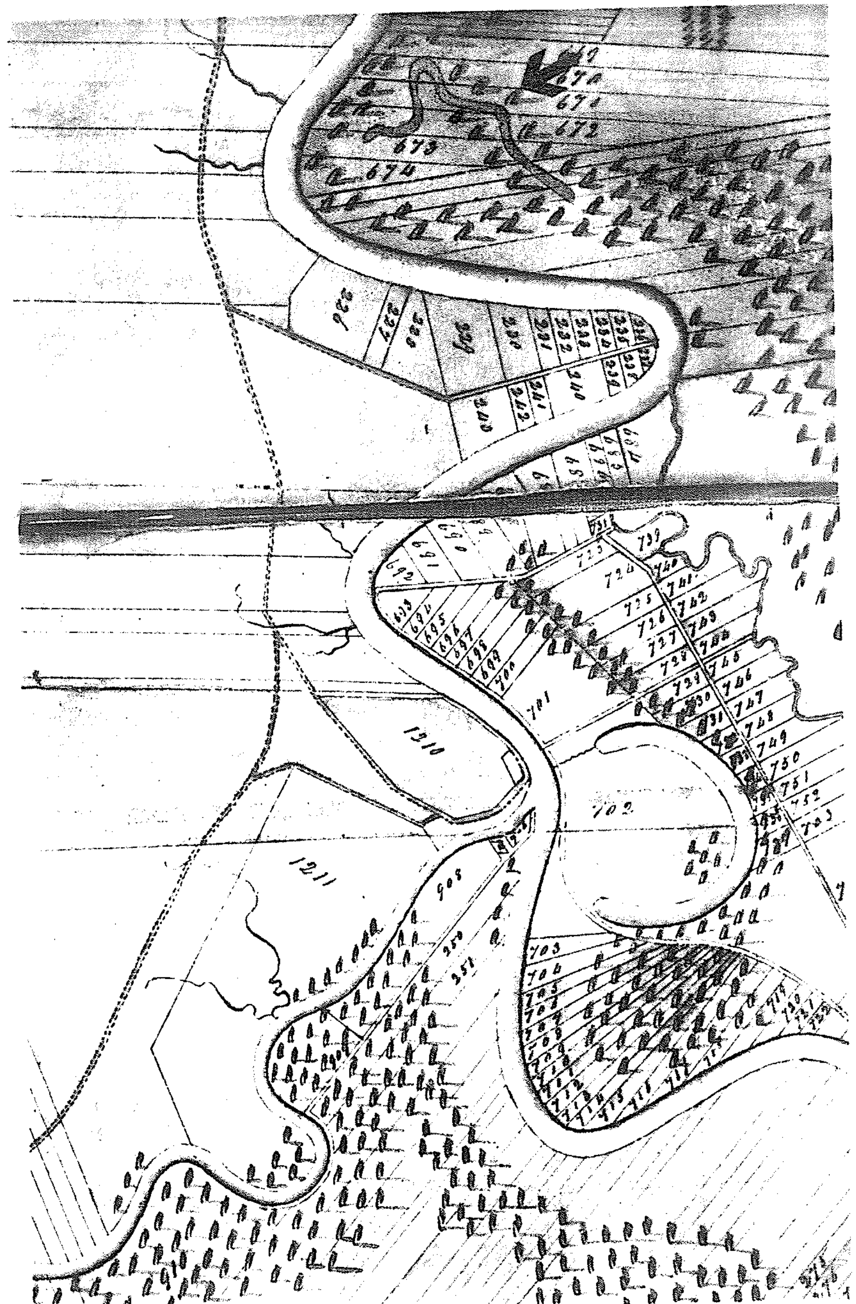
Figure 22
The Oxbow of the Red (Detail McPhillips Map of Winnipeg, 1883). This enormous land form was drained by a small intermittent stream.



HBC Archives PAM

Figure 23
The Oxbow and the Beheaded Seine River. Taylor's plan of the region, 1838, indicated the beheaded Seine River for the first time. It must have been capable of storing large amounts of water for long periods of time. Sinclair, 1874, termed the area marsh or hayland.

clays), formed under conditions of excessive moisture or standing water, indicate the general extent of the wet meadows (Figure 15). In addition it must be remembered that waters would also tend to collect in micro-depressions in the subtle ridge and swale topography. The extent of these depressions must have been considerable, as continual reference to these ponds is to be found throughout the newspaper accounts of the early years of Winnipeg. In particular, the waters of Colony Creek, entering the area from the northwest and sheet draining across the prairie, formed extensive areas of standing water (Doupe, 1878).

In addition to the wetlands attributable to the micro-depressions in the clay plain, two large marsh areas existed as a result of the erosive power of the Red River in flood; the Oxbow of the Red river in present day St. Boniface and a beheaded channel of the Seine River in present day East Kildonan (Figures 22 and 23). The Oxbow served as a natural location for off-line storage during the spring flood. After the subsidence of these waters, the Oxbow released its waters into the Red through a small ephemeral creek, although two areas of standing water evidently remained in most years. The marshland in present day Elmwood was created when the Red River, over time, cut into its inside bank thus beheading the final reach of the proto-Seine River (Stene, 1984).

2.3 THE URBAN LANDSCAPE

In general terms, the altered or urban landscape can be, for purposes of description reduced by land drainage engineers to definitions of pervious and impervious areas. Impervious surfaces such as buildings, concrete or asphalt roads have, incrementally, come to occupy a greater and greater percentage of the Winnipeg landscape. This is true of all urban centres across North America and indeed around the world. The inefficiencies of the conduit system in place in Winnipeg today and the massive and expensive overhauls of that system in the past (and to be expected in the future) are, in large part, attributable to the increase in impervious area over the last century. In addition the remaining pervious areas have had their original soils and vegetation altered

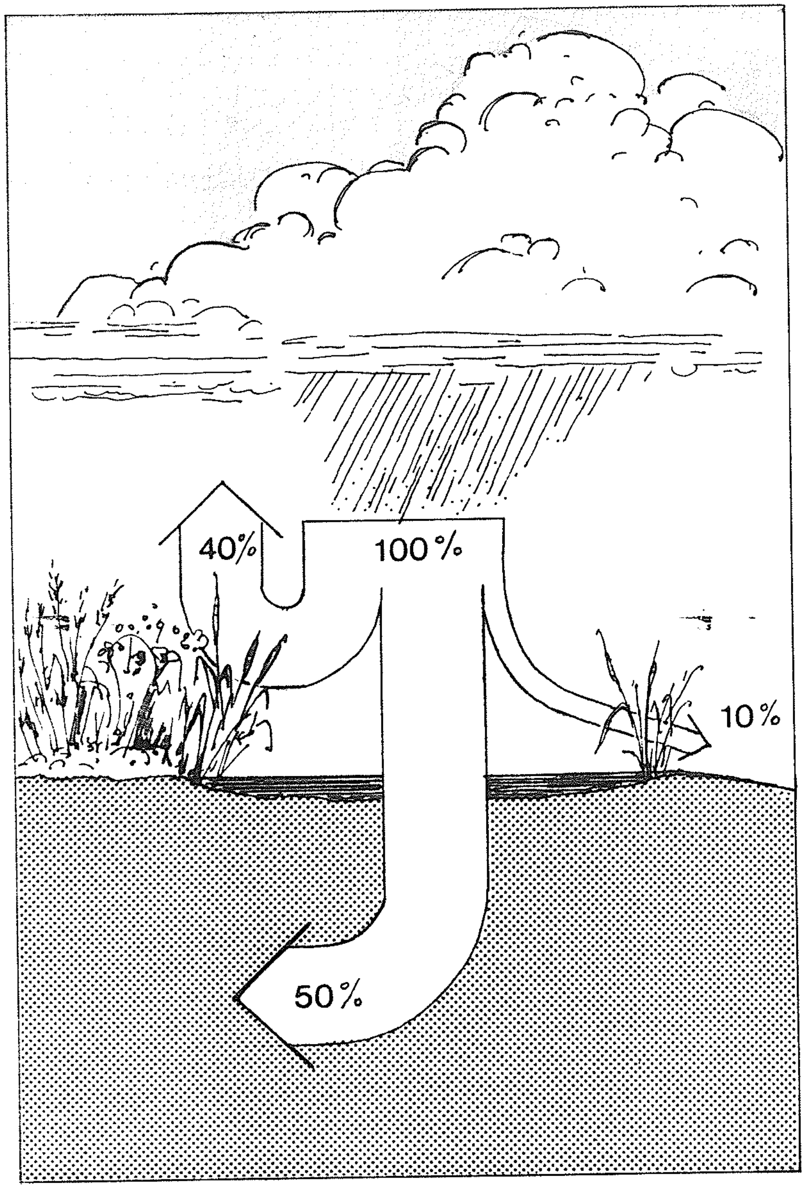


Figure 24 Source: Environment Canada
Hydrology in the Native Landscape

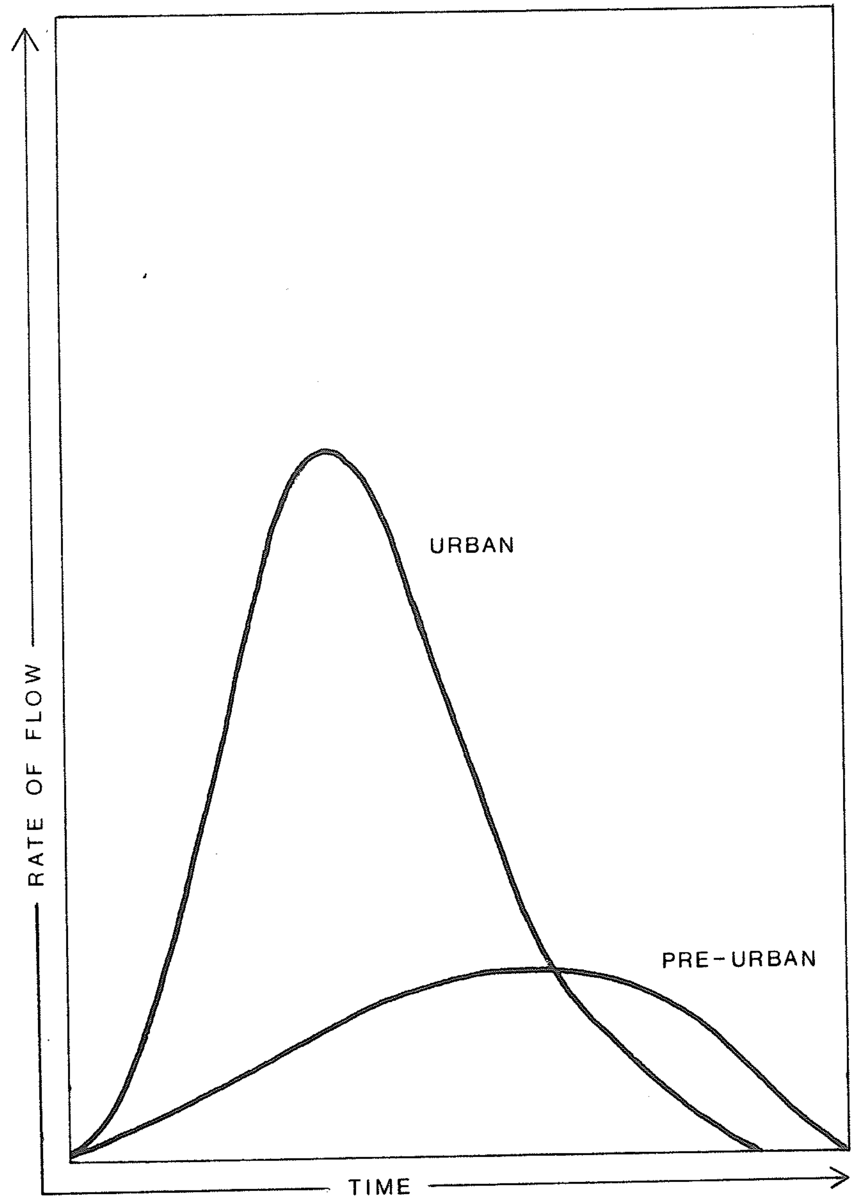


Figure 25 Source: Environment Canada
Peak flows and runoff volumes in the urban and Pre-urban landscape.

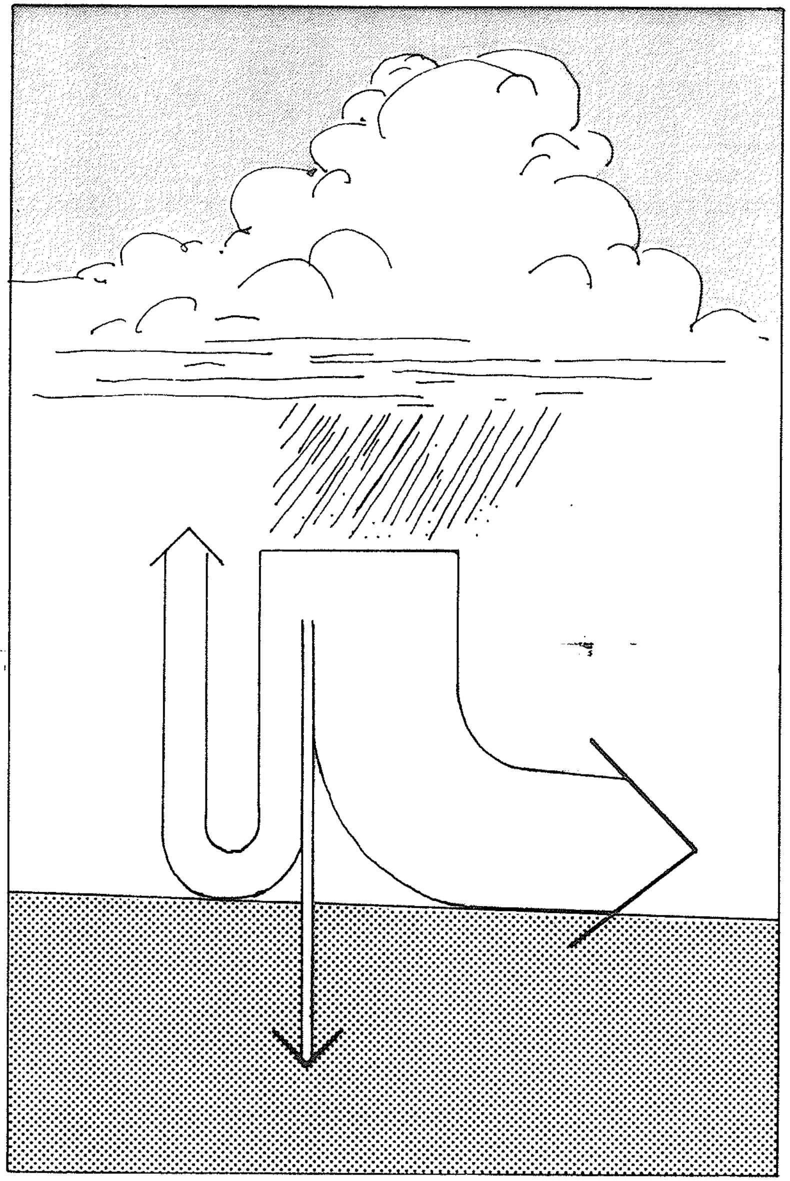


Figure 26

Hydrology in the Impervious Urban Core

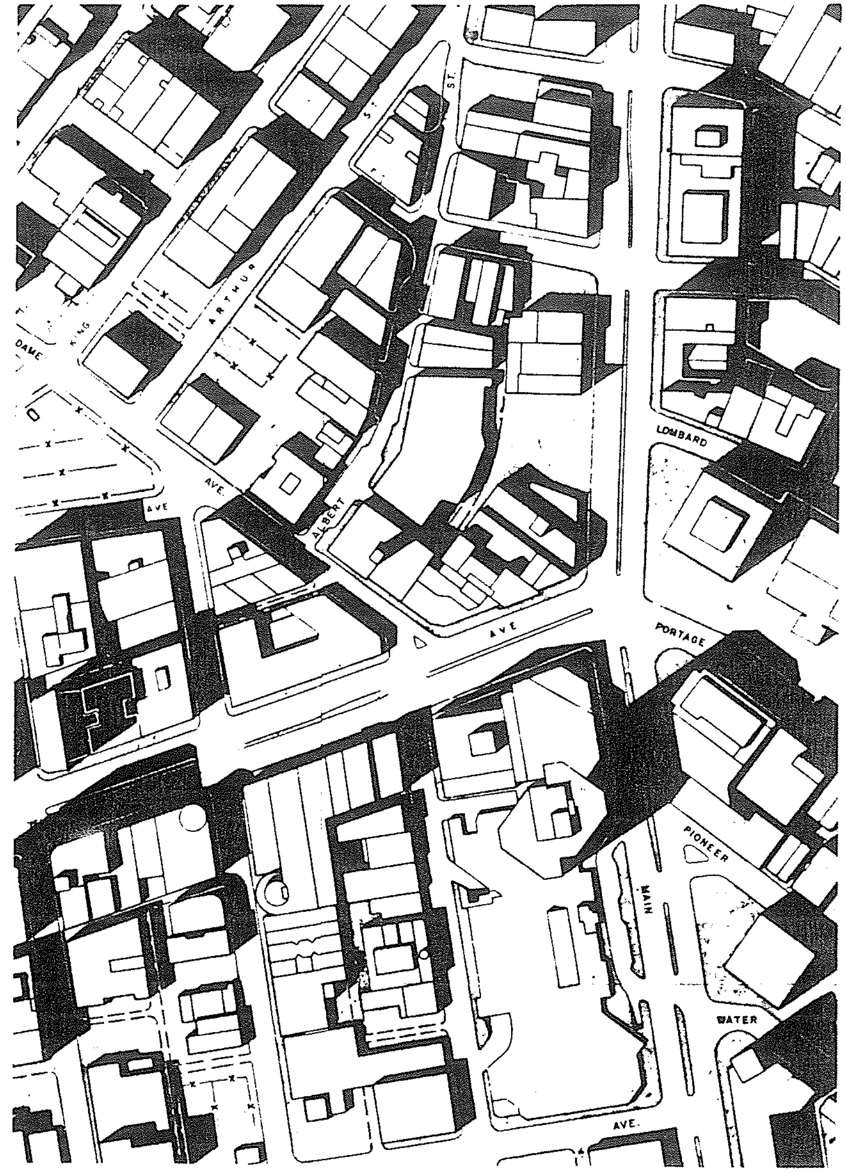


Figure 27

The Urban Core: Portage and Main, 95% Impervious

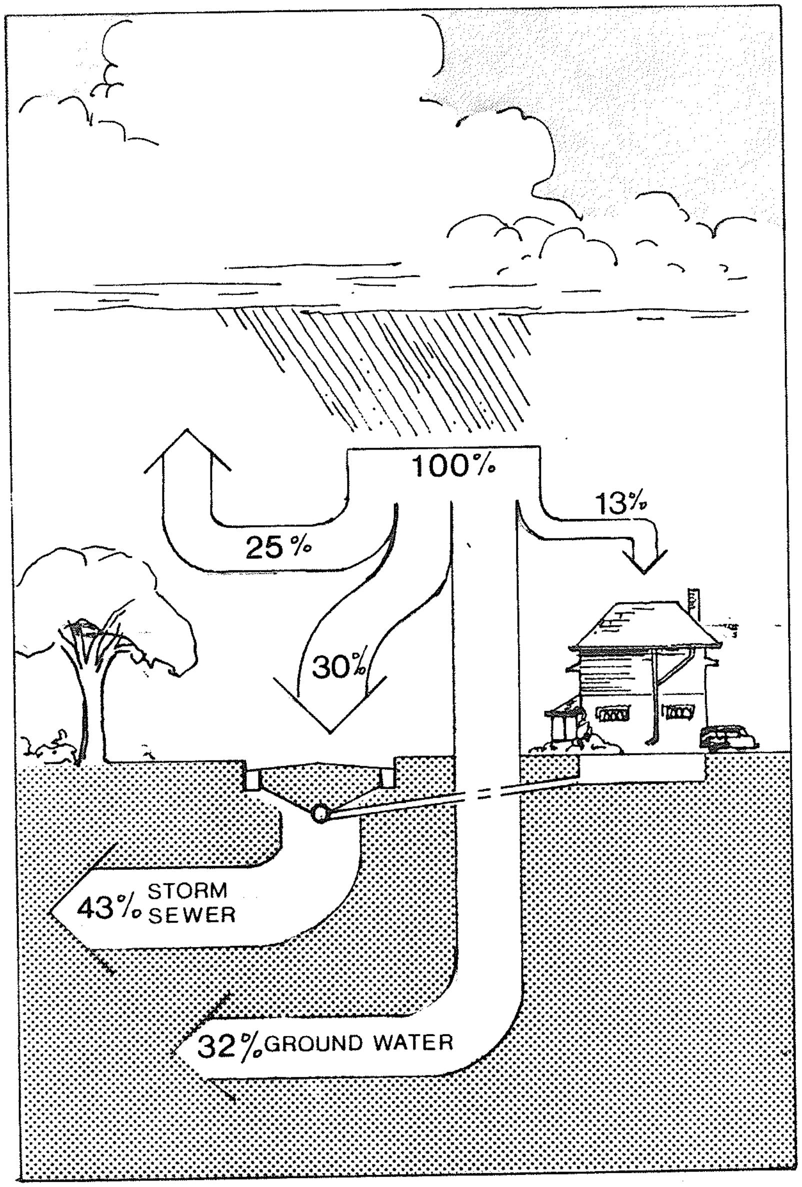


Figure 28
Hydrology in an Urban Residential Neighborhood
(Combined System).

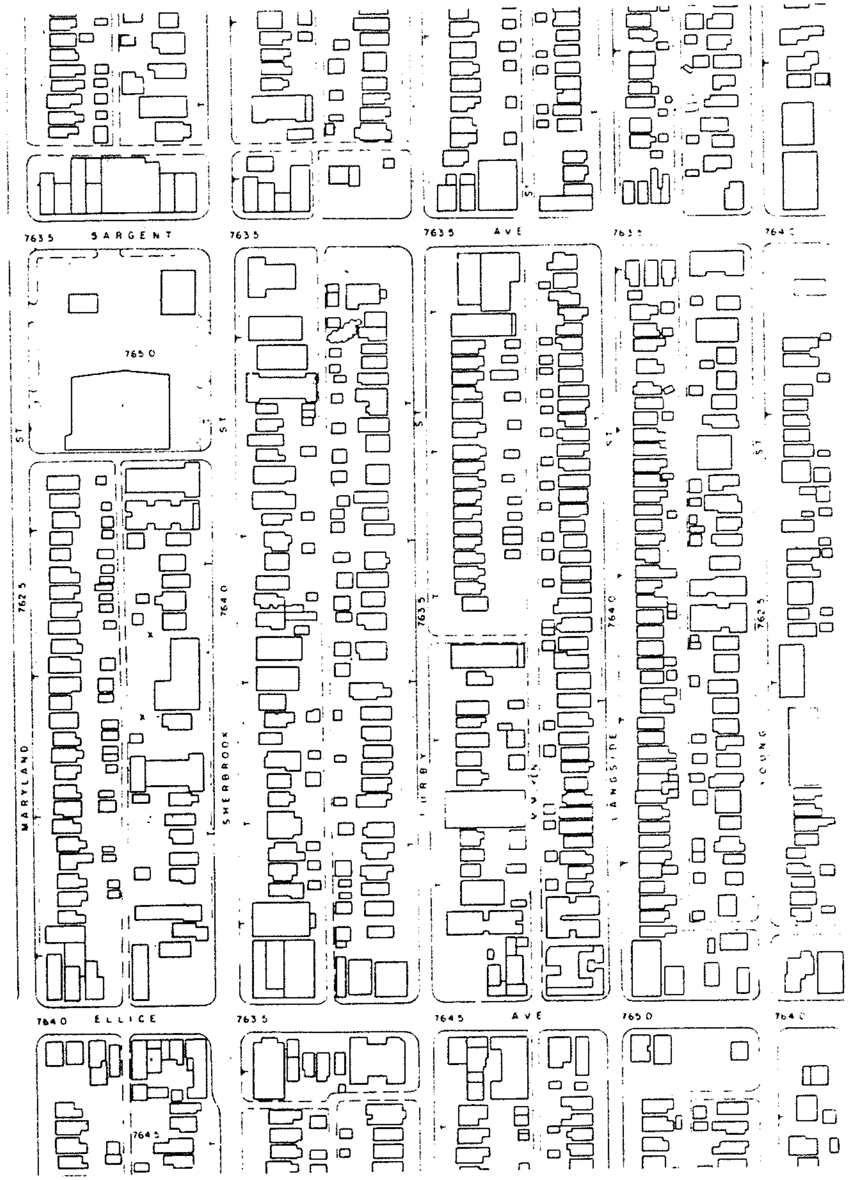


Figure 29
Typical Inner City Residential Neighborhood
The ratio of impervious surfaces (roads, buildings) to pervious surfaces allows approximately 35-40% runoff.

which in turn has altered the amount of precipitation runoff. Figures 24 through 29 illustrate the differences between runoff in the pre-settlement landscape and the different degrees of runoff to be expected from different types of urban areas.

2.3.1 IMPERVIOUS AND PERVIOUS SURFACES

Professionals concerned with land drainage base their calculations on computations of impervious and pervious areas. These areas are, for calculation of runoff and sizing of conduit systems, ascribed values or coefficients of runoff that approximately characterize their ability to absorb precipitation. The coefficient for an area is estimated from the percentage of rainfall expected to runoff from that area. The following approximate values characterize the percentage of runoff to be expected from a specific type of area (Lynch 1974).

Area Type	% Runoff
Roofs, ashphalt and concrete pavements, other waterproof surfaces	90
Macadam, compacted earth and gravel, without plant growth	70
Impervious soil, with plant cover	50
Lawns and planted areas with normal soil	20
Woods	10

The more urbanized an area has become, the higher the likelihood of greater surface runoff values. In Winnipeg, generally, in urban residential areas 35% of the precipitation falling as rain runs off into the stormsewers, and in commercial, industrial and downtown areas 90% of all rainfall runs off to enter the storm sewers (MacLaren 1974).

2.3.2 URBAN VEGETATION AND SOILS

The original soils of the area have, since widespread land drainage was undertaken, undergone and are undergoing a gradual change in character (Ellis 1953). Stipped of their native vegetation, these soils, unless re-vegetated, are highly susceptible to compaction, baking, and sheet and gully erosion. In highly urbanized areas pedestrian and vehicular traffic has compacted the soil, greatly reducing infiltration capacity. The removal of vegetation from many urban soils has further reduced the ability of the soil to absorb and hold water. A visit to any construction or industrial site after a rainfall amply demonstrates the exacerbated standing water problems that result from the stripping of vegetation and the compaction of soil.

The characteristic tall grasses of the native landscape, with their high interception and evapotranspiration values have, in the urban landscape been replaced by the ubiquitous mixture of Kentucky Blue Grass and Red Fescue Grass. These lawns, so highly prized by urban man, and mown to lengths rarely in excess of 2.5" have very low rainfall interception values and are subject to extreme moisture stress in the region's clay soils. In turn, the baking of the upper layers of the soil that takes place in summer further lowers an infiltration capacity already reduced by mowing and the regular removal of grass litter. In the thunderstorm events of June, July and August, rain often falls with such intensity as to inhibit infiltration in these so called pervious areas, which are then capable of contributing high values to surface runoff. The original riverbank tree species have been extended by man, selectively, across the plains and augmented by many non-native species. Interception values for these trees, elm, ash, maple, poplar, and willow are high and in heavily planted districts they can significantly ameliorate otherwise high runoff values. When planted in swales and ditches these species have the potential to significantly reduce standing water problems.

*

Chapter 3

LEGISLATION AND LAND DRAINAGE : AN OVERVIEW

3.1 EARLY LAND DRAINAGE IN THE RED RIVER VALLEY

The first settlements were along the well drained levees of the Red and Assiniboine Rivers. Access by water was the major factor in the choice of site and apparently outweighed the dangers of spring flooding. Only after these lands were occupied did settlers move back from the rivers into the marginally drained prairie lands. That move necessitated the first agricultural drains (Figure 14). Farmers and settlers regarded (and indeed, continue to regard) marshlands, sloughs, and pot holes as obstacles to agricultural production. From the beginning of agricultural settlement in Manitoba there have been projects to drain lands for development. H.Y. Hind in 1859, had been the first to make the case for the economic benefits of land drainage.

> If the drainage of many thousand square miles of swamp and marsh in this part of the country should ever become a question of national interest, I know of no enterprise of the kind which could be executed with so little cost and labor, and promise at the same time such widespread beneficial results.

Land drainage works in the Winnipeg area of the Manitoba Lowlands most certainly date from the pre-1874 period. These early drains were agricultural and the first record of them is to be found in the Survey Notebooks of Sinclairs River Lot Survey of 1874 (Figure 13). It is difficult to separate these agricultural drains from the early drains of the settlement of Winnipeg. Both were simply shallow ditches dug to receiving water bodies to drain standing waters. In the Winnipeg region, originating as it had as Lord Selkirk's agricultural settlement and only later developing into a trading centre, agricultural and urban drainage were essentially one and the same.

During the first period of urban growth Hon. C. P. Brown, Minister of Public Works for Manitoba, whose decisions regarding the drainage of Winnipeg were to have such far reaching results, stated in his Annual Report of 1880 that;

> The evils arising from a superabundance of water caused by a succession of very wet

seasons, could only be counteracted by an efficient drainage system. Immigrants were either deterred from entering the Province, or were forced to pass through it and settle on drier plains beyond. So apparent did this become that the Government made it an important part of their policy to inaugurate a comprehensive drainage system... Extensive marshes in dry seasons of 7 or 8 years ago, comprised comparatively small areas but, augmented by the wet seasons of the last 3 or 4 years, have overflowed and deluged the surrounding country, in some sections forcing settlers to abandon homesteads.....

3.2 LEGISLATION: PROVINCIAL

The first Drainage Act (S. M. 1880, C.2 1st Session) was assented to on February 14, 1880. Winnipeg lay in, what was at that time, Drainage District No. 3. Warkentin (1967) summarizes this period,

> That year (1880) drainage plans were made, surveys undertaken, and some ditching commenced. The ditches were shallow and not very wide and were therefore rather ineffectual....

Prior to 1880 little effective drainage was accomplished. During the wet years of the late 1870's the Provincial Government constructed a number of drains to the Assiniboine River to drain marginal lands. Other drains were dug in connection with the construction of the railways, the first Colony Creek Diversion among them. These early drainage works were constructed as the need became apparent, with little thought of downstream consequences or the future needs of drainage in that area. The inefficiencies of this type of planning have long since been recognized but Winnipeg was to learn only by painful trial and error during the period 1874-1882 and, as we shall see, this trial and error was to extend up to the present day.

3.3 LEGISLATION: MUNICIPAL

The need for a more comprehensive program led to the Land Drainage Act 1875 (S. M. 1895, c.11) assented to March 29th, 1875. Under terms of this act, Maintenance Districts were formed. Each municipality was responsible for the streams, wetlands, and drainage works within its own boundaries. From that time, up until amalgamation of the various municipalities in the Winnipeg region under the City of Winnipeg Act 1972, land drainage was the sole responsibility of the individual municipalities, and no specific legislation was enacted to protect streams or drainage runways.

The resulting involvement of numerous agencies resulted in a fragmented approach to land drainage. A systematic approach requires that drainage be planned for a whole watershed, from the highland areas, through to the final water disposal area.

The split jurisdiction did not favor or encourage regional planning of drainage outlets. This is particularly true of those drains crossing several municipal boundaries such as Omands Creek. Omands Creek was, historically, the boundary between the City of Winnipeg and the City of St. James. Although the creek exits into the Assiniboine River within the Winnipeg city limits, the responsibility for its maintenance was the burden of St. James alone.

The incremental disappearance of MacLeods Creek in East Kildonan during the 1950's and 1960's can be attributed to the lack of such a regional authority. Prior to unification in 1972, each municipality had a political and economic incentive to encourage development within its boundaries (Figure 30).

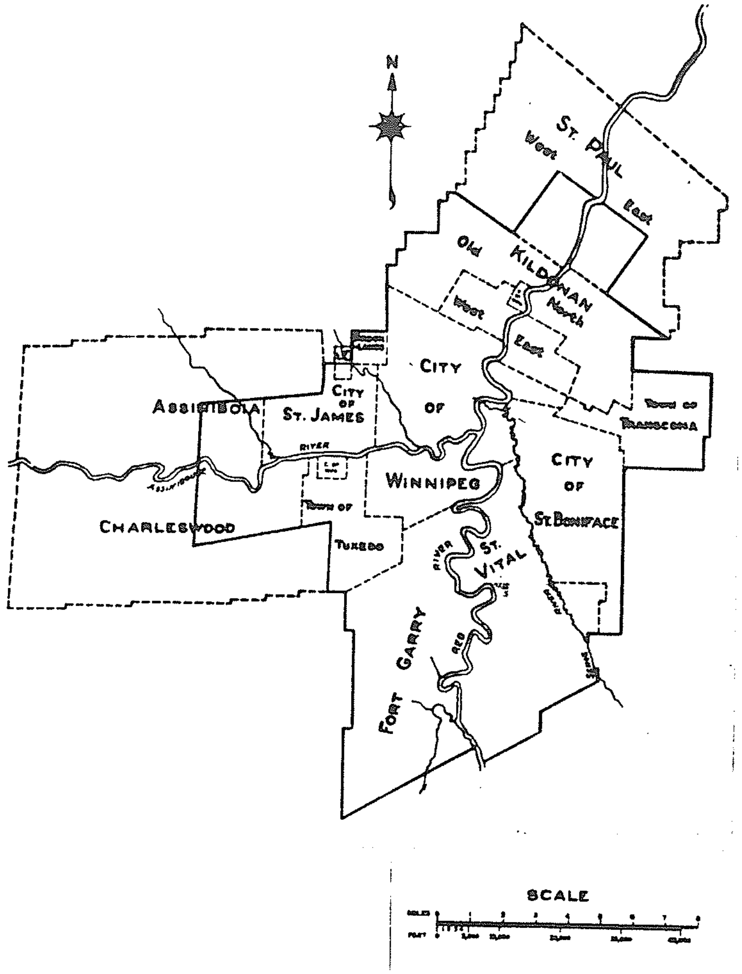


Figure 30 City of Winnipeg N.d.
Metropolitan Greater Winnipeg prior to unification
Note the path of Colony Creek exiting into the Assiniboine River just west of Armstrongs Point. This topographical information exists on no other map and may either be a drafting error or represent one of the paths of Colony Creek as it sheet drained southeast towards the Red and Assiniboine Rivers.

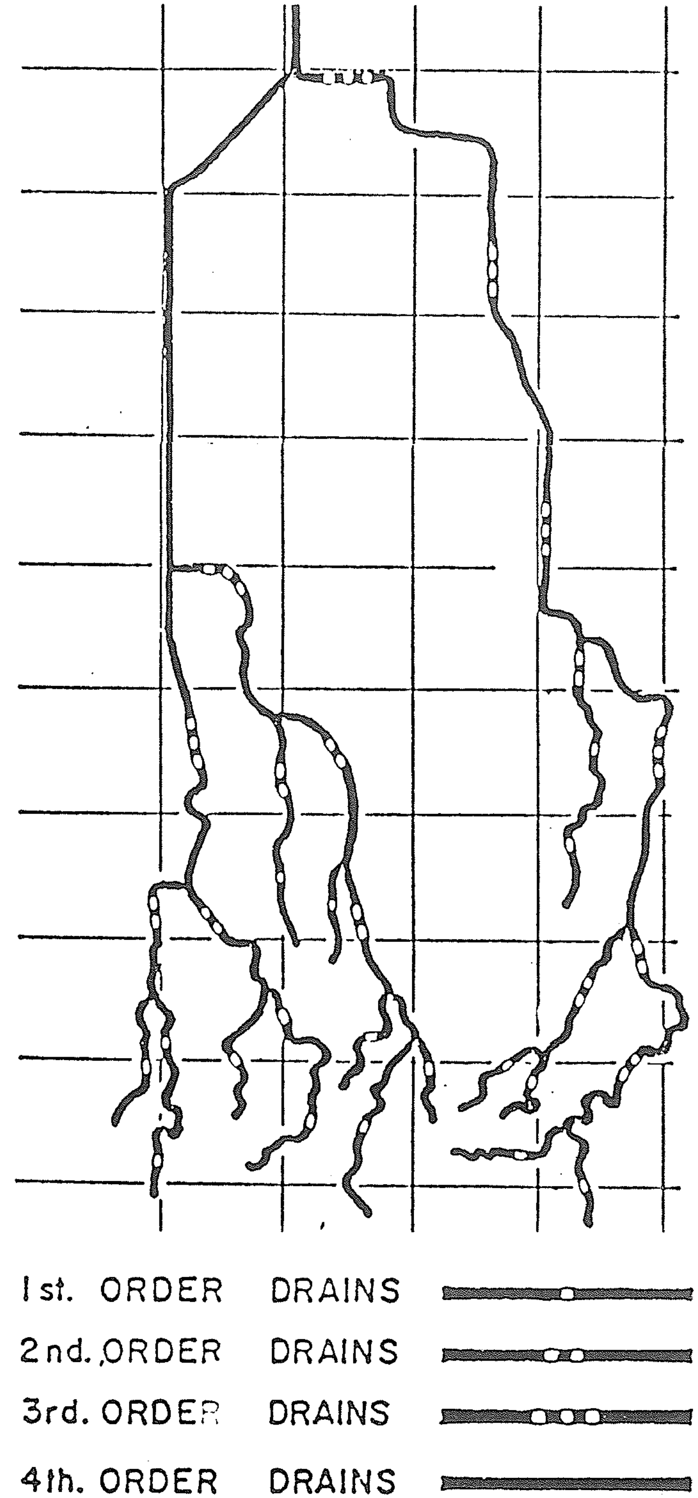
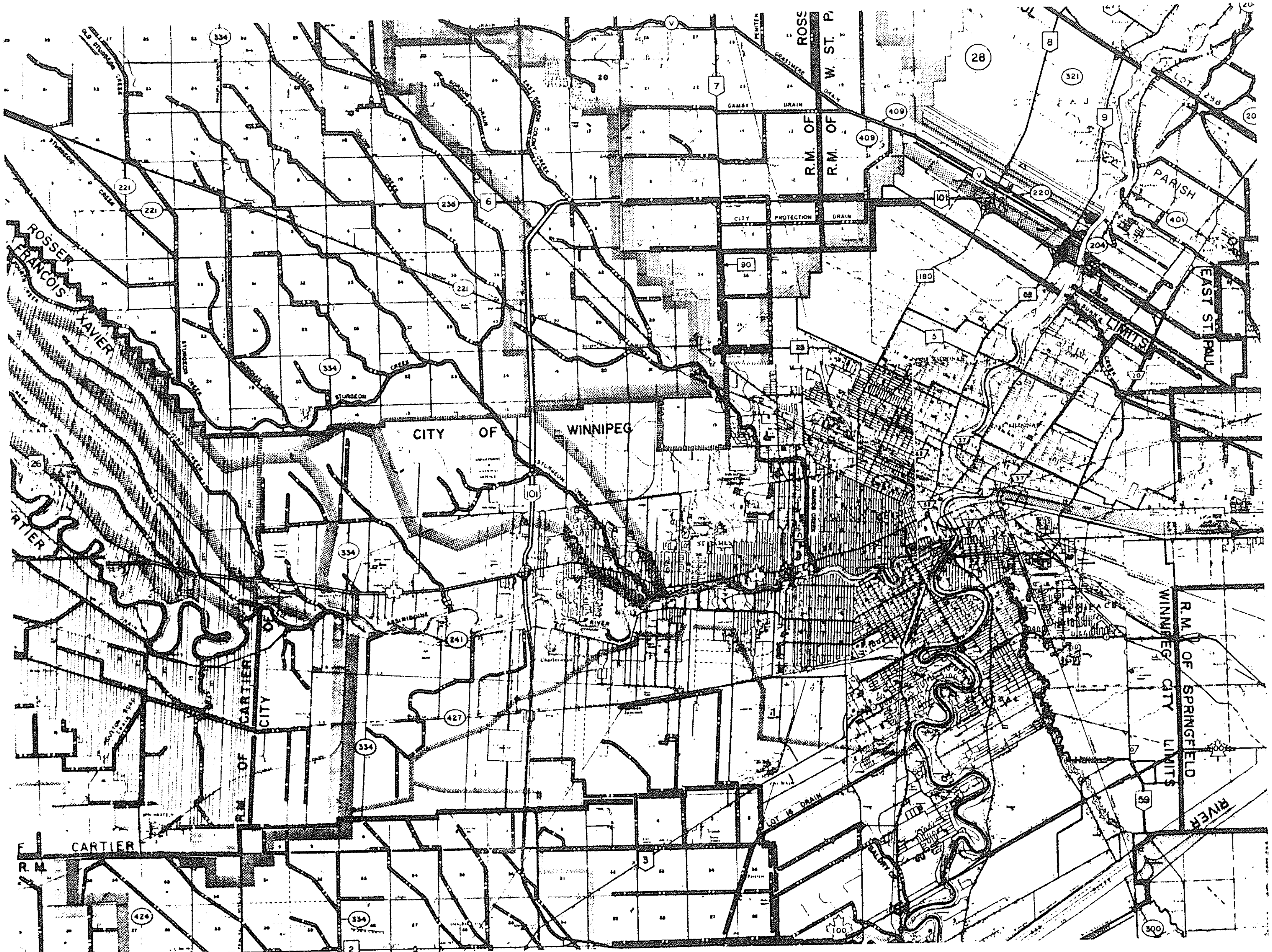


Figure 31 The Designation of Drain Orders



Province of Manitoba, Water Resources

Figure 32
Winnipeg and The Order of Drains 1984. Note that Winnipeg is protected from incursions of water from the heights of land to the northwest by a complex system of drains. This system has been built up over a century but was pre-figured by the Omands-Colony Diversion and the St. Johns Creek Drain as early as 1883.

3.4 THE SEPARATION OF RESPONSIBILITIES

Not until the 1960's did the province step in to exert control. In 1964 the Michener Commission undertook a comprehensive review of local government organization and finance with regards to land drainage. It recommended that, in general, a clear cut separation was required between local and provincial responsibilities. In dealing with drainage, the Commission recommended that the Province assume the complete control and cost of the main system of trunk drains, and that the municipality assume the entire cost and responsibility for local drains which serve the land within its boundaries (Sexton, 1975).

3.5 THE ORDER OF DRAINS

As a result of the Michener Commission's recommendations, an order system was devised for rating drains in each local watershed within the Province (Figures 31 and 32). They are as follows:

First Order - drains or watercourses serving a watershed with a drainage area of up to one mile.

Second Order - drains or watercourses serving a watershed with a drainage area greater than one square mile or having a tributary or tributaries of the First Order.

Third Order - drains or waterways formed at the point of confluence of at least two Second Order Waterways and may have tributaries of the Second Order and lower.

Fourth Order - drains or watercourses formed by the confluence of at least two Third Order Waterways and may have tributaries of the Third

Order or lower. Higher order Waterways (Orders 5, 6 and 7) are defined in the same manner.

With the ordering system the Provincial Waterway Policy came into effect, providing the Province with the responsibility for those channels declared as Provincial Waterways by Order in Council under the Rivers and Streams Act. All other drains fell under the jurisdictions of municipal governments. Essentially the municipalities retained responsibility over First and Second Order Drains and Waterways, and the Province assumed responsibility for Third Order and higher drains. Concern arose, justifiably, that a means of protecting or maintaining any natural waterways or man-made water courses did not exist. As late as 1963 the City sold a 3.2 acre parcel of land abutting Omand Park at the corner of Wolseley Avenue and Raglan Road to a Winnipeg lawyer and investor after he offered to buy the land and put in a flower garden. Sold for $2,800 the purchase agreement stipulates that he was to use the land "solely for the purpose of a decorative flower garden" and may not build on the land (The Winnipeg Tribune, December, 1979). The land has since been mortgaged for $130,000, and in 1974 the buyer attempted to have the building restriction removed by offering to lease the property to the City for the cost of taxes for sixteen years. Although the City did not accept, the investor successfully fought City efforts to downzone the property from residential to parkland.

In 1967, The Water Control and Conservation Branch Act (S.M. 1967, C.70) gave the Lieutenant Governor in Council the power to designate any water control work, natural water channel or lake as a provincial waterway under Section 21(1) of The Rivers and Streams Act. The Act, designed essentially to maintain the Province's control of outlets to the Red and Assiniboine Rivers was late and came in response to a situation already complete. Not until 1972 and the passage of Section 22(1) of the Rivers and Streams Act (R.SM., C. 231, 5.1) did the authority exist to prohibit encroachments within a 350' horizontal distance from the normal summer water mark. Although under Section 24(4) of the same Act the authority exists for agents of the province to enter upon land to check for violations, and provision has been made for the recovery of costs by action, Section 24(3), the Act is essentially without teeth according to sources at the Water Resources Division.

Chapter 4

THE TRANSITION FROM A RURAL TO AN URBAN LANDSCAPE

4.1 THE SITE OF THE FORKS

With regard to land drainage, it is hard to imagine, among the great cities of Canada, a poorer physical site for a large urban centre than that of Winnipeg. It has been noted before that had an engineer chosen the site of the future city, the Bird's Hill esker or the limestone outcrops of Stoney Mountain would have made safer and more logical choices than the poorly drained clay plain that is subject to severe spring floods from the waters of the Red and Assiniboine Rivers. Engineering logic, however, played no part in the siting of this city which owes its existence to its strategic geographical location at the junction of the two rivers. The Forks of the Red and Assiniboine Rivers was a good place from which to control the business of the fur trade.

The country about the confluence of these two rivers is a transition zone that borders on three distinct geographic and vegetation zones; The Great Plains, The Canadian Shield, and the Prairie Parkland. Each of these regions dictated diverse patterns for their inhabitants while the rivers and their tributaries provided ready access to each zone. The confluence (or Forks) of these two rivers, due to the transitional qualities of the region, was the domain of diverse peoples and cultures and the natural zone of their interaction (Guinn, 1980). Beginning with La Verendrye in 1738 and throughout the fur trade era (1730-1850), during which five forts were built at or near the Forks, throughout the days of the Selkirk Settlement (1813-1870), and well into the early years of Winnipeg (1870-1885), the Red and Assiniboine Rivers were the major arteries along which traffic flowed.

4.2 THE SETTLEMENT OF WINNIPEG 1862-1873

The first to take advantage of the initial site of Winnipeg was Henry McKenney, who in 1862 built a store where the fur-runners' trail coming down the Assiniboine to Fort Garry crossed the trail running down the Red River from the Lower Fort - the present day corner of Main Street and Portage Avenue. In 1928, M. McWilliams, writing in Manitoba Milestones, described the reaction of settlers to the site.

> With much amusement....the people from the Fort and the settlers from Point Douglas and points farther down the Red watched this building go up. It was much too far from the river, they said, and in spring the land was so low it was nothing but a swamp (Figure 33).

The most significant reasons for the siting of early Winnipeg were commercially based. After the transfer of Ruperts Land and the proclamation of the Manitoba Act in July 1870, the Hudson's Bay Company establishment at Upper Fort Garry became the seat of the government for the new "postage stamp" province and the northwest Territories. Located nearby was the first Dominion Land Office in the west, which was to handle the large and intricate business of adjusting the titles of old inhabitants of the river lots, to administer the Metis reserves, and to register the claims of new settlers. Also, the Canadian garrison stationed at Fort Garry until 1872 greatly enhanced local trade. By 1872 Winnipeg and Fort Garry were beginning to merge. It was Winnipeg that swallowed up the Fort, for the City's rapid rise as a commercial centre serving as gateway to the west exceeded and overshadowed the old role of the Hudson's Bay Company in the northwest (Artibise, 1977).

When Winnipeg was incorporated in November 1873, there were over nine hundred buildings by the end of that year. Over four hundred of these were houses, twenty-seven were occupied by manufacturers, over one hundred by merchants, and the balance were offices, hotels, boarding houses and saloons. By fall of 1874 the population of the community had grown to three thousand and the assessed value of the city property amounted to over $2,000,000.00 (Artibise, 1977). If Winnipeg were to grow, the growth, it was realized, would only be achieved through immigration and railroads.

> The two great wants of this country are railroads and settlers. The former is necessary to secure the latter. (MDFP December, 1873).

In December 1874 Prime Minister Alexander MacKenzie announced the continental railway would cross the Red River not at Winnipeg, but at Selkirk, and run north westward to Edmonton. This announcement precipitated persistent lobbying by the City of Winnipeg between 1875 and 1881 and vociferous denials of its alleged flooding problems. Ultimately the City's offer of $500,000.00 to aid in the construction of the Louise Bridge, exemption from taxation forever to all C.P.R. property, the grant of free land for a passenger terminal, plus $200,000.00 in cash, carried the day. In 1881, a main route through Winnipeg was confirmed, and in the years following this decision, Winnipeg became the most populous and prosperous community in Western Canada. During these early years, and well into the twentieth century, economic and population growth were the City's primary goals and the City Council did everything in its power to encourage railway development, and nothing to control it. This attitude had serious consequences for Winnipeg's physical appearance and altered the natural drainage regime for all time.

4.3 THE CITY OF WINNIPEG: THE FIRST DRAINS

It was apparent to the citizens of Winnipeg and the City Council that if Winnipeg was to develop, the issue of urban land drainage had to be met and resolved. As early as the spring of 1874 Council discussed the issue of storm sewers and passed a bill appropriating money for them. The expenditure of public monies on land drainage by the City Council was begrudged from the first. Throughout the spring of 1876 there was considerable debate concerning sewers, their value and efficiency. In May there was a debate as to whether or not the City Engineer, T.H. Parr, was worth $1000.00 a year, and the sum of $600.00 was proposed as more appropriate. The Manitoba Daily Free Press reported that on Monday, May 14, the Council decided it was the wrong time to eliminate a city engineer when the first sewers were being laid that year. "After the sewer was completed, the reductions might be made." (MDFP, May 15, 1876).

City Council was clearly not aware that sewers and land drainage are a comprehensive long term commitment. The treatment of the issue of land drainage over the next fifteen years says a great deal about the nature of these men's vision of the City of Winnipeg. That early City Councils were run by businessmen acting to protect and promote vested interests, and not the common good, has been well documented (Artibise, 1975). On May 15, 1876, the bill for the construction of the first sewers in Winnipeg which, in its initial wording had placed the authority for the sewers in the hands of the City Engineer, was changed. The decision of the, "City engineer as to the quality of materials and work" was amended by Council to read, "Subject to appeal to Council" and the "work was placed under control of Council instead of the Board of Works." (MDFP, May 15, 1882). This action effectively hamstrung the City Engineer and the Board of Works, placing their expertise at the mercy of businessmen. This pattern was to be repeated over the years. The first decisions, it appears, were politically based rather than grounded in sound engineering practices. The spring flood of 1877, in which several thousand dollars worth of damage was done, was the first of a century of floods attributable to man's interference with the natural drainage regime.

4.4 <u>THE WATERS OF COLONY CREEK</u>

Many of the problems faced by Council in the early years can be attributed to the original encroachments upon the flood plains of Browns Creek. Development proceeded incrementally along this waterway during the years 1848-1874 (Figures 34 and 35). The 1860's were dry or average years and the serious implications of the continued encroachments into the flood plains and the coulee itself did not begin to appear until the wet years of the late 1870's and early 1880's. Had this stream not been encroached upon, few of the ensuing problems would have developed. But once man has invested his time, energy, and money into the alteration of a natural waterway, there is, the experience of history teaches, no going back. From that point onwards all actions are stop gap and ad hoc until the fundamental nature of the problem is comprehended.

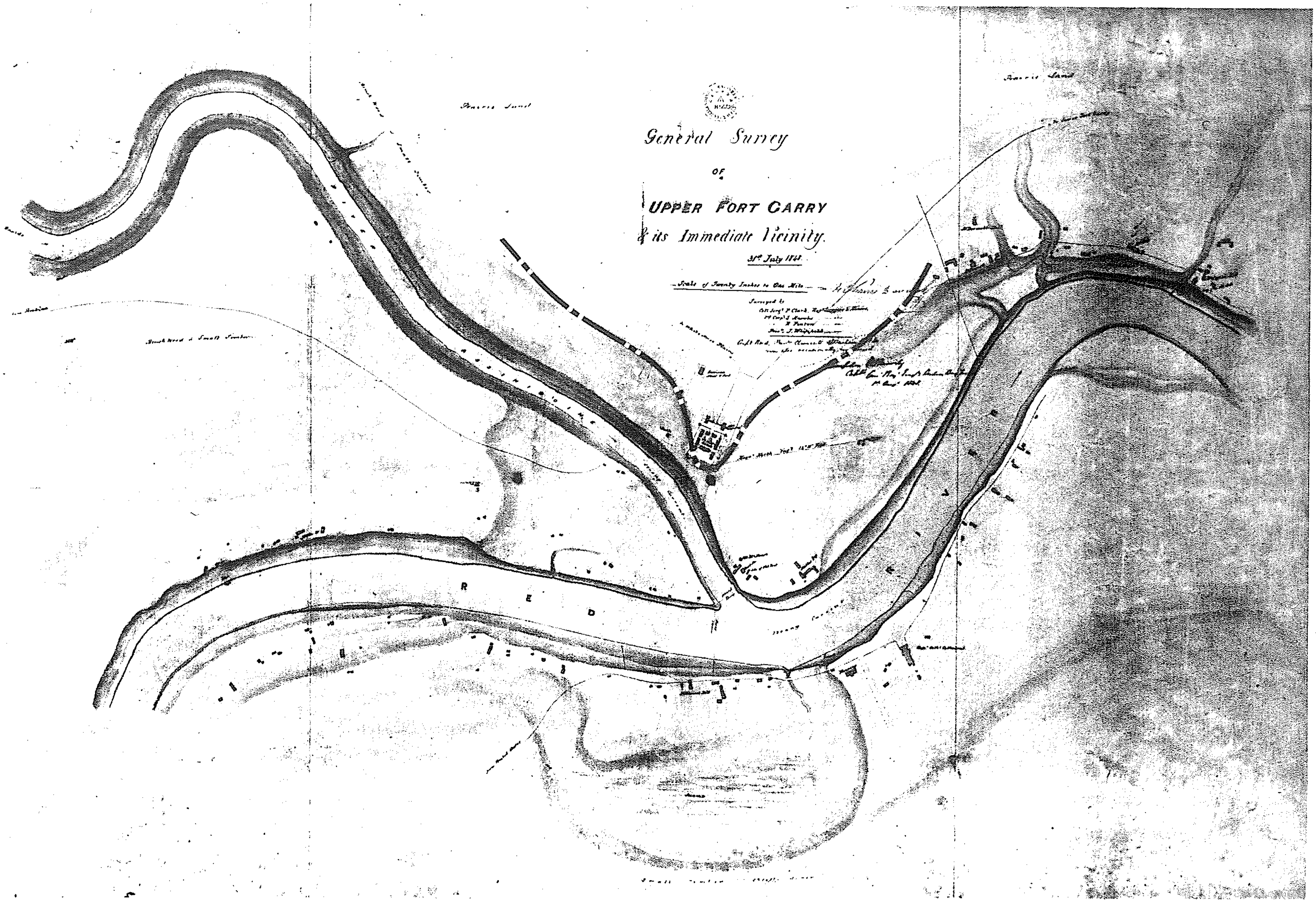
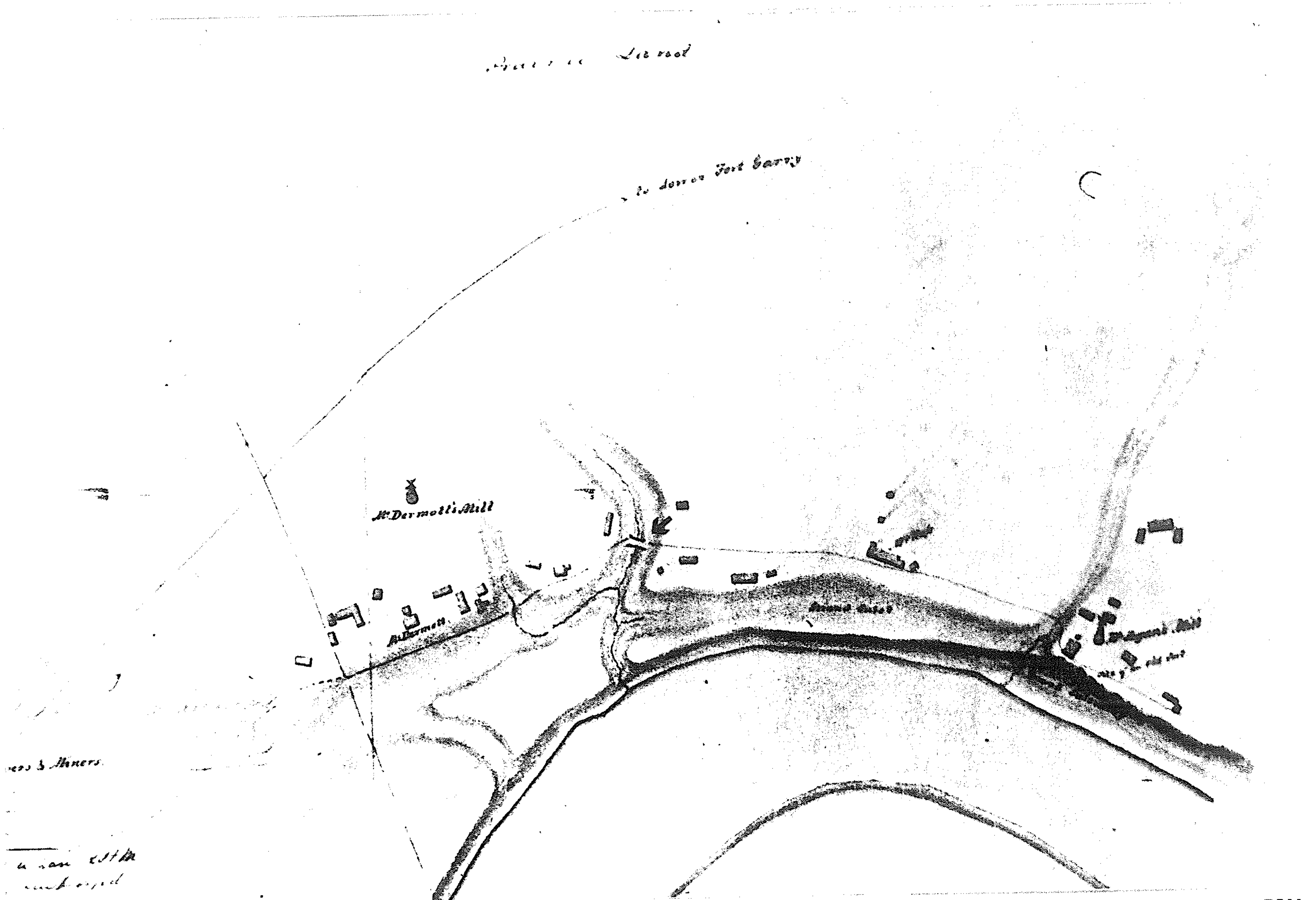


Figure 33

PAM

This fine water color map gives the clearest possible picture of the topographic character of the region surrounding the "forks". Note Fort Garry is located on the highest point. All other areas were clearly subject to frequent inundation.



PAM

Figure 34
Encroachments on Browns Creek, 1848: Detail of Figure 33. The encroachments on Browns Creek that began well before 1848, and reached a climax with the construction of the City Hall and the Market in its floodplains, can be cited for the loss of this and five other streams in the Colony-Omands Diversion of 1880. Note the bridge over the stream bed proper of Browns Coulee.

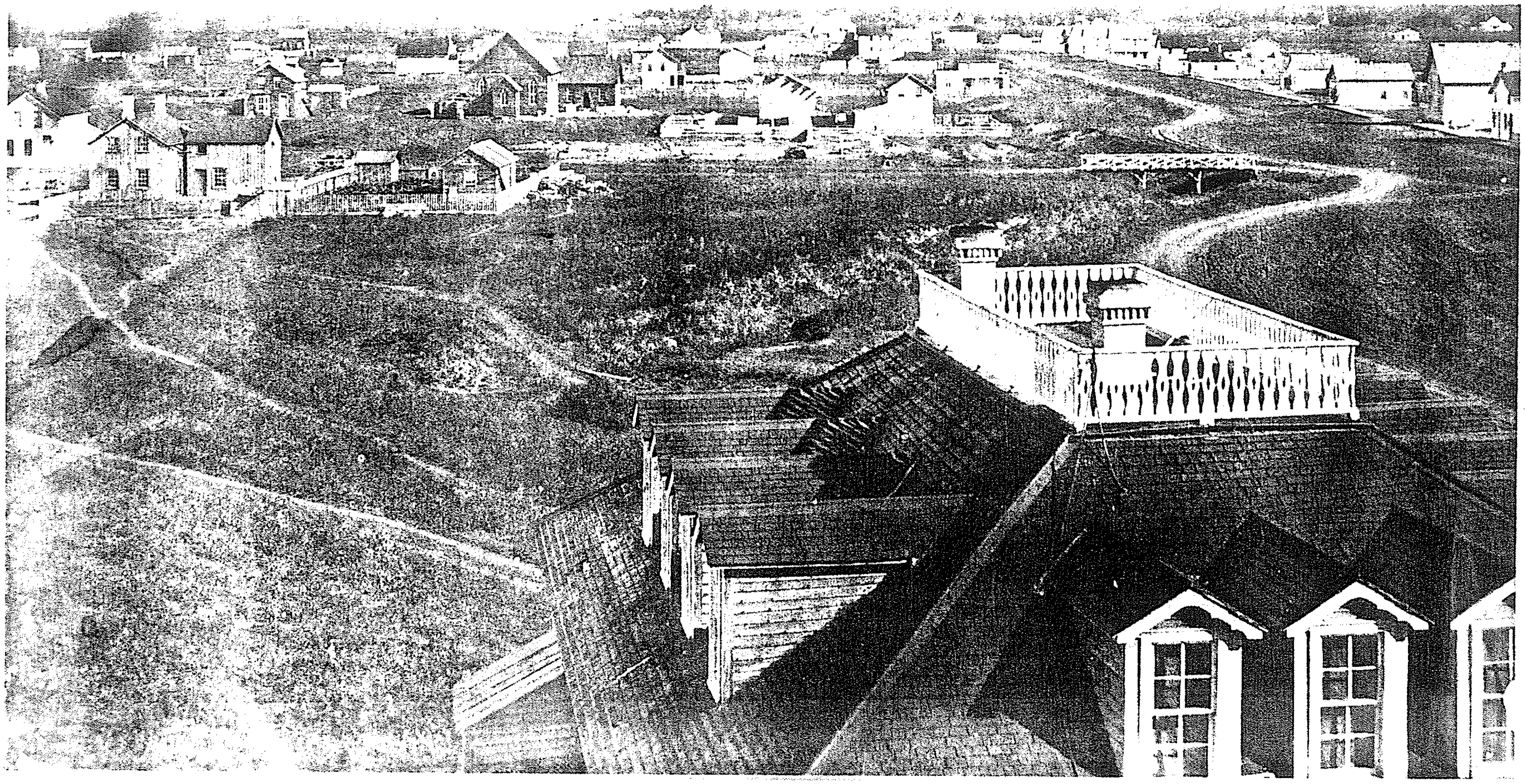


Figure 35
PAM
Encroachments on Browns Creek. This photograph, circa 1871, indicates the investment in real estate along the coulee of Browns Creek. Due to the low gradients, photographs do not give an accurate picture of the size or depth of this coulee which was over 50 feet wide and capable of carrying over 8 feet of water.

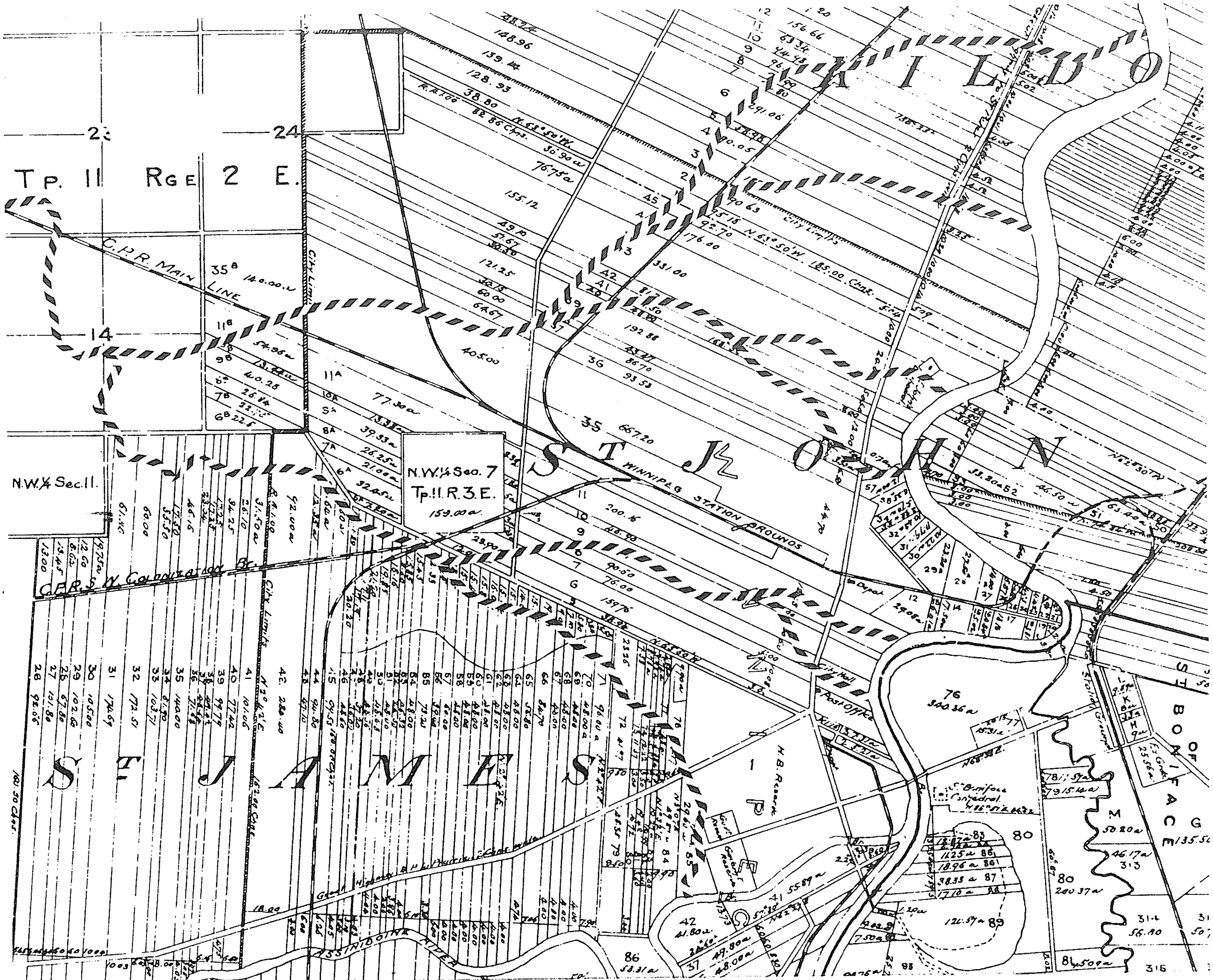


Figure 36

C.S. Lott base map in private collection

The Paths of Colony Creek After Doupe. The dotted serpentine lines indicate the approximate paths of Colony Creek as surveyed by Joseph Doupe, 1880.

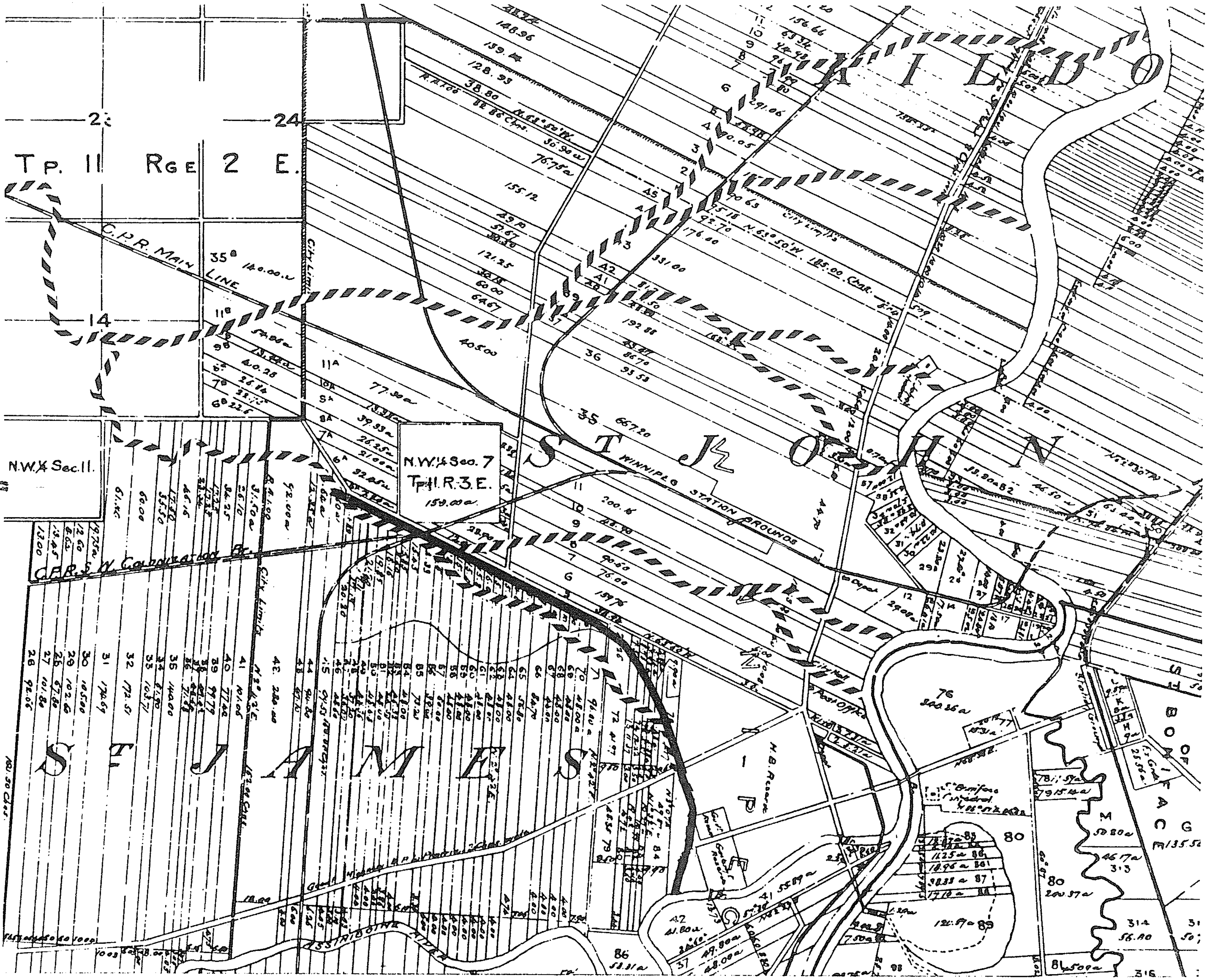


Figure 37 The Doupe Diversion Proposal
This proposal would have taken advantage of the natural inclination of the waters towards Colony Creek Coulee.

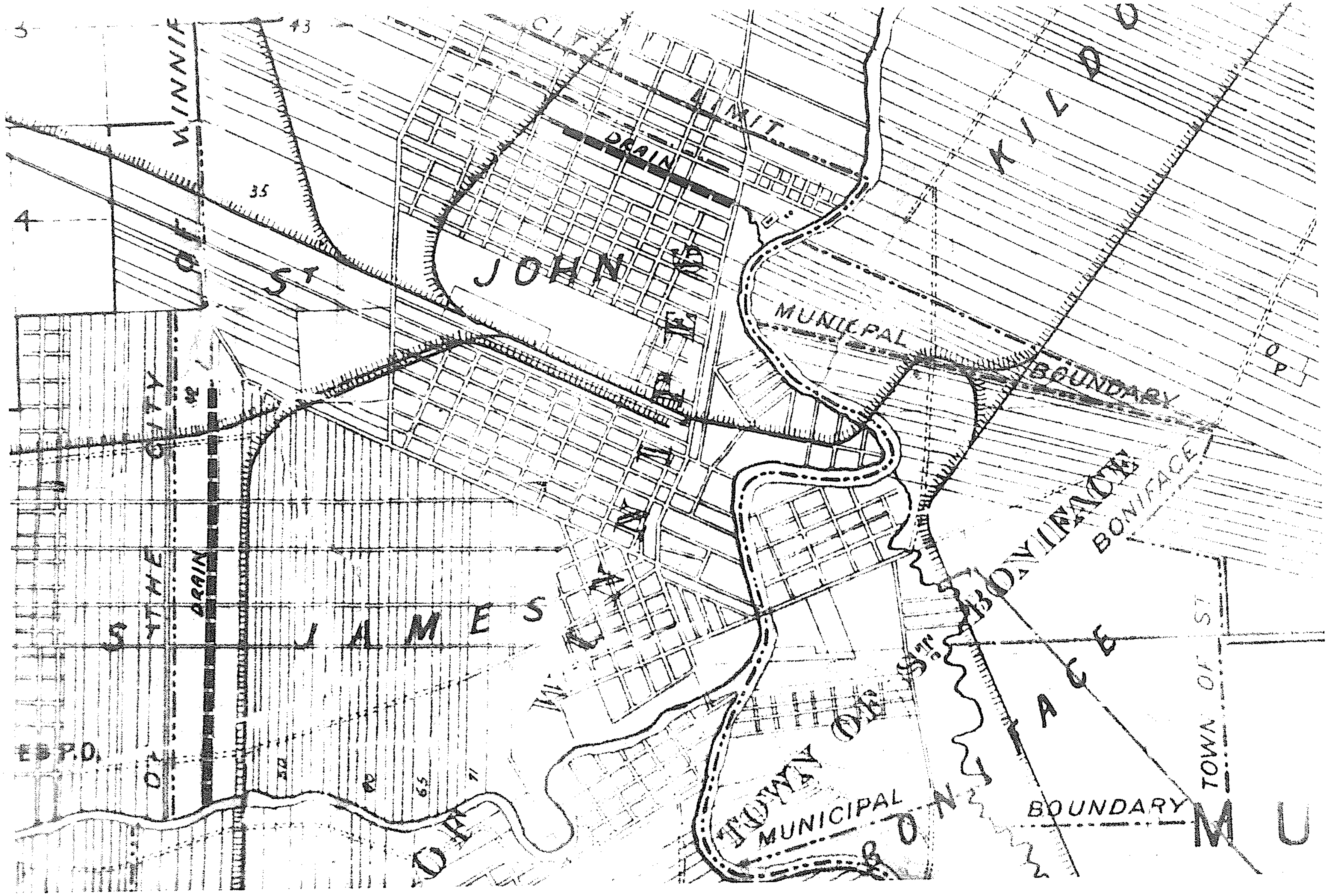


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Figure 38
The Omands-Colony Diversion (Detail of Figure 14)
The Omands-Colony Diversion was a joint Federal, Provincial and Municipal undertaking in 1880. Note that the diversion, in combination with the drain utilizing St. Johns Creek as an outfall, protected the city from the problematic waters arising in the northwest.

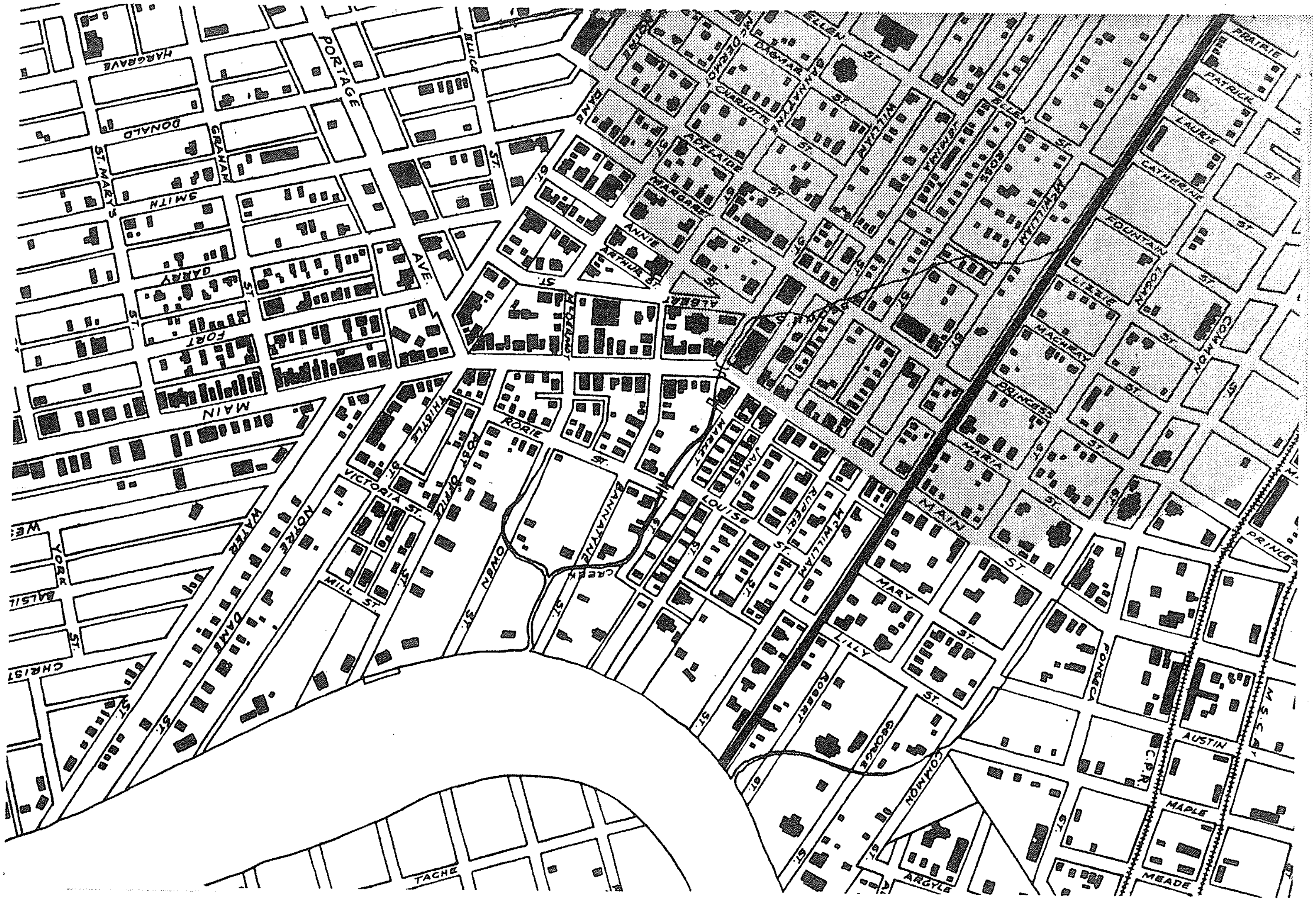

Figure 39

Base Map Courtesy of Ralph Baker,
Dept. of Environmental Planning, C. of W.

The Colony Creek Flood of 1882. Although the shaded area is approximate, and developed from newspaper accounts only, it gives a good picture of the size of this flood. Waters in excess of 3 feet were reported in some regions and the Alexander Street Flume (the black line) was unable to drain the floodwaters.

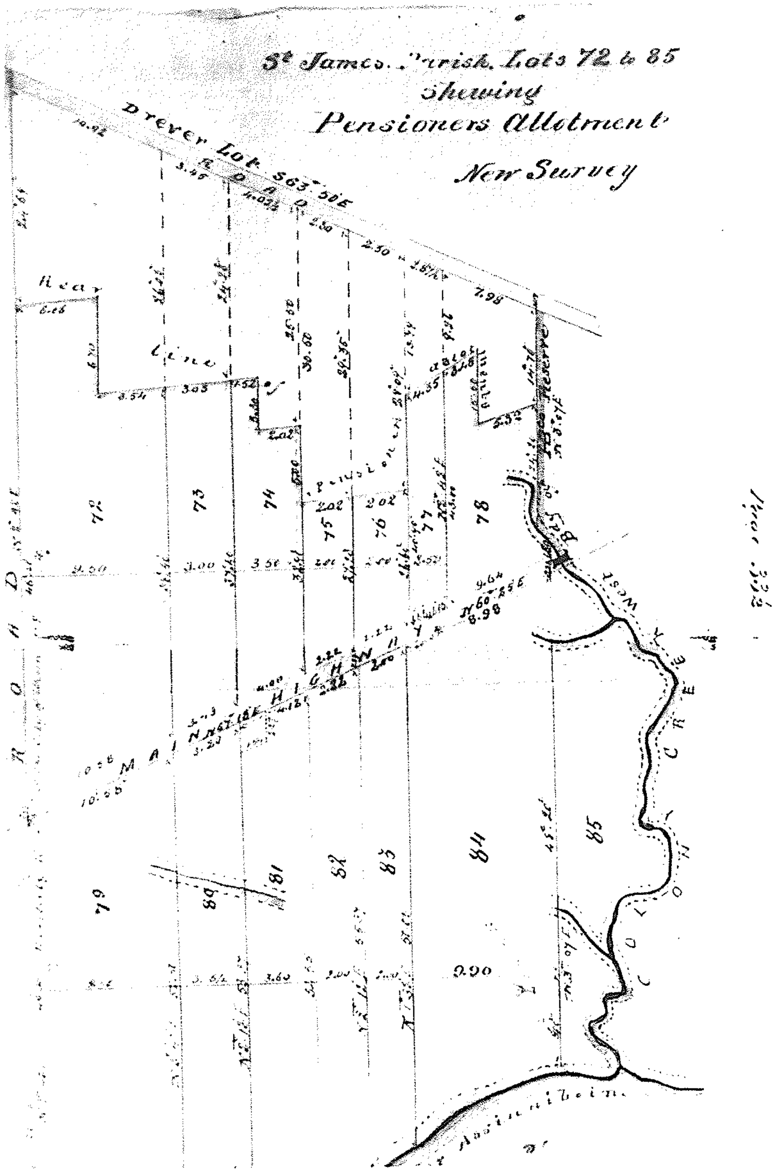

Figure 40 PAM
Colony Creek in St. James Parish, 1874,
Survey Notebook No. 538.
Note the stepped configuration of lots west of the coulee which may possibly be attributed to drainage runways acting as natural boundaries.

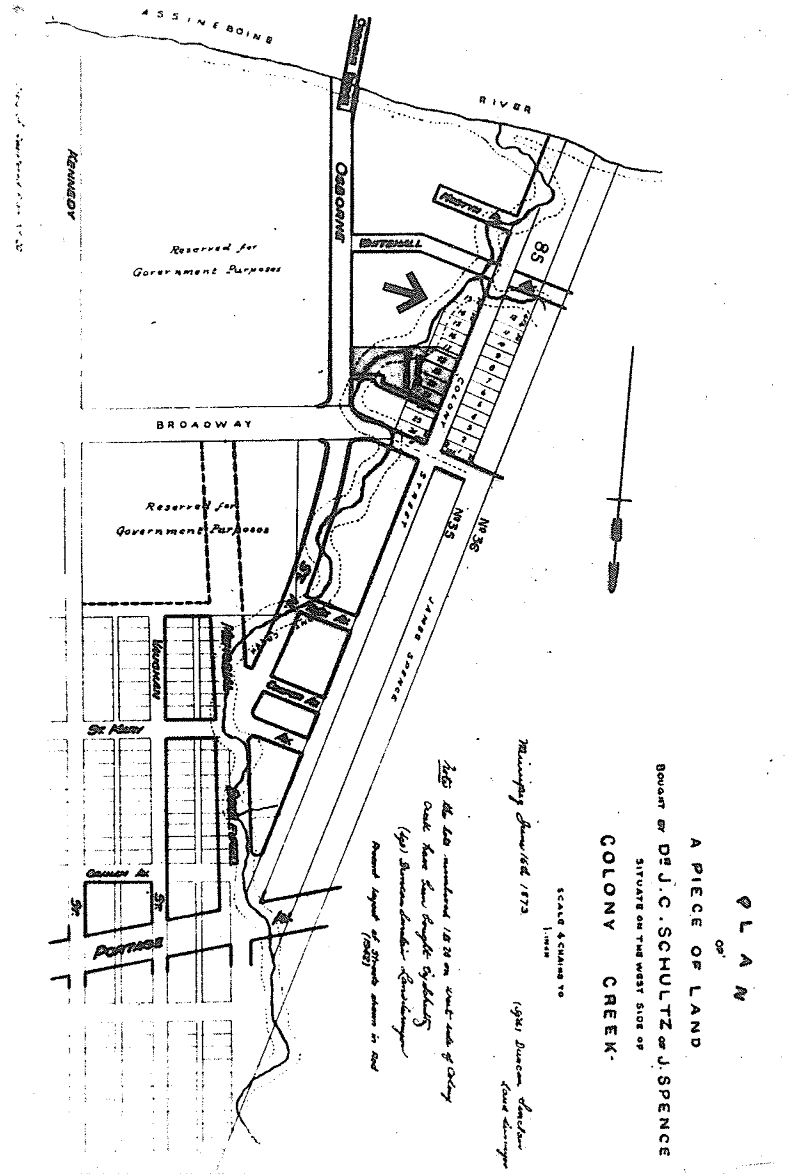

Figure 41 PAM
Dr. Spence was one of the first men to sue the city, in the last century, for damages arising from alterations to the streams. Note lots laid out in the floodplains of the coulee proper.

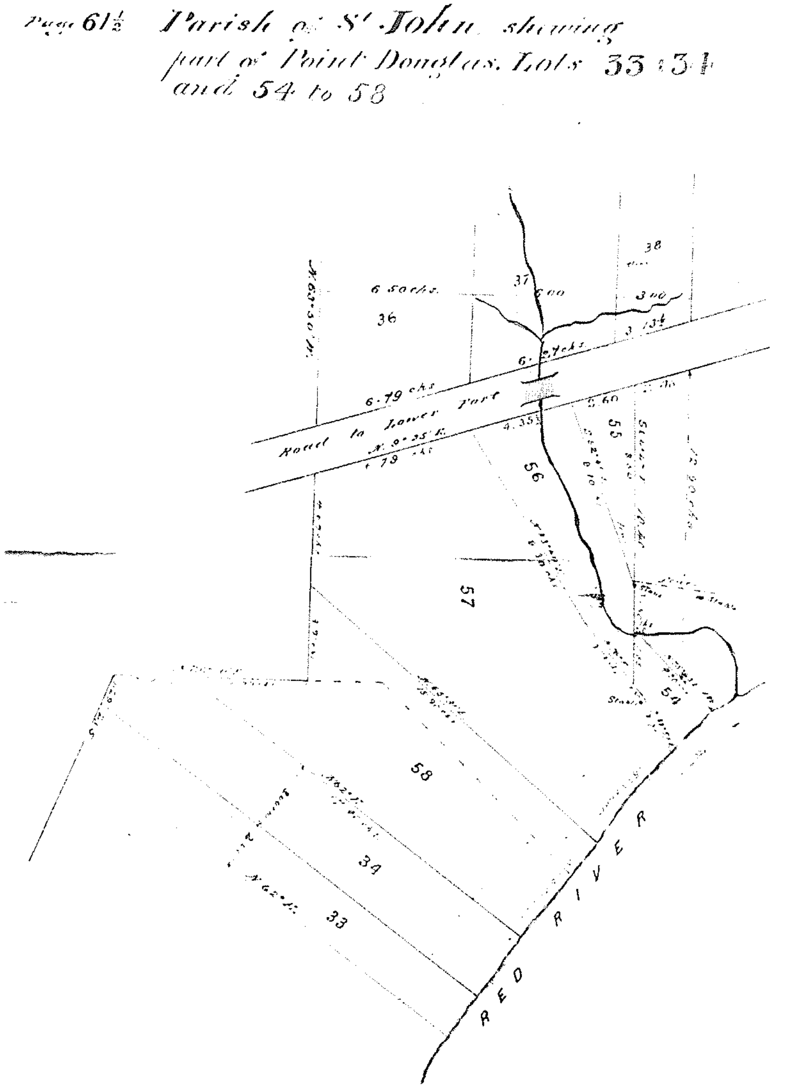

Figure 42 PAM
Pritchard Creek 1874, <u>Survey Notebook No. 538</u>
Note the bridge over what was later to become Main Street and the indication that this Creek drained waters from three directions.

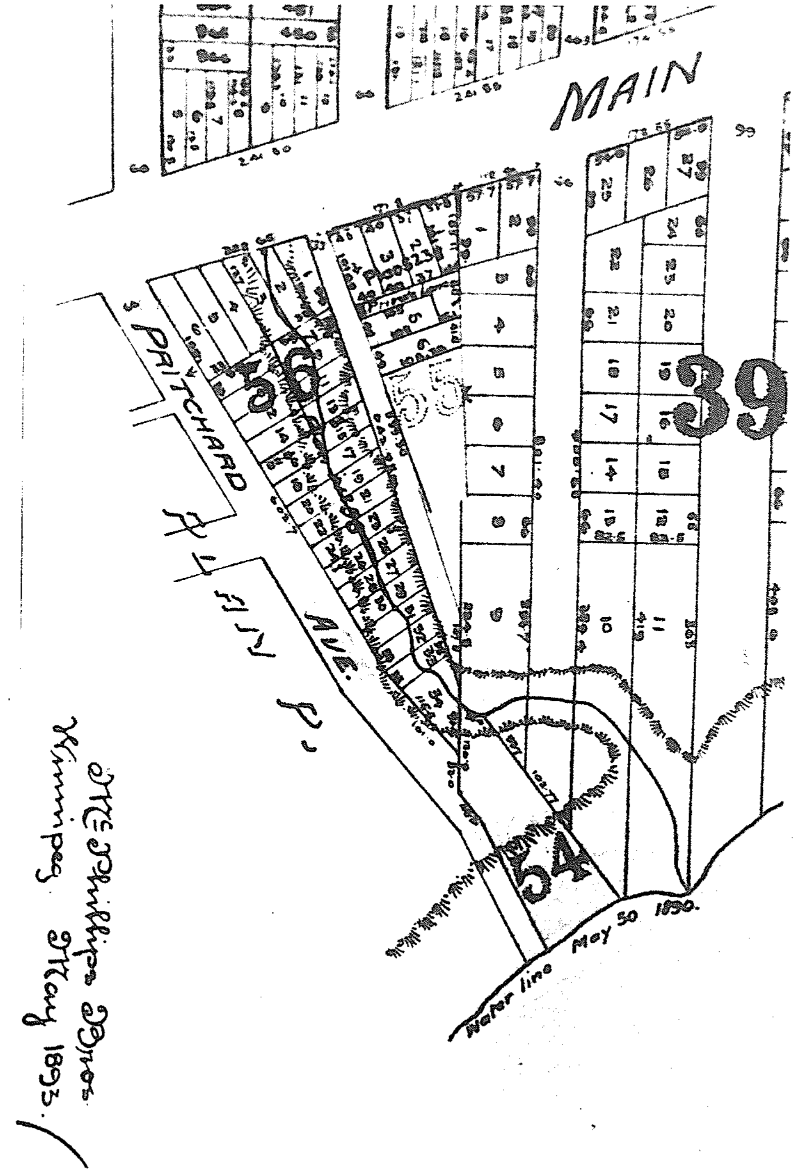

Figure 43 PAM
Pritchards Creek 1893
Note the layout of residential lots over the bed of the former stream that once carried waters from one of the arms of Colony Creek.

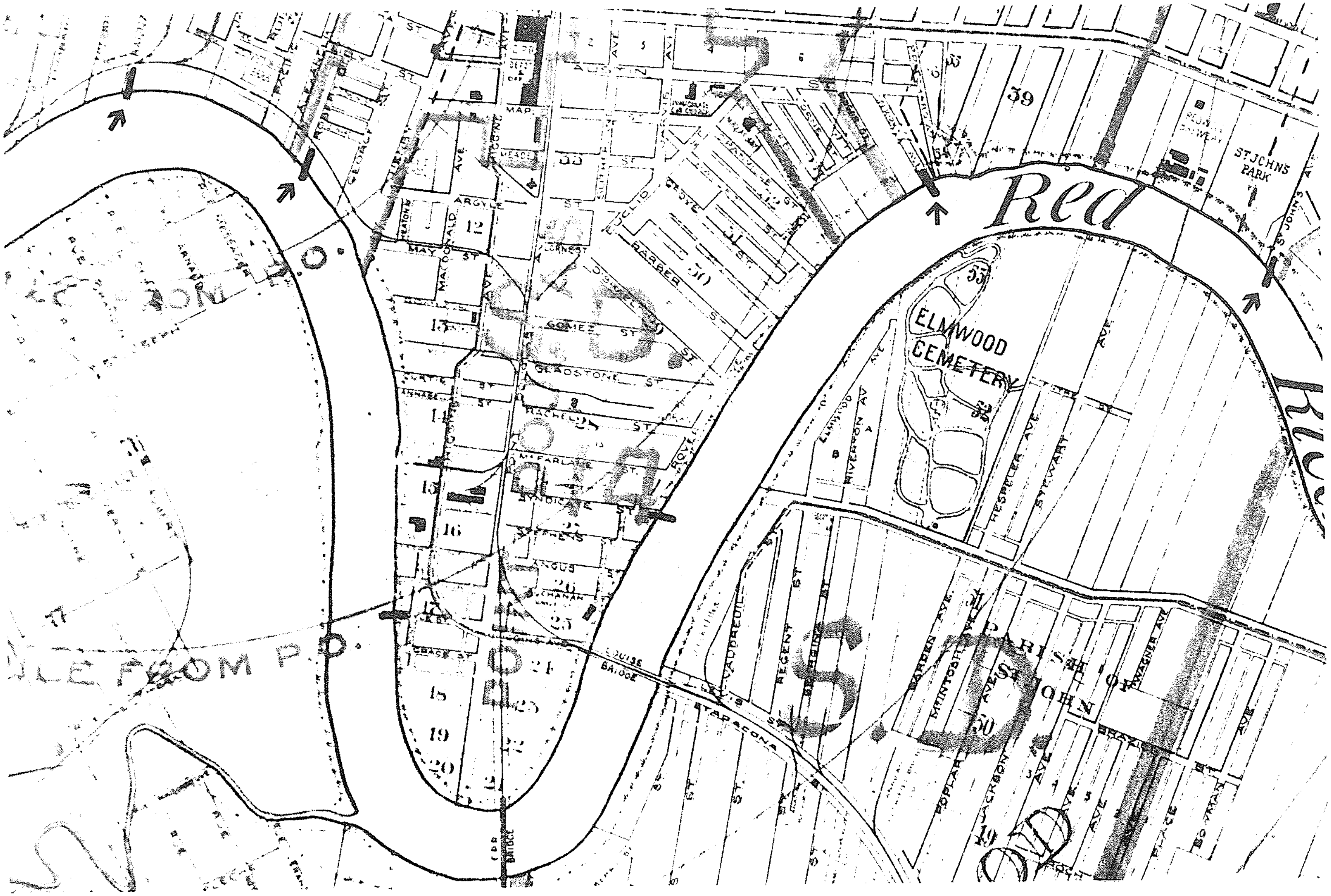

Figure 44

PAM

Sewer Outlets Replace the Streams

By 1905 the mouths of the streams had been replaced by combined sanitary and storm sewers that were laid in or adjacent to the coulees of the former creeks.

4.4.0.1 THE FLOOD OF 1877

On April 20, 1877 the Manitoba Daily Free Press reported that,

> The warm weather of the past few days melted the large snowbanks on the prairie north and west of the city.... and the three great natural outlets being cut off without adequate provision having been made for carrying off the water, the consequence was that part of the city being lower than the prairie, the water came pouring down in large quantities.

The gullys of the three natural outlets, Colony, Browns and Logans, had been filled or culverted. The Board of Works had installed one underfit culvert, on Browns Creek where it had formerly crossed Main Street over the objection of T. H. Parr City Engineer who "...it was said" had intended "more than one outlet, but the Council decided otherwise." (MDFP, April 20, 1877). Alderman More pointed out in Council that "He himself had told them that eight feet of water came down the gully (of Browns) by the Market and... that amount couldn't be put through a three foot pipe. We could see that more outlets were necessary." The consequence was that the bed of Browns Creek west of Main Street began to fill and spread over the area.

> To meet the emergency, a dam, about 150' in length was constructed on Alexander Street, several blocks north-west of the market; and to carry the water to Logan's Creek, gangs of laborers were put on to construct a drain from the miniature ocean to the creek ... in former years large quantities of water were drained off by Logan's Creek, but this year scarcely any found its way to the river through it. (MDFP, April 20, 1877)

The City and/or private land drainage systems had clearly interfered with the natural drainage of the region. The efforts of the City to deal with the floodwater read rather like a version of Walt Disney's <u>The Sorcerer's Apprentice</u>.

The dam on Alexander Street,

eased the water from the gully at the market, ...but being backed up it spread over the land northwest of the hall, (City Hall) and... describing a semi-circle coming down across lots to Alexander Street and reaching Main Street... Here a drain was cut across Main Street, which drew off a little of the water into a catch-basin on the other side of the street, by which it found its way into the main sewer, but the larger portion poured down the gutter, carrying away the earth filling of the street...and filling the gully north of the Market. At this time there were a large number of houses out on the prairie which were entirely surrounded by water...., the Alexander Street dam was broken, orders to that effect being given. This eased the rush of water that was coming down Alexander Street just referred to; but of course the water rushed into the gully south of the market, and rising rapidly ... it reached the level of Main Street, small streams crossed the road and ran into the gully on the other side. the cellars of ... the market were filled to the ceiling... Viewed from the roof of the City Hall, the prairie northerly and westerly appeared to be covered with large lakes, extending over an area of probably four square miles, and .... averaging a foot in depth. (MDFP, April 20, 1877).

The approximate amount of water passing through the three outlets of Browns, Logans and Colony would then be 445,054,400 cubic feet.

The amount of water is a great deal larger than is usual in the spring; but those who ought to know are confident that such is not the case, and ... the flooding is mainly attributable to the very sudden thaw and the stoppage of the natural outlets ... The sewers, not being constructed to their entirety, (another outlet to drain a great

> portion of the deluged land not having been constructed owing to the want of the necessary funds)... were unequal to the task of carrying off such a vast body of water as lies to the North-west of the City. (MDFP, April 20, 1977).

Terming the amount of water unusual indicates the predicament settlers in a "new" land face without extensive meteorological records. The years 1875-1880 are now classified, a century later, as wet years. It is highly unlikely that had the sewers been constructed to their entirety, such a volume of water could have been carried off without access to the natural outlets. In a Council meeting of April 23, 1877 Alderman Alloway stated that, "no engineer would think of draining all the water that came off the prairie this year which flowed in from 8 to 10 miles out." Opinions, however, differed sharply on the Council, Alderman Brown stating "that anyone could take off the water if he had money enough to build sewers out into the country." Alderman Alloway put "blame ... upon the North Ward alderman... who, because a sewer was built in the South Ward, must have one in the North, without waiting to see how the system worked." (MDFP, April 24, 1877).

In a particularly sanguine frame of mind, Alderman McNee felt that there, "was no occasion for alarm, nor need to go to any great expense to save a few citizens from a temporary inconvenience" (MDFP, April 24, 1877). The remark, although perhaps not typical, was hardly an attitude to be expected from a City Council aspiring to civic and commercial greatness. The divisiveness in Council was characteristic of the infighting between wards (Artibise 1975) and also clearly indicates that land drainage was being treated on a piecemeal basis, heavily influenced by political and financial considerations. The nature of the landscape upon which the City was being built was not being treated as a whole problem and would not be so treated for nearly one hundred more years. Despite an amendment passed on April 23 to create "a special committee with power to consult and examine resident engineers and send for persons and paper and report upon the sufficiency of sewerage and also to report upon a remedy against flood ....", the spring of 1878 brought renewed flooding.

The April floods of 1878 were further exacerbated by underfit sewers and the blockage of the natural outlets. Broken sewers, erosion and property damage were again the result. On May 13, A.G.B Bannatyne approached the City Council,

> calling attention to the dangerous condition of his warehouse on the bank of the creek opposite the open portion of the sewer, where the action of the water had caused the land to slip, drawing the piles away, and asking that the sewer be repaired or he would look to the city to make good any damage. (MDFP, May 13, 1878).

By 1878 health problems associated with the pollution of stagnant ponds by raw sewage seeping from box-closets were common place in the summer. If the City was to be connected to the railway, and grow into the commercial centre envisioned by City Council, the issue of land drainage, it was recognized, would have to be dealt with on a larger scale. A number of solutions were proposed, each of which sheds light on the nature of conditions in the area at the time, and indicates the several conceptual approaches to the problem.

4.5 THE FIRST LAND DRAINAGE PLANS

4.5.1 PROPOSAL A

In May of 1878, T. H. Parr, City Engineer, and the Board of Works proposed a wooden flume, six feet square and "six inches narrower at the top so that it would be bound in place by the pressure of the earth on its sides", to be laid down Alexander Street in "such a way that the top could be made available for a sidewalk" (MDFP, May 28, 1878). Presumably the wooden flume was intended to minimize the risks of erosion by the velocity of the large volumes of water during spring runoff. The question arises, if 8' of water was not uncommon in

Browns Creek then why was it felt a 6' flume would be sufficient? That a wooden flume 6' wide, set in the ground to a depth of 6' would be subject to severe frost heave does not seem to have occurred to anyone.

The flume, estimated to cost $8000.00, was intended to carry off the waters of Colony Creek sheet draining from the northwest towards the coulees of Browns and Logans Creeks (MDFP, May 14, 1878) (Figure 36). Parr stated that "the flume proposed would carry off all the water which accumulated in that portion of the city as well as all that came from the north and at the same time would prevent... water flowing south and flooding the low land in the vicinity of Notre Dame Street." (MDFP, May 28, 1878). It was pointed out to Council by Alderman More of the Board of Works, "that a great deal of the sickness in the city during the past two years had been caused by the stagnant waters behind the city... the outlet proposed was the shortest route to the river and would also relieve Alderman Logan from any further damage to his property" (MDFP, May 28, 1878). The Alexander Street flume was acknowledged by Parr to be only part of a larger $25 - $30,000 scheme (MDFP, May 28, 1878). There is today no graphic record of this early master plan for draining Winnipeg.

4.5.2 PROPOSAL B

Unconvinced by Parr's flume proposal, Council called upon Joseph Doupe D.L.S. to give a second opinion. His proposal prefigures later diversion schemes in its combination of man-made ditches and natural streams. Doupe testified that from his field survey, "he had come to the conclusion that nearly all the water which overflows the back part of the city comes from the S.W. quarter of section 14, Township 11, R2E where Colony Creek spreads out and runs all over the prairie, both north and west" (MDFP, May 28, 1878). Doupe stated that the proposed Alexander Street flume would only carry off all the water if it were "continued beyond the city limits... and said ... the least expensive plan would be to carry the flume down Notre Dame Street west and tap Colony Creek at a cost of $11,000" (Figure 37) (MDFP, May 28, 1878).

4.5.3 PROPOSAL C.

Alderman Fonseca proposed that "Alexander Street was not the place to build it (the flume) but it should be laid down Common Street..." as the, "excavation would be materially reduced by the utilizing of Logans Creek, east of Main Street..." (MDFP, May 28, 1878). This proposal was similar to proposal B in its combination of ditch and natural watercourse.

4.5.4 PROPOSAL D.

The final proposal put forward by Alderman Lyon might be termed the "good steward" scheme and combines eminent sense with sensitive whimsy. Lyon thought the easiest way to handle the flooding problems would be to, "open the natural watercourse by the City Hall (Browns). If that had not been filled up there would never have been any trouble from water. He was afraid ... if the city undertook to drain ponds they might get into trouble, as ... residents in the suburbs might want to raise ducks and would sue the city for damages if their ponds were taken away" (MDFP, May 28, 1878). It is difficult not to be cynical and assume that Lyon's proposal made too much sense to be listened to. In any case, it was doomed due to the extensive investment in property within the flood plains of Browns Creek.

The Alexander Street flume proposed by the Board of Works was adopted by City Council on May 28, 1878. The larger portion of this scheme, acknowledged by Parr to total up to $30,000 was not, it appears from Council Minutes, ever presented to Council who opted for an entirely man-made scheme that made inadequate provision for frost heave and was incapable of draining the waters ponded by the blockage of Browns and Logans Creek. From a close reading of Council meeting records in The Manitoba Daily Free Press, it would appear that the Doupe proposal, which treated the drainage issue at a regional scale, was ignored for political reasons. The proposal to re-open the course of Browns Creek was not even discussed.

The flume was partially constructed during the summer of 1878 and suffered considerable damage due to frost heave that winter and during the spring runoff of 1879. The flume, as constructed, had indeed proven to be inadequate to drain the standing waters and on May 27 the City Engineer was instructed by Council to, "advertise for tenders for excavation of the ditch to the City limits." (MDFP, May 27, 1879).

4.6 THE DIVERSION OF COLONY CREEK

During the wet years of 1870's, as the marshes filled and spilled over into intermittently drained lands, it became clear to the Provincial Government that if the Red River Valley was to attract and hold agricultural settlers, a system of drainage would have to be applied.

> The evils arising from a super abundance of water, caused by a succession of very wet seasons, could only be counteracted by an efficient system of drainage. Immigrants were either deterred from entering the Province, or were forced to pass through it and settle on drier plains beyond... Extensive marshes in dry seasons of seven or eight years ago comprised comparatively small areas, but, augmented by the wet seasons of the last three or four years, have overflowed and deluged the surrounding country, in some sections forcing settlers to abandon homesteads... so general did this state of things become that there was a serious question as to what effect it would have on the permanent settlement of the country. (Elliott, 1978).

During the late 1870's the Provincial Government constructed drains to the Assiniboine River and others were dug in connection with new railway construction. The first diversion of Colony Creek was a narrow and shallow ditch connecting the West branch of Colony Creek with Omands Creek, excavated (in part) to divert the water of Colony Creek from undermining the bed of the Midland and C.P.R. South Western Branch Railways (Figure 38). However in the wet spring of 1880, the MDFP of June 24 reported that the "railroad grade on the Winnipeg Branch is making a regular dam along a part of its way, and backing water over large sections of country west of the City." The problem was to reoccur over the next few years.

4.6.1 COLONY CREEK AND THE FLOODS OF 1880-1882

Due to the establishment of the railway beds and despite the rudimentary diversion, severe flooding was experienced in the City of Winnipeg due to the waters of Colony Creek in 1880 and again in 1882. The Alexander Street flume "succumbed in several places under pressure of running water" (MDFP, April 29, 1880). Culverts collapsed, properties encroaching on the stream were severely undermined, and damages were claimed for the first time against the City by James Spence, "arising from the Portage Road being diverted through his property on account of the washout on Colony Creek" (MDFP, July 28, 1880). The damages claimed by Spence were to be the first of a long series of such claims by citizens against the city, up to, and including the present day.

Reports of City Council meetings published in the MDFP, indicate that local drainage (private) works were still being undertaken piecemeal, proceeding incrementally, as was the filling in of natural streamcourses. Caught between damage claims resulting from inadequate drainage works, the continuing demands for land drainage by private citizens, and mounting expenses for repairs to drainage works already installed, the City turned to the Province which in turn requested the assistance of the Dominion Government. The diversion known today as Omands Creek was the result.

On June 1, a committee consisting of Alderman Wright, Pearson, Strong and Alloway was formed to "wait upon the Minister of Public Works with reference to the widening and deepening of the ditch between Omands Creek and Colony Creek" (MDFP, June 1, 1880). The Hon. C. P. Brown, Minister of Public Works had already received a petition "from a number of citizens respecting the condition of Colony Creek" (MDFP, June 15, 1880). On July 13, the "special committee appointed to interview the Government in reference to the excavation of a ditch between Colony Creek and Omands Creek", announced to Council that "it was the intention of the Government to proceed..." (MDFP, July 13, 1880).

> The waters of Colony Creek, which lies outside of the city limits, were formerly carried in two different directions, one branch spreading itself out in a northerly direction, and finding its way into the Red River through St. Johns College Creek, Inksters Creek, and other outlets; and the other branches emptying into the Assiniboine near Fort Osborne, and at points further west. In order to drain a large portion of the City, a ditch thirty feet wide was cut, by the advice of the city engineer, under the joint authority of the local and The Dominion Governments, extending from Colony Creek near its intersection by Notre Dame Street to Omands Creek by which it was connected with the Assiniboine River. A dam was at the same time built across the branch which emptied its waters northwards, in order to force the entire stream into the ditch... Along the east side of the ditch a quantity of earth was thrown up, forming an embankment to prevent any overflow in the direction of the city. (MDFP, April 24, 1882).

The winter of 1881-1882 was marked by an exceptional snowfall late in the season all of which melted rapidly in April 1882 while the ground itself remained frozen.

> For many miles the unusually great quantity of snow which had covered the prairies has all melted, leaving the whole country under water as far west as Long Lake. The natural tendency of this water is...southward... its course, being interupted by the grading of the CPR, ... has been dammed up so that its depth north of the track is in places 2 or 3' deeper than that to the south. (MDFP, April 24, 1882).

The waters of Colony Creek, diverted into the Omands ditch diversion which was underfit for the intensity of flow, broke through the ditches eastern embarkment and the,

> water no longer kept back was then confined between the grading of the Manitoba South-Western Railway and the CPR South-Western Branch and The Air Line... This resulted in its rising and finding its way rapidly down Logan street, aided by the ditches along the sides, the Alexander Street ditch and flume being insufficient to carry it away. (MDFP, April, 24, 1882).

The water "flooded the entire area of the city" (Figure 39) and "seemed to culminate in the gully at Ross Street seeking the old natural outlet by the creek (Browns) to Red River, but here again its efforts were prevented, for in closing up the natural outlets no sufficient provisions had been made to supply their place." (Manitoba Sun, April 24, 1882).

At the, "corner of Logan and Princess Streets a water wheel might have been driven." (Manitoba Sun, April 24, 1882). The city in a northwesterly direction and "away beyond as far as the eye can reach is more like an inland sea or lake than a prairie" (Manitoba Sun, April 24, 1882). To relieve the floodwaters City Engineer T.H. Parr was obliged to cut through the embankment of the CPR Southwestern branch, "to let some of the super-abundant water down through the former channel fo Colony Creek."

During this flood, against Parr's advice, Council passed a resolution to dig a ditch across Main Street at James to open a channel to the Red River and relieve the flooding in the manufacturing and business district and protect their business interests. Parr had termed the scheme, "impracticable, the banks of the Red River being so much higher than the country farther west" (MDFP, April 24, 1882). Council disagreed with Parr. The ditch was excavated and failed to drain water. It was, "difficult to discern any object in thus injuring the Street", the Free Press noted, stating that "all this comes from keeping a paid professional gentleman to give advice and then acting contrary to his judgement." (MDFP, April 24, 1882).

Throughout 1882, the breach of the embankment along the east side of the Colony-Omands Creek Diversion was repaired and the grades re-established. This diversion of the waters of Colony Creek effectively blocked the source of the waters of six of the major streams in the Winnipeg area; Colony, Browns, Logans, Pritchards, St. John's, and Inksters. Within twenty years only traces would remain of many of their original courses. Residential lots were subsequently laid down and built over their former courses, sewers laid in or adjacent to their beds, and the stage was set for the flooding episodes that have marked the City's growth since that time (Figures 40, 41, 42 and 43).

Chapter 5

THE COMBINED SEWER SYSTEM

5.1 INTRODUCTION

The first storm sewers in the City of Winnipeg, had been constructed in 1876 under the direction of T.H. Parr, City Engineer, and the Board of Works. These rudimentary sewers were seriously underfit for the waters they were intended to receive. These pipes initially emptied directly into the Red and Assiniboine Rivers. The Alexander Street flume, a part of this system, had carried runoff waters from the western section that were polluted by seepage from outdoor "closets". Health problems, specifically typhoid fever, were common in summer months and were attributed to the standing water that stagnated throughout the area intended to be drained by the Alexander Street flume. The Colony-Omands Creek Diversion of 1880 opened the way for the development of a system to deal with precipitation falling within the city. With the coming of the railroad in 1882, and the certainty that commericial growth was imminent, the City recognized the need for a sanitary and storm water drainage system. On February 9, 1882, Mr. E.S. Chesbrough, the First city Engineer of Chicago, was requested to come," in connection with a drainage scheme for the city." (MDFP, February 10, 1883). It had been determined by Council that "an eminent sanitary engineer should be got to visit the city to devise a system of drainage", the system partially in place being clearly unsatisfactory (MDFP, February 10, 1883).

5.2 THE CHESBROUGH REPORT

In June of 1882, E.S. Chesbrough, termed a "pioneer and international authority on the proper design and construction of sewers", came to Winnipeg to advise upon a conduit system for the City (ABH, 1943). Chesbrough had designed the original combined system (storm waters and sanitary effluents combined in a single pipe) intended to serve the "loop" downtown area of Chicago. That system, said to have a capacity for 1" of rain in 24 hours, was inadequate by the turn of the century, and due to urban development, even a moderate rain resulted in flooding of all basements not protected by backwater valves. Chesbrough's report, presented to City Council on June 7, 1882, and adopted by them on that date, sheds considerable light on the many problems experienced by Winnipeg in the last one hundred years (Appendix A). Chesbrough proposed a combined system for Winnipeg.

> In reference to what is called the separate system of sewage, which has been spoken of as advisable to this City, I do not think it would be wise to recommend it here, because of the needless extra expense it would entail. You must have stormwater sewers and they can be made to carry away the sewage proper without the necessity of other sewers for this purpose, especially with the abundant supply of water... The present prices of materials and labor required for your sewers seem to be extravagantly high, and must tend to retard their construction, especially in view of the increased taxes consequent upon their extension. (MDFP, June 8, 1882).

Considerable emphasis was placed on the "nuisance" experienced by the City due to the pollution of standing waters by raw sewage seeping from outdoor toilets.

> The disposal of your sewage must be in some place where it cannot again become a nuisance to the City. Fortunately you have a river sufficiently wide and deep and rapid to receive without becoming offensive, all the sewage that a population twenty times as large as the present could pour into it. (MDFP, June 8, 1882).

On this point Chesbrough was remarkably accurate. Winnipeg's total population (including the municipalities), was 13,856 in 1882. The Red and Assiniboine Rivers did not begin to present a serious pollution and odor problem until 1931 when the area wide population reached 280,064. On the issue of capacity, Chesbrough was not so prescient. "It will be necessary", he noted, "first to construct outlets and other main sewers much larger than immediate necessities would require in order that they may be of sufficient capacity when the system is completed." (MDFP, June 8, 1882).

Of particular interest, considering the damages claimed against the City over the past one hundred years, is the fact that

Chesbrough raised the issue of private versus civic responsibility with regard to drainage in an area so historically prone to floods.

> There is no good reason why owners of property under such circumstances (Red River floods) should not run all risk with regard to the flooding of cellars, than those who have cellars near the sea coast with bottoms below high tide. Precautions necessary to protect cellars against floods, would also protect them from the backwater caused by occasional excessive storms. (MDFP, June 8, 1882).

It would be almost one hundred years before backwater valves would become mandatory, and then only in new developments. As recent events have shown, the public has come to regard dry basements as a municipal and not a private responsibility.

The sewers introduced by Chesbrough were based on the Adams modification of the Hawksley formula.

This formula, "said to be based on a 50% runoff from a rainfall of 1" per hour" (ABH, 1943) was used from 1882 to 1910 and did not account for the degree of perviousness of the surface receiving rain. At the time of the introduction of this formula by Chesbrough, Winnipeg was a small town whose streets were not paved. By 1912, at the time of the completion of the system as designed in 1882, Winnipeg was a city of 136,035 with 2.5 million yards of impervious paving. One half of the total capacity in trunk sewers was built before 1907, and almost 90% by 1910. By 1912 (with the single exception of the Jefferson Sewer in West Kildonan serving the area in the Inkster Creek Watershed), all the trunk sewers now in place had been constructed. The total combined capacity of the system in 1943 amounted to approximately .22 cubic feet per second per acre or slightly less than 1/4" per hour of runoff per acre. Rainfalls of 1" per hour are common in Winnipeg. There were several early warnings of trouble to come.

5.3 EARLY WARNINGS

June 22, 1909

Meteorological Stations records show 1.3" fell in 3.5 hours, which is an average of only .3" per hour. The Winnipeg Tribune of June 23rd reported a heavy electrical storm which flooded the Main Street and Notre Dame roadway, stating that the drains were unable to carry off the water fast enough.

July 2, 1904

Meterological Station records show 2.64" of rain fell in 4.5 hours. The Winnipeg Tribune of June 4, 1904 stated that 3.26" fell in 6 or 8 hours; 2.64" in a first storm and .62" more in a second. The streets were reported as small torrents and the Y.M.C.A. basement was flooded.

June 24, 1907

This storm, according to the Meteorological Station dropped 1.61" of rain most of which occurred in two hours. The Winnipeg Free Press, July 25, 1907, stated that "Winnipeg was flooded last night." The Newspaper reported that horses were wading in some streets up to their knees and that basements and cellars were flooded. Considerable damage was done to the Warehouse District and almost all the large buildings in the business section suffered from flooded basements. The sewers were "quite unable to carry off the water." The basement motor room of the Free Press Building was so severely flooded that the plant and presses of the Winnipeg Tribune were used for the morning and evening issues (of the Free Press). The Free Press stated that nearly all hotels' basements on both Main Street and Portage Avenue were flooded with between 2 and 3' of water. A storm of that intensity might be expected once in ten years.

August 10, 1907

Rainfall in this storm amounted to 1.57" falling in approximately two hours. Extensive flooding resulted. The streets were flooded knee deep in many cases. Broadway and Garry Streets were flooded, the latter "resembling a river" south of Portage. Extensive damages to businesses were reported; individual cases on Main Street reached as high as $8000.00. The Free Press, had by this time, installed pumps.

July 19, 1909

The 1.6" that fell in four hours or less, according to the Meterological Station, resulted in street flooding.

August 5, 1909

Two storms occured on this date, one year before the sewer system was virtually complete. In the first storm 1.66" fell in just under two hours and during the second, 1.26" fell in four hours. The Free Press of August 6 reported that streets were flooded and many basements were flooded from several inches to several feet deep. After the first storm, Garry Street below Portage was flooded almost level with the sidewalks, the sewers "being unable to carry away the water."

Despite there early warnings during which severe street and basement flooding was experienced, with attendant damage and financial loss, the sewer system based on E.S. Chesbrough's calculations proceeded to completion in 1912. Aware that there were problems ahead, after the construction of the underfit combined sewer system, Mr. Aldridge and Col. Ruttan, City Engineers introduced the Rational formula "Q = CiA" in which:

Q = runoff in cubic feet per second

C = coefficient expressing the amount of runoff in percent of rainfall from a particular type of area eg. park, impervious surface, etc.

i = rainfall intensity expressed in inches per hour

A = the tributary area in acres.

A rainfall intensity curve used by Mr. Aldridge was expressed by the formula

$$I = \frac{60}{t+10}$$

or the equivalent, according to records of the time, of a two year rain. Aldridge and Ruttan were aware as early as 1912, that the system as built was deficient and would require extensive and expensive upgrading. In 1943 in an inter-departmental memo Aldridge wrote,

> We have for a great many years known that something of this

> sort would become necessary ... in fact, I made some figures for Col. Ruttan as long ago as 1913, and, the whole City as it now extends, is in the same position in this regard... as the outer districts are built up and sewers constructed they too will tend to over tax the present trunk sewers to a greater or lesser extent and will require some expenditure on relief sewers. (Aldridge Papers, May 17, 1943, PAM).

5.4 CITY COUNCIL AND THE EXTENSION OF THE SYSTEM

During the period 1884-1914, Winnipeg's public resources were directed almost exclusively towards growth producing programs. The allocation of sufficient funds to supply a sewer system to serve the needs of a rapidly expanding community came about only very slowly.

The sewers proposed by Chesbrough, were termed "flushing sewers" because of the necessity for a continual supply of water to keep waste from collecting and putrifying. The delay in the general extension of this system can in part be attributed to financial mismanagement on the part of City Council. In 1880, $40,000 was appropriated for the purpose of a water supply system but these funds were misappropriated.

> Instead, in what would prove to be a hastily conceived agreement, City Council gave a franchise to supply water to a privately owned company. The reasoning behind this move was simply that the city would thus obtain a modern water supply system without the necessity for any large capital outlay of public funds. (Artibise, 1975).

Under the terms of the act incorporating the Winnipeg Water Works in 1880, the company was granted an exclusive right to supply water both to the City of Winnipeg and for one-half mile around city limits. The franchise ran for twenty years beginning July of 1882, and stipulated that a water supply for sewer flushing, street watering, and other public purposes was to be provided at a reduced rate. The expense of acquiring access to the system was bearable only by the commercial elite. Less fortunate citizens continued to rely on the box closet. In 1890 there were only 553 sewer connections, and although this increased to 2,600 by 1902 this represented only 33% of the houses in Winnipeg (Artibise, 1975). The extent of the pollutional problem during spring runoff and the aforementioned summer storms can be readily imagined when it is realized that in 1905, excluding the suburbs, Winnipeg had over 6,500 "box closets" or outdoor toilets even on such thoroughfares as Main Street and Portage Avenue.

> On one street... a continuous line of outdoor toilets only a few feet apart were allowed to drain freely into a ditch on either side of the roadway. (Ruttan, 1905).

E.S. Chesbrough had pointed out the necessity of sewer connections throughout the city and strongly recommended that these be made mandatory in 1882. City Council chose to do nothing in regard to this matter, fearing additional expense and protests against this "violation" of the concepts of private property. A letter to the Free Press dated 3, May 1887 makes the point.

> We desire respectfully to draw your attention to the state of the streets and lanes in the thickly settled portion of the city. Many of the streets running north and south have never been graded, and consequence being that in the spring and after all rains they are almost impassable to the inconvenience, annoyance and loss of the residents on those streets, the carters and dealers who have to deliver goods, and all who require to use them to get to their homes. The water becomes stagnant, and with the accumulation of decaying vegetable matter, breeds various diseases such as typhoid fever, scarlet fever, diphtheria, etc., with which we have been so much afflicted in these districts of the City. While, as just said, some of the streets are in very bad shape, the lanes are very much worse.....the natural fall is so slight that the slightest

> obstacle obstructs the drainage and the result in hot weather is a most disgusting and dangerous amount of poisonous and offensive gases... A thorough system of drainage will have to be applied to the lanes... [for] if something is not done at once, one of two results must happen; either we will have an epidemic, or the houses in these districts will be vacated. Upon the Council must rest the responsibility of neglecting to take the necessary precautions to prevent great loss of life and property. (MDFP, May 3, 1889).

While noting that such conditions existed and were intolerable, Council "neither proposed or attempted to provide a remedy and maintained the position that its hands were tied by a lack of funds, a position that was hardly tenable in light of the financial commitments so freely made for railways and advertising" (Artibise, 1975).

The results of Council inaction were the well documented typhoid epidemics of 1893-94 and 1900-1905.

Winnipeg's typhoid death rate for 1904, the year of the two storms that so severely flooded main thoroughfares and basements, stood at 24.85 per 10,000. This was a higher rate than in any other North American or European city. Despite Chesbrough's recommendations and frequent outbreaks of typhoid (largely in the poorly serviced North End), no action was taken by Council until after the epidemic of 1904 that struck the southern section of the City populated by the commercial elite. (This epidemic was later traced to the pumping of polluted Assiniboine River water into drinking water mains to fight fires). Not until 1905 with the passage of by-law 4143 did the City stipulate that, "all buildings in the city situated on streets where sewer and water mains existed, had to be connected, thus enforcing the recommendations made nearly a quarter of a century earlier. Although considerable opposition was raised to this infringement on personal liberty and violations were common,with the demise of the outdoor privy (one of the symbols of the frontier town), typhoid fever cases dropped dramatically (Artibise, 1975).

By 1914, the Combined Sewer System now in place and still serving the City of

Winnipeg, although considerably upgraded, was completed. Sewer outlets had largely replaced the streams of the native landscape (Figure 44). Between 1915 and 1939, there were no storms of sufficiently high intensity to cause the widespread flooding reported between 1904 and 1914, although some flooding of a localized nature did occur in 1928, 1930, and 1938.

Chapter 6

THE COSTS OF THE ALTERED LANDSCAPE

6.1 RETURN OF THE WET CYCLE

August 16, 1939

On this date the Winnipeg Tribune reported the heaviest rainfall since 1914. According to Meteorological Records 1.39" fell in 1/2 hour, followed by 1.48" in just over 4.5 hours for the day's total of 3.23". Although this rainfall took place over nine hours, tipping gauge records obtained indicate rates of rainfall much higher than the average. Extensive flooding of basements and streets resulted. Hardest hit was the Colony Sewer District in the flood plains of Colony Creek.

August 1, 1941

On this date, 2.57" of rain fell in a little over three hours causing extensive flooding of streets and basements. The Free Press reported that most of this rain fell in a two hour period. Records reveal a rate of .95" per hour for two hours. Hundreds of basements were reported flooded.

July 25, 1942

A total of 2.34" fell on this date, with the tipping gauge recording a maximum rate of 1.18" per hour for two hours. This storm resulted in widespread flooding of streets and basements.

July 29, 1942

On this date, 2.72" of rain fell, with the tipping gauge recording a maximum rate of 1.32" per hour for two hours. This storm resulted in the most widespread flooding of basements and streets in the history of Winnipeg to that date (Figure 45).

With the return of the wet cycle and the widespread flooding that ensued, the 1912 forecasts of Aldridge and Ruttan came true. It was obvious that the combined sewer system was inadequate. Prior to 1939, the design basis provided for a storm frequency of approximately once each year. In 1939 this was changed to provide protection from a rainfall having a frequency rate of approximately once in two and a half years (Appendix B).

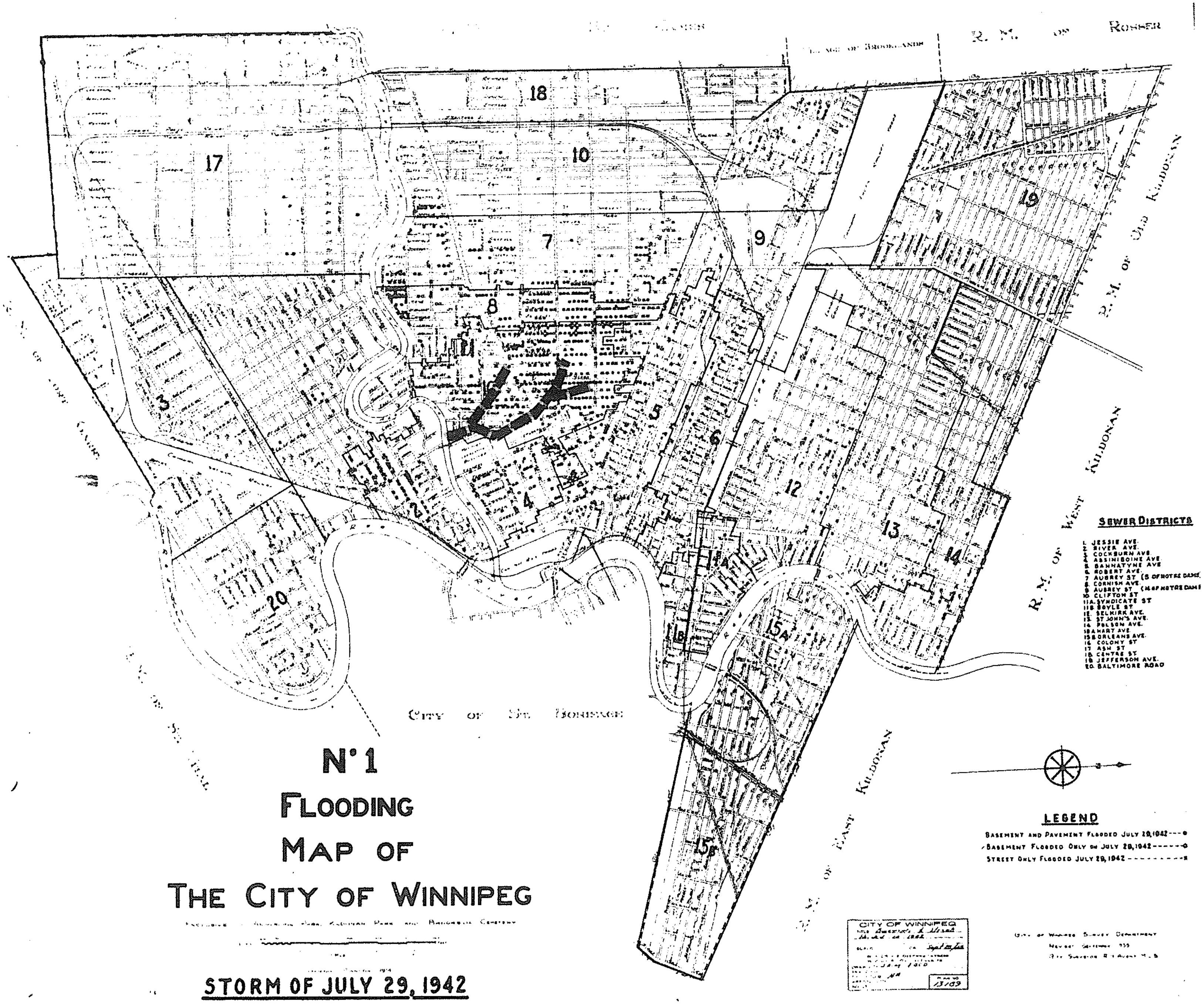

Figure 45 ABH Report

This flooding map indicates the severity of the problem of waters backing up into basements in the Colony Creek area in 1942. Although relieved by larger stormsewers in the 1960's the area still experiences flooding.

6.2 THE ALVORD, BURDICK AND HOWSON REPORT

In 1942, faced with the outrage of property owners, extensive damages to commercial establishments, and the threat of infection, The City of Winnipeg commissioned Alvord, Burdick and Howson, a firm of Chicago engineers, to undertake a study of the sewer system. Their Report on Storm Water Sewers for Winnipeg, Manitoba, March, 1943, stated, in an exacting analysis, that none of the rainfall formulas used by Winnipeg up to that time provided for adequate stormwater drainage in Winnipeg. "More liberal provision must be made if frequent basement and street flooding is to be avoided" (ABH, 1943). "The original sewers in Winnipeg were apparently properly designed and adequate provision... made for the conditions existing at the time of their design." (ABH, 1943).

Making the requisite allowance for diplomacy on the part of Messrs. Alvord, Burdick and Howson, and reading between the lines of the phrase,"adequate provision for conditions of the time," can only refer to the conditions in 1882, prior to widespread development and the introduction of impervious paving materials. Between 1910, when the system was virtually complete, and 1943, the population of Winnipeg increased approximately 55% compared with the increase in trunk sewer capacity of only about 11%. The already inadequate trunk sewer capacity had not kept pace with the increase in population or with the increase in impervious surfaces throughout the City. Since 1900, when the total amount of paving was approximately 800,000 square yards, the square yardage had increased to 2,500,000 in 1910 (when the system was largely complete). By 1940, paving had increased to approximately 5,200,000 square yards. In other words, since 1912 when 90% of the trunk sewer system was built, the amount of impervious areas expressed in street and lane paving (exclusive of building roof surfaces) more than doubled.

"Sewers", the report diplomatically stated, "which may have been adequate, or nearly so, in those areas which were not paved, have...become considerably less adequate...with the greatly increased rate of runoff" (ABH, 1943). Between 1900 and 1940 there was a 50% increase in the miles of sewers. In the same period there was a

260% increase in catch basins in relation to the increase in impervious surfaces. In other words, that is an increase in the numbers of catch basins per mile of sewer of roughly 65%. Considered small (in 1943), compared with what was considered adequate in other cities, the report concluded that, "in view of the relatively small capacity of the existing sewers... the catch basin capacity is reasonable" (ABH, 1943). The report then points out that, "there is some advantage in having a relatively small number of catch basins because this condition permits the development of surface storage and minimizes basement flooding during periods of excessive rainfall." (ABH, 1943). Here, in 1943, was the recognition of the positive nature of surface storage, the value of which was not to be recognized for another twenty years, until the City had grown to such an extent that the cost of storm sewer installation had become prohibitive to development.

6.3 RELIEF STORM SEWERS

The Alvord, Burdick and Howson Report noting that a more liberal provision must be made if frequent basement flooding is to be avoided recommended a system of Relief Sewers identical to those already installed at Chicago. The report stated that "experience has shown that to avoid too frequent flooding, provision must be made for the amount of rainfall likely to occur on the average of once in five or ten years." (ABH, 1943). Acknowledging that the question of relief was largely an economic one, depending on the cost of sewers and the amount of damage or inconvenience resulting from inadequate capacity, the report proposed construction of Relief Sewers adequate to take care of a storm recurring once in ten years. In other words, approximately 16% more capacity could be provided by only 8% more money (protection from a storm of twenty-five year frequency was rejected by the report as not "warranted by the benefits secured") (ABH, 1943). The Relief Sewers proposed were intended to constitute a basic design adequate up to as far as 1970.

The political and financial issues of cost, benefits and taxation were quickly raised*. The City Treasurer estimated the cost of the Relief System at 5 million dollars and foresaw three alternate methods of assessment; a frontal charge against the property benefitting, a mill rate for each sewer district, or a mill rate levied on the City at large. He decided that, "in the long run a levy against the City at large, based on the value of land and buildings would present fewer inequities." (City Treasurer, 1943). W. Aldridge agreed stating, "it is the burden of all... from a health point of view and the undoubted improvement of the City's reputation, the benefit may be said to be general." (Aldridge, 1943). The flooding was not universal however, and Winnipeg at this time was still a divided city made up of seven separate and distinct municipalities. In the Colony district the City Solicitor noted that, "16% of the expenditures takes care of 35% of the flooding, while in the Selkirk district... 18% of the total expenditure remedies only 5% of the flooding." The City Solicitor in recognition of this advised, "if the cost were assessed against the City at large it would be necessary to obtain either the approval of a 3/5 majority of the ratepayers, or special legislation, in order to borrow the money... It will be seen, therefore, that there does not seem to be any way to carrying out the work without either ratepayer approval or legislation... Is it reasonable to collect from the taxpayer $7.5 million dollars over the next 20 years to remedy what happened in 1937 and 1941 and only partially remedy what happened in 1942, (not all the flooding could be corrected as Aldridge had noted because "there are basements which are as low or lower than the sewers") but which did not happen at all during the previous twenty-five years?" (City Solicitor, 1943 PAM).

In this series of inter-departmental memos the City Treasurer had the last word.

* The following section relies on interdepartmental memos preserved by Mr. Aldridge, City Engineer in his personal copy of the ABH report donated recently to the PAM and as yet uncatalogued. Permission was granted for the author to use those papers.

> Undoubtedly at some future date storm sewers will have to be constructed, but in the meantime Council would be well advised to proceed slowly. Such portion of the works as may eventually be decided on should in any case be postponed until after the war... (City Treasurer, 1943, PAM).

In 1945, a $2,000,000 money by-law was prepared by Council in response to the Alvord, Burdick and Howson Report. It was subsequently defeated in a dry season three years after the last major flooding episode. The Report had warned that other sewer districts would develop similar inadequacies as development continued, but these were not to appear for twenty years. Between 1945 and 1962, no localized major storms of a sufficient intensity to cause widespread flooding occured with the exception of the Red River Flood of 1950 which was a regional event.

6.4 RETURN OF THE WET CYCLE 1962

In 1962, a recurrence of severe basement floodings in precisely the areas the ABH Report had pinpointed as needing relief resurrected the study and the City Engineer stated that the 1943 report was equally valid for the conditions of 1962. Money by-laws for construction of Relief Sewers were approved subsequent to flooding in 1962, 1964 and 1968. In 1943 the construction had been estimated at 5 million for ten sewer districts. By 1968, the cost had risen to 12.5 million for only seven. Despite the fact that a design level of ten years is considered good practice for combined sewer relief, and contrary to the economics demonstrated in the ABH Report, the City chose to implement a system based on a five year storm return period. Consequently the combined sewered areas experience floodings in both basements and streets from storms exceeding the five year return.

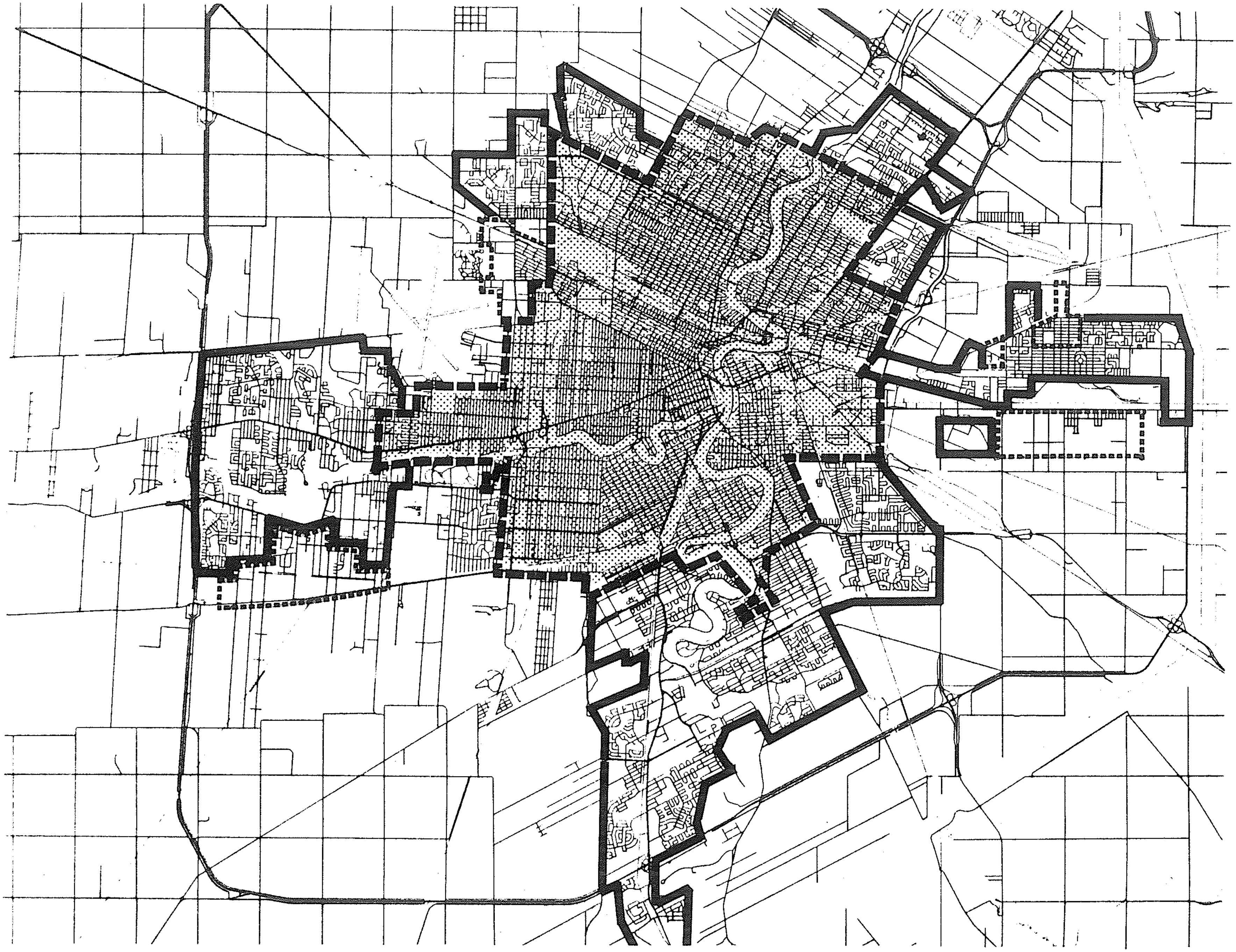

Figure 46

The Combined and Separate Sewered Areas

The shaded area bounded by large dashed lines indicates the old combined system as constructed by 1914. The unbroken lines are serviced by separate sewers and the small dashed lines indicate separate sewered areas serviced by ditches rather than conduits.

6.5 THE SEPARATE SEWER SYSTEM

The separate system rejected by E. S. Chesbrough and the City of Winnipeg for its first sewer system, was initiated in 1961 for all new developments within the city (Figure 46). The system was designed, using the Rational Formula, to accommodate storm waters from between a two and five year event (depending on the district). Intended to alleviate the problem of sewer backup and pollutional spills of raw sewage into the rivers in wet weather, the separate system soon proved to be ineffective in terms of basement flooding. Severe basement flooding occurred at high frequency due to extreme amounts of storm water flow into the sanitary sewer. This was attributed in large measure to lot grading, improper surface drainage, unextended downspouts, plus foundation drains connected to sanitary sewers. Between 1967 and 1972, the City monitored the storm water influx and discovered the overall average weeping tile flow rate at between 1 and 2 gallons per minute per house, with individual values up to 6 gallons per house. Typical sanitary sewer design allowed less than .06 gallons per minute, per house. In Winnipeg, foundation or weeping tiles are permitted a connection designed to carry the extraneous flow, and thus extensive basement flooding occurs. Relief was undertaken in 1974 for the separate sewered areas experiencing basement flooding and to date over 4 million dollars has been expended. However the relief is limited to a five year return and homeowners have been "encouraged" to install building sewer check values and sump pumps as a means of preventing back up.

6.6 LOCAL FLOODING 1972, 1974, 1977, 1978, 1984

In 1912 W. Aldridge and H. N. Ruttan had been aware that serious inadequacies existed and would continue to develop in the combined system as development grew away from the rivers. The Alvord, Burdick and Howson Report had also warned that as development increased, with the concommitant increase in impervious materials, flooding problems would be exacerbated. In 1972, 15,400 homes experienced basement flooding, in 1974, 9,000 homes, in 1977, 17,860 and in 1978, reports totalled 10,500 homes that were flooded. In other words 7,000 more homes

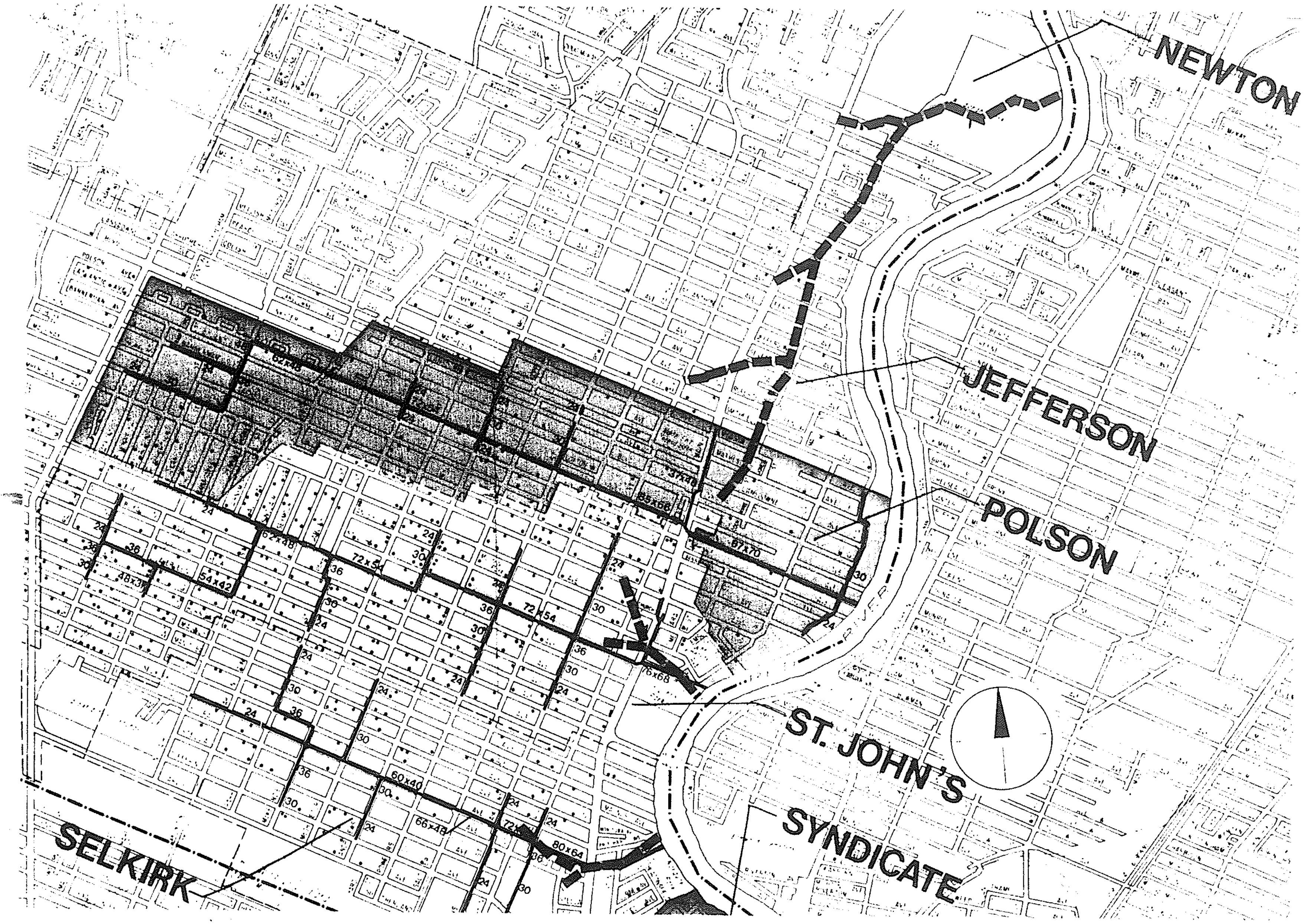

Figure 47

City of Winnipeg

Basement Flooding, July 13, 1977

The superimposition of Pritchards, St. Johns and Inksters Creeks on this City of Winnipeg Basement Flooding Map indicates the problems that could have been avoided had the waters of the streams not been diverted and the coulees retained for surface runoff. Each dot represents 5 or 6 incidents of basement flooding. This area has one of the worst records of severe flooding.

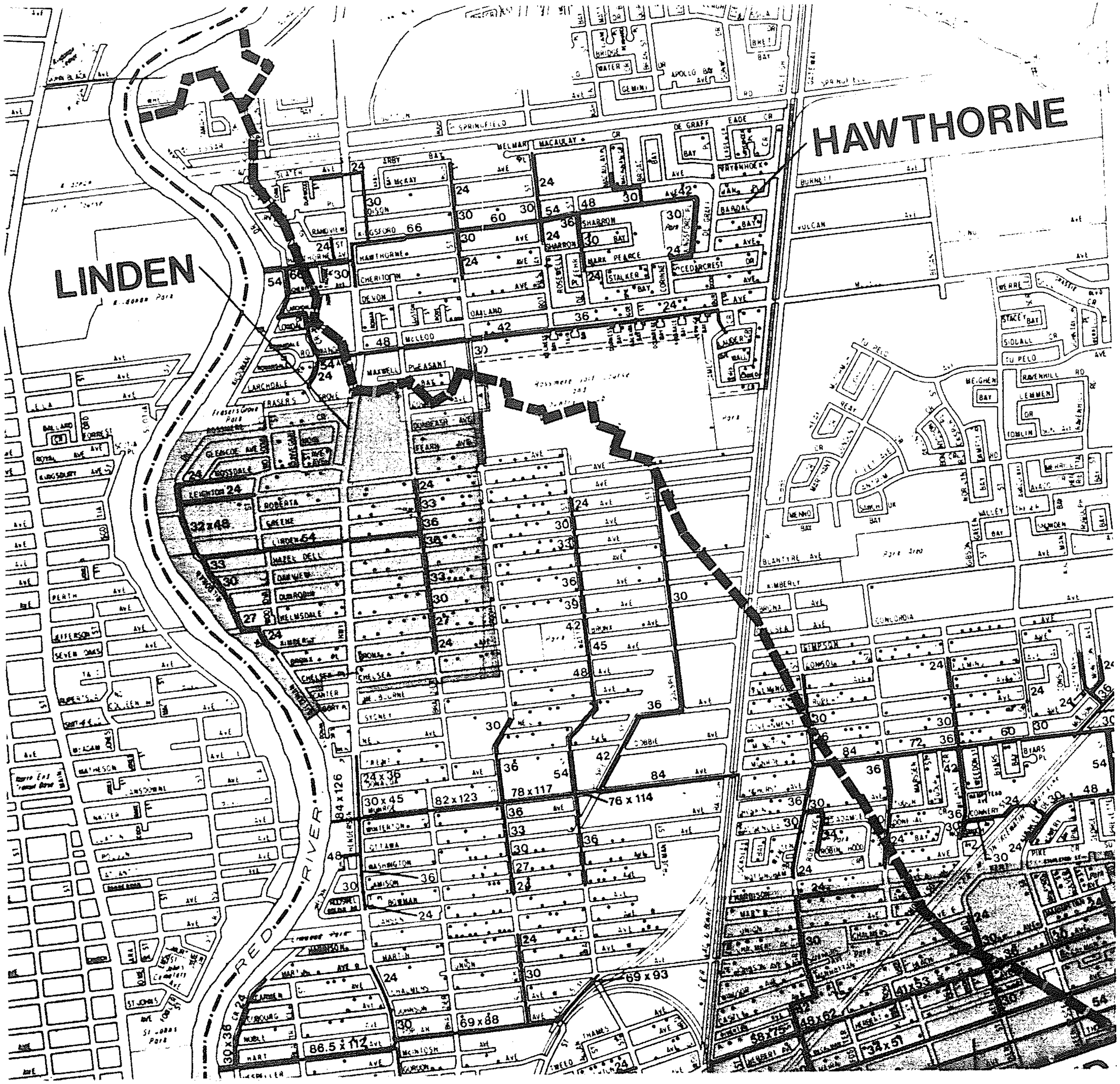

Figure 48

Flooding in the Catchment Basin of MacLeods Creek

Another map indicating flooding during the July 13, 1977 storm. The loss of MacLeods Creek would not be tolerated in 1984 now that their value is recognized.

were flooded during the July 13,1977 storm which had a return period of 1.3 years than the 1950 Red River Flood which had an estimated return period of 23 years (Figures 47 and 48). The July 13 storm resulted in the City of Winnipeg's application to the Provincial and Federal Governments for declaration as a Peacetime Disaster Area. Between 1.5 and 2 million dollars were eventually paid out to victims of the flooding under the Disaster Aid Program.

The July 13, 1977 storm resulted in City Council approving a 60 million dollar, ten year program to upgrade the combined system with the installation of Relief Sewers based on a five year design storm. The total estimated costs for relief of the combined system were estimated in the region of 115 - 140 million dollars in 1980. The value received or benefits to be expected from a direct reduction in basement flooding damages was estimated conservatively at 170 million plus the benefits of community stability.

Again in June of 1984, severe rainstorms brought extensive basement flooding to the City. On June 16, 1.8" of rain fell in an hour, corresponding to approximately a once in thirty year event. On June 21, 2.23" fell in an hour exceeding the once in a hundred year event. A total of 18,500 homes were flooded in these two storms which totalled 8000 more homes than were inundated in the Red River Flood of 1950. Damages were severe throughout the combined and separate sewer systems and again the City applied for aid from the Provincial and Federal Governments. Only the areas serviced by storm water retention ponds escaped the severe basement floodings. An incident reported in the Winnipeg Free Press of June 23, 1984 could just as easily be dated 1884. Region Walford, resident of Vimy Road (just west of Sturgeon Creek), found a 12" deep lake forming in his back yard.

> At issue, said Walford, is a ditch on city property between the houses on Vimy and Parkhill Street. For five years, Walford said, he and the previous owner of his house have been after the city to maintain the ditch to carry away surface water. But he said the city has sat idle while some neighbors filled in the ditch and claimed the land

for their back yards. (WFP, June 23, 1984).

By July 11, flooding claims totalled more than 2.8 million dollars with an average estimated damage per home of $3000.00. In a diplomatic understatement of the history of the problems of Winnipeg's land drainage, a Waterworks, Waste and Disposal Division Report in 1980 stated:

> The ... inadequacies of ... visible services such as rush-hour traffic jams.. generate immediate and continued demands from the public. However the effect of inadequate capacities of underground services are not apparent until major breakdowns occur,... The public demand improvements for the out-of-sight services tends to become sporadic and often very costly. (Basement Flooding Relief, 1980).

6.7 POLLUTION 1900-1960

With the increase in urban population, problems of pollution began to appear in the Red and Assiniboine Rivers. From the date of the first sewer installations in the 1880's, levels of pollution mounted in the rivers until the low flows during the dry years of the 1930's provided such limited dilution to the discharged wastes that an extremely offensive and dangerous situation existed. The two rivers were, at that time, essentially open sewers, as the open prairie had been forty years earlier when E.S. Chesbrough stated that the rivers could handle raw sewage up to a population of approximately 200,000. This dangerous situation led to the incorporation of the Greater Winnipeg Sanitary District for the purpose of constructing an intercepter sewer system to collect and pipe raw wastes. Interceptors were built, approximately parallel to both rivers, to collect the sewage and convey it north to a Treatment Plant Site in North Winnipeg for primary treatment.

The major goal of primary treatment is to remove from wastewater all material which will either settle (such as the heavier suspended solids), or float (such as grease). Primary treatment typically removes about 60% of suspended solids and 35% of the B.O.D. (5 day bio-oxygen demand). It does not substantially alter the coliform count due to human and animal wastes, pathogenic bacteria or viruses. The plant was in service by 1937 and was the first primary treatment facility in a major Canadian city. These sewers intercepted all the dry weather flow in the combined system but were capable of intercepting only a small fraction of wet weather flow.

By the 1950's, as development continued, pollutional discharges, even when provided with primary treatment, had reached such volumes that objectionable conditions again occurred in the Red and Assiniboine Rivers during months of lower flows. This led to the development of a ten year program for pollution control, the major goal of which was to intercept discharge from all dry weather flows and provide the equivalent of secondary treatment.

The goal of secondary treatment is to remove the soluble B.O.D. that escape the primary treatment and provide improved removal of suspended solids. These removals are typically achieved by using biological processes providing the same reactions that would occur in the Red River if it had the capacity to assimilate the massive wastewater discharges. Secondary treatment may remove up to 90% of the B.O.D. in suspended solids. It does not remove any significant amounts of nutrients that promote aquatic plant growth, heavy metals, pathogenic bacteria, or viruses. These can only be removed by advanced wastewater treatment processes. Secondary treatment however has a higher impact on the receiving stream. The breakdown of raw sewage is only partial, and therefore more nutrients are produced and made available to aquatic plant life, which in turn depletes the oxygen supply in the receiving body of water.

6.8 SURFACE RUNOFF POLLUTION

Increasing awareness of the potential magnitude of wet weather pollution has focused attention on the quality of urban surface runoff. The sources for this pollution are attributed to be litter, salt, animal droppings, erosion, vegetation, solid wastes, vehicle deterioration, and air pollutants settling as dust.

Coliform concentrations, although low in comparison with values in treated sewage and combined overflow, are high enough to exceed recreational water bacteriological standards. Although no figures on the effects of surface runoff are available for Winnipeg, the deterioration of the bacteriological quality of the Rideau River in Ottawa has been attributed to surface runoff following urbanization.

6.9 POLLUTION 1984

By 1982, pollutional levels had again increased to levels that were unacceptable, this time to the residents of Selkirk downstream of Winnipeg. Selkirk draws its drinking water from the Red River. At the present time in Winnipeg, according to information provided by A. Reimer of the Waterworks, Waste and Disposal Division, there is a sewage load equivalent to a population of 900,000 people. This breaks down, as follows; the sewage load of the approximately 600,000 actual citizens of Winnipeg plus the equivalent sewage load of a population of 300,000 from industrial and commercial developments. Assuming a 90% efficiency of secondary treatment, which is likely on the high side of average, there is the daily equivalent in raw sewage load of a population of 90,000 still entering the Red River after secondary treatment. In addition to this figure there is, during wet weather, a significant overflow of untreated raw sewage from the combined and separate sewer systems into the Red and Assiniboine Rivers. This overflow occurs when stormwaters combining with the sanitary flow cause the water levels in sewers to overtop the wiers built into the underground system that, in dry weather, directs the flow to the intercepter sewers and thence to treatment. These overflows could, in major storms, be one hundred or more times dry weather flows due to build up in the sewers (Manual of Practice for Urban Drainage Report No. 104). This overflow corresponds on a yearly average to a one in thirty day event (Plan Winnipeg, 1981). However this figure is misleading because actual overflows can occur as often as once or twice a week during the summer months. During such storm events pollutant loadings are many times greater then the treatment plant effluent discharge. Present day Red River quality is not safe for primary contact (swimming), nor does it meet typical criteria for secondary recreation (boating), based on the criteria of bacterial levels (Plan Winnipeg, Water and Waste Component, 1981).

> Any further pollution control strategy beyond upgrading the treatment plants must be based on cost-effectiveness in protecting water quality under all conditions. Further pollution control will be expensive and will not show much visible benefit to the public. (Plan Winnipeg, Water and Waste Component, 1981).

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Chapter 7

MIMICKING THE NATIVE LANDSCAPE

7.1 RETENTION PONDS

In the early 1960's a housing development firm in Winnipeg proposed a system of retention ponds or man-made lakes to deal with the stormwaters of the then proposed Southdale suburban development (Figure 49). Although a conventional closed conduit separate sewer system was economically feasible for this development, impoundments were seen by the developer as a means of making the subdivisions more marketable with the addition of private lakeside property. This is essentially, the "unearned increment" discovered to accrue to property fronting the first public parks in early 18th century Britain.

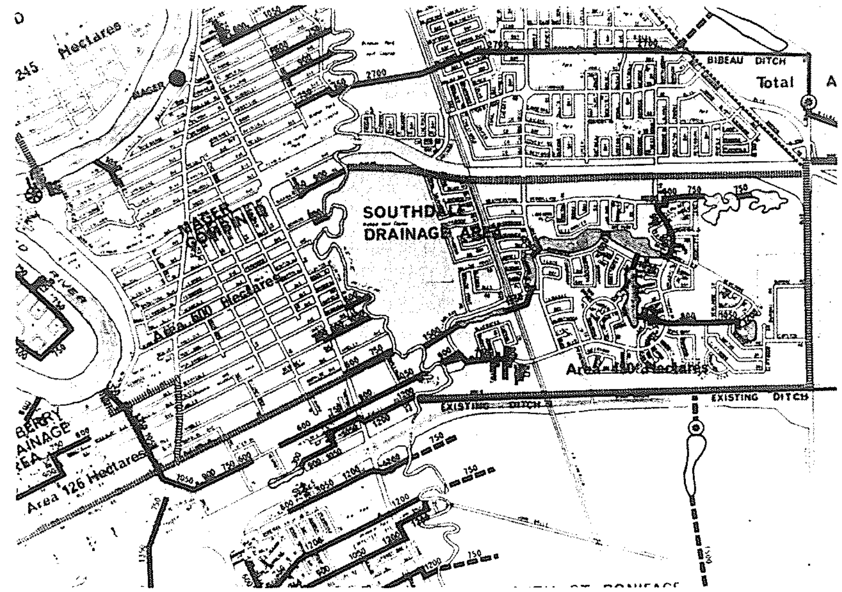

Figure 49
The Southdale Stormwater "Lakes"

7.2 DESIGN BASIS

Essentially these "lakes" mimic the marshes of the native landscape by storing stormwaters and releasing them to the regional system by pumping or gravity flow, over a longer period of time. Peak flows are thereby discouraged and no surcharging of existing systems takes place. The impoundments are not very much different from John Inksters mill pond of the previous century. Urban stormwater runoff is directed to the impoundment from many branch conduits and discharge from the "lakes" is controlled through one outlet. The outflow pipe or open channel is designed with less capacity than the sum of the capacities of the inflow pipes. Consequently, a volume of stormwater is temporarily stored in the impoundments following a rainfall, for a period of hours or days, depending on the amount of rain. The design capacity of the impoundments brings the point of discharge closer to the source of runoff, resulting in fewer trunking systems. At present, a five year design storm is used for the collection systems which drain into impoundments. The rational method, and more recently the computerized hydrograph method have been used to design this feeder system. The impoundments are designed for a once in twenty-five year event. The design of the impoundment allows for a 4' rise in water level during a twenty-five year storm. In addition a freeboard allowing for an additional 2' for a total of 6' is considered necessary for major events (a one hundred year storm). In June of 1984, the one hundred year event did indeed occur and the lakes operated as designed. No flooding was experienced due to failure of the impoundments design. In contrast, the combined systems of Winnipeg and the separate sewered area of Windsor Park experienced severe basement flooding.

In 1975 the City of Winnipeg, in recognition of the benefits to be derived from stormwater impoundments, and the demonstrated deficiencies of conduit systems, formally adopted the concept for all new developments.

7.3 BENEFITS

7.3.1 ECONOMIC

Appreciable savings in capital costs over conventional all conduit systems are realized by the impoundment system. The average capital cost savings in Winnipeg were found to be 36% with maximum savings of 79% occurring for development farthest from the receiving stream (Chambers and Tottle, 1978). The 36% figure reflects a saving of $2,590.00 per acre in capital costs for serviced development.

Although the Chambers and Tottle Report states that maintenance for conduit systems is nil, when the inadequacies of the combined sewer system and portions of the Separate System are taken into account, and with the 115 million price tag assigned to the Relief Sewers Program in 1980, it cannot be said that maintenance for a conventional all conduit land drainage system is nil. Continual repairs are in fact built into a conduit system by the very nature of the materials used.

7.3.2 POLLUTION

An additional advantage of impoundment lakes, which was not originally appreciated, is that they remove pollutional loading from urban runoff. This has important implications for the waters of the Red and Assiniboine Rivers which are already heavily loaded with pollutional contaminants.

> To date, Winnipeg has spent no dollars on stormwater treatment and as such has realized no saving in this area. It is recognized, however, that this may be a saving to Winnipeg in the future. (Chambers and Tottle, 1978).

In the two impoundments systems studied, Southdale and Richmond Lakes, it was found that significant amounts of pollutional loading were removed from urban stormwater runoff by settlement.

7.3.3 RECREATION (DUAL USAGE)

Impoundments are utilized for a significant amount of recreational activities. Canoes, sail boats, paddle boats and wind surfing are popular on the Southdale Lakes, Waverley Heights Lakes, and the lakes of All Seasons Estates during the summer months. During winter, impoundments are actively used for ice skating, hockey, tobogganing and cross-country skiing by the local residents.

7.3.4 AESTHETICS:

Impoundment lakes bring the potential for valuable visual relief to the grid iron structure of Winnipeg's urban landscape. The Southdale lakes are sculptured, the All Seasons Estates Lakes are almost serpentine in form, whereas the lakes of Fort Richmond, formed by enlarging the coulee of Baldry Creek, are unrefined and ditch-like. In 1978, it was found that the Southdale Lakes were better maintained than the Fort Richmond lakes and the difference in aesthetic appearance was attributed to land ownership and population density.

The residents of Southdale take part in maintaining the lakes on which they own property, whereas the multiple family residents along Fort Richmond Lakes apparently are not concerned about maintenance needs along the lakes for which they feel no ownership. It would seem that aesthetics are improved and City maintenance costs reduced by making a portion of each impoundment shoreline private property. (Chambers and Tottle, 1978).

7.3.5 WILDLIFE

Impoundment lakes attract a variety of shore birds and waterfowl throughout the summer season. Reeds surrounding Beaverhill Creek in Southdale provide a nesting area to small birds and ducks.

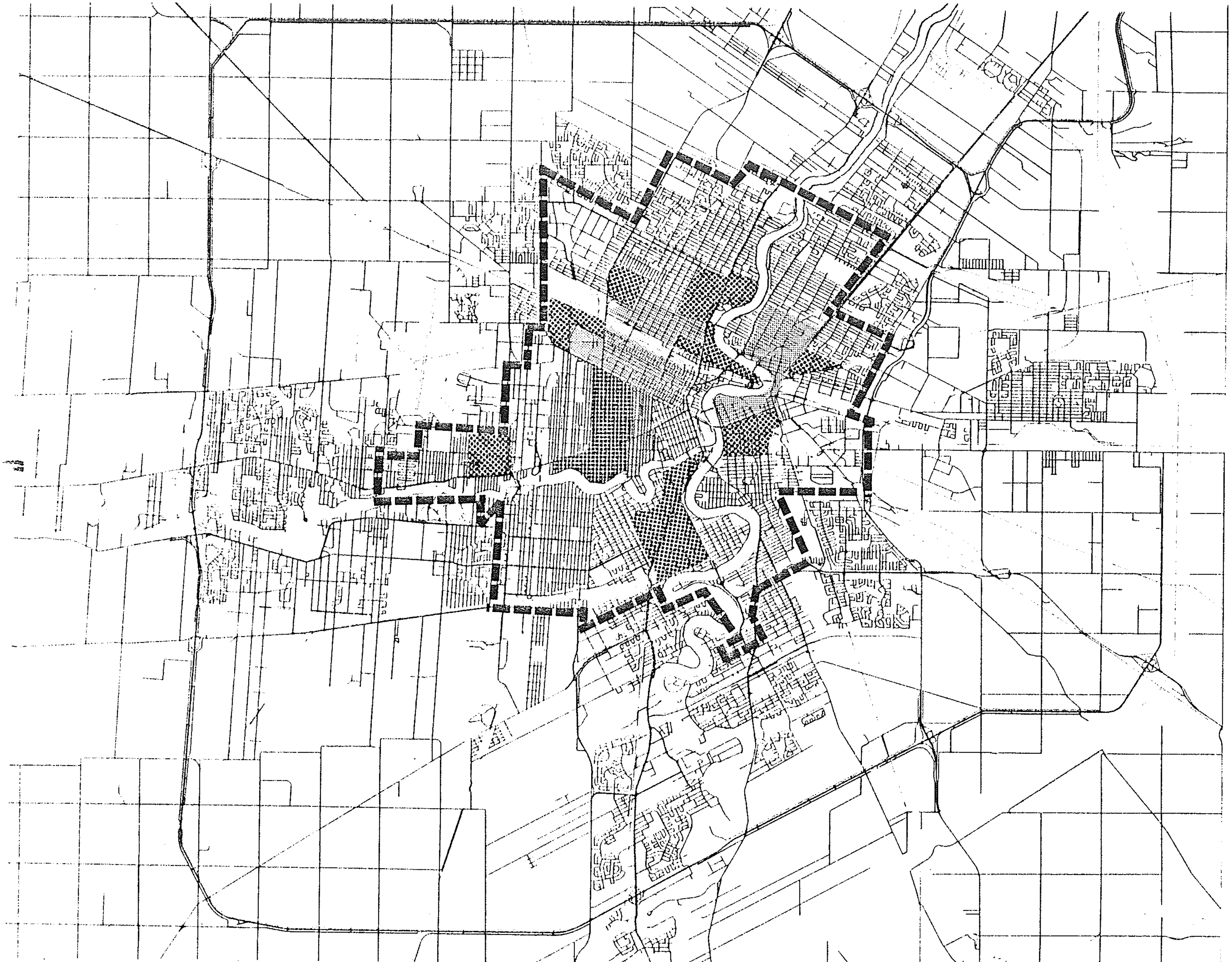

Figure 50

Source: City of Winnipeg Neighborhood Characterization

Neighborhood Decline in Combined Sewered Areas. The dark grey tone indicates major rehabilitations.

COST COMPARISON

CONVENTIONAL PIPING VS IMPOUNDMENTS

Development & Study Year	Serviced Area (ha)	Distance to Receiving Stream (km from centre)	Capital Costs* (per hectare services) Conduit	Impoundments	Savings With Impoundments $	$
South St. Boniface 1974	3 950	4.9	A	$ 6,063		
Bunn's Creek 1975	3 786	3.7	A	$10,074		
Fort Garry 1975	1 659	4.9	$14,853	$ 3,167	$11,686	79%
Charleswood	1 147	1.7	B	$ 9,733		
Fort Garry 1975	896	3.0	$ 9,733	$ 2,942	$ 6,791	70%
South St. Vital 1975	589	1.4	$ 9,434	$10,338	no saving	
St. James 1967	405	3.2	$50,514	$28,759	$21,755	76%
North Main 1977						
-Stage 1	172	0.9	$16.322	$15,556	$ 766	5%
-Stage 4	119	0.6	$14,420C	$14,420C	no saving	
-Stage 2	97	0.6	$18,374	$14,561	$ 3,813	21%
Average			$19,093	$12,820	$ 6,402	36%

* Costs adjusted to 1978 using Engineering News-Record Annual Average Building cost Index. Index Data obtained from sector concept reports produced for the City of Winnipeg since 1974

A - Limited receiving stream capacity eliminated conventional piping alternative.

B - Cost of conventional piping not investigated due to cost being obviously prohibitive.

Source: Tottle, 1980

Figure 51

Comparison Costs Conduits vs. Impoundments

7.3.6 UNEARNED INCREMENT AND COMMUNITY STABILITY

The increase in value of shoreline properties was not lost on developers, and the areas serviced by storm water lakes have continued to appreciate in value in contrast to the decline of many neighborhoods serviced by combined sewer systems (Figure 50). It would appear that stormwater lake developments have a much better chance of appreciating over time with the reduced likelihood of de-stabilization due to basement flooding.

7.3.7 CONVENTIONAL CONDUIT SYSTEM V.S. STORMWATER IMPOUNDMENT

A conventional conduit system, in which high replacement and upgrading costs are built in, provides protection from street and basement flooding for a two to five year return period, at best. In Winnipeg, intent has been expressed for eventual upgrading to meet the ten year event. Upgrading to a twenty-five year or more event would be prohibitively expensive within the parameters of such a system and upgrading to a one hundred year event largely impossible. In contrast, the Stormwater Impoundment System in Winnipeg provides protection from a twenty-five year event with allowances for the one hundred year event. These stormwater lakes provide the additional benefit of decreased capital costs (Figure 51), increase in property values (the unearned increment), elimination of basement flooding, recreational amenity, increase in aesthetic values, possibilities for significant wildlife habitat, and protection for the receiving stream in terms of pollution load. In short then, the system that most closely mimics the native landscape has proven to be the most cost-effective and provides the best protection from stormwater flooding.

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Chapter 8

THE FUTURE OF LAND DRAINAGE

8.1 REGIONAL SCALE PLANNING

At the time of the unification of the municipalities in 1972, the responsibility of regional land drainage service was centralized and undertaken by the City of Winnipeg. This centralization had become vital to the future growth of the City. A critical point had been reached; most of the areas situated close to the remaining drainage outlets (rivers, streams and ditches), were fully developed and at capacity. As the various municipalities had obliterated many of the natural drains, and continued to grow away from those remaining, the system had become increasingly expensive and required longer range planning when the cost of land drainage, exclusive of sanitary sewers and watermains, had risen to between $10,000 and $15,000 per acre.

In essence it has become necessary to integrate drainage into other City Regional Services and thus, at last, into the City Planning framework. The success of the first stormwater impoundments introduced by private developers, the benefits of increased protection, the reduction of peak flows and pollution loadings, as well as increased recreational amenity, encouraged the City to explore the Dual Drainage or Master and Minor Concept of which impoundments are but one component.

8.2 DUAL DRAINAGE

Dual drainage systems are a regional planning concept designed to reduce the size and extent of expensive storm sewer installations, pollution loads, peak flows and the accompanying erosion problems, by utilizing upstream and downstream storage facilities, both natural and man-made. To that end upstream and downstream storage facilities are utilized in both the Major and Minor systems. Such a concept is essentially an attempt to approximate the hydraulic regime of the native landscape and restore the original time values to surface runoff.

8.3 MAJOR AND MINOR SYSTEMS

The Major System comprises the major drainage facilities rivers, streams, man-made lakes or watercourses, and a definition of their associated flood plains. By definition the capacity of a Major System must be sufficient to minimize loss of life or major property damage.

The Minor System may be characterized as "convenience drainage" and includes storm sewers, street gutters, etc. This protection is geared to reducing localized flooding and minimizing complaints from residents. By definition this flooding does not result in major economic loss on an individual basis, although such has not been the case in Winnipeg where individual losses have reached 3000 dollars in some years. The Minor System is essentially designed to handle the more frequent, less intense storms. The required extent of the Minor System is a function of the design of the Major System and is essentially dependent on the distance of the outfall to the Major System.

8.3.1 FUTURE STORMWATER DESIGN REFINEMENTS

For all new development, in the older combined and separate sewered areas of Winnipeg, it has become a necessity to maintain or reduce the current rate of runoff and thus lessen the possibility of flood damage due to backups and overflows during extreme events as occurred during June of 1984. To that end, the introduction of upstream storage facilities has opened up considerable design possibilities for new development and the rehabilitation of older areas.

Upstream storage captures and detains water near or at the point of rainfall occurrence before the runoff enters the drainage system. Upstream storage mimics, to a remarkable degree, the original hydraulic regime of the Winnipeg landscape. Figures 52 and 53 indicate the similarity between rates of runoff in the pre-settlement landscape and in runoff from a design example utilizing a computerized hydrograph model.

Generally speaking, for all types of upstream surface storage, computerized hydrograph methods (Appendix B) are

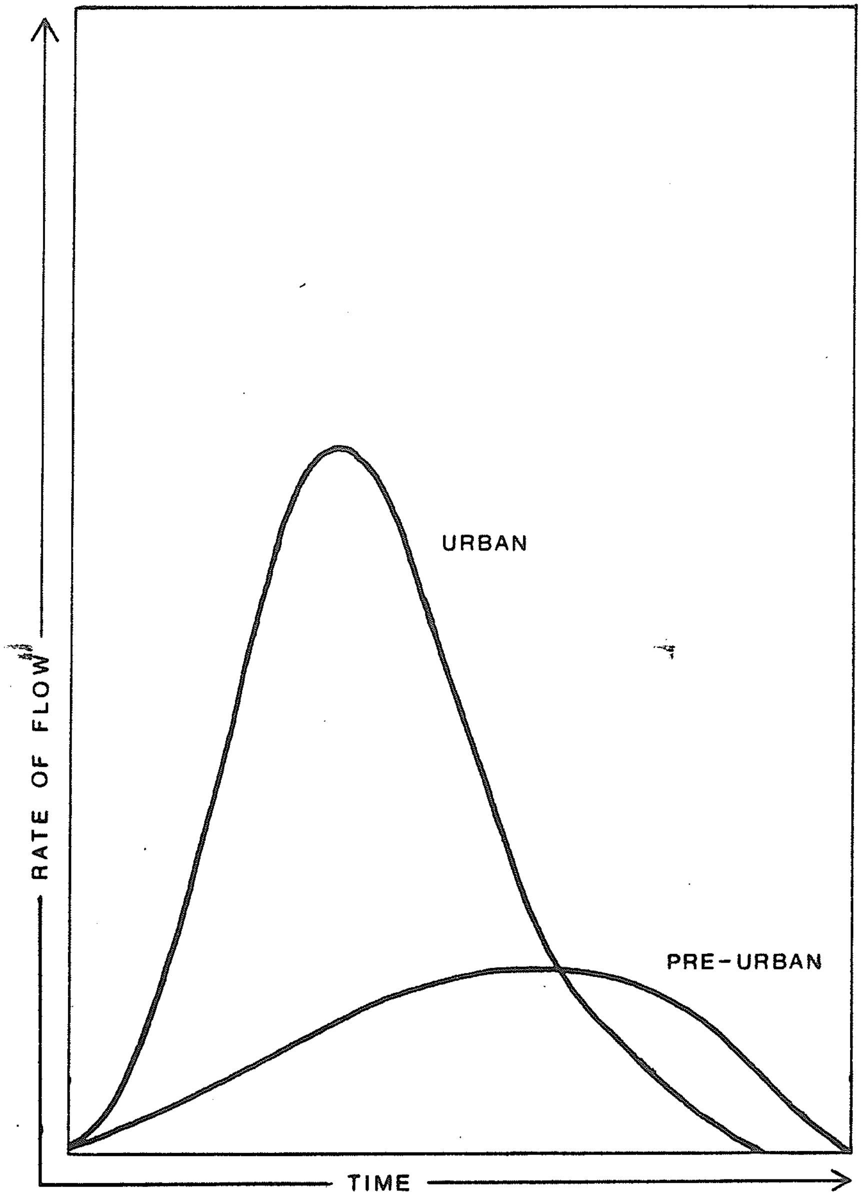

Figure 52 MacLaren 1974

Impact of Urbanization on Runoff

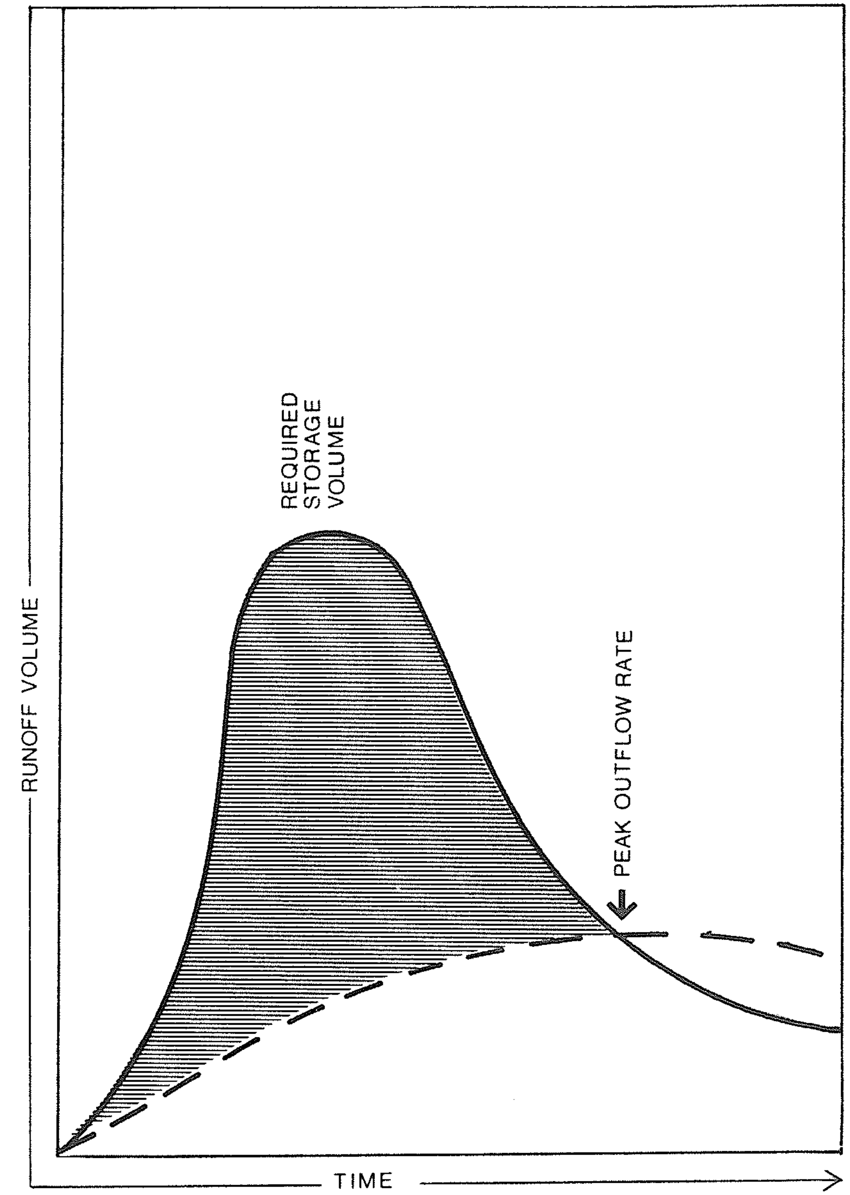

Figure 53 MacLaren 1974

Effect Storage on Runoff Peaks

Note the similarity between runoff peaks from stored waters and the runoff in the native landscape.

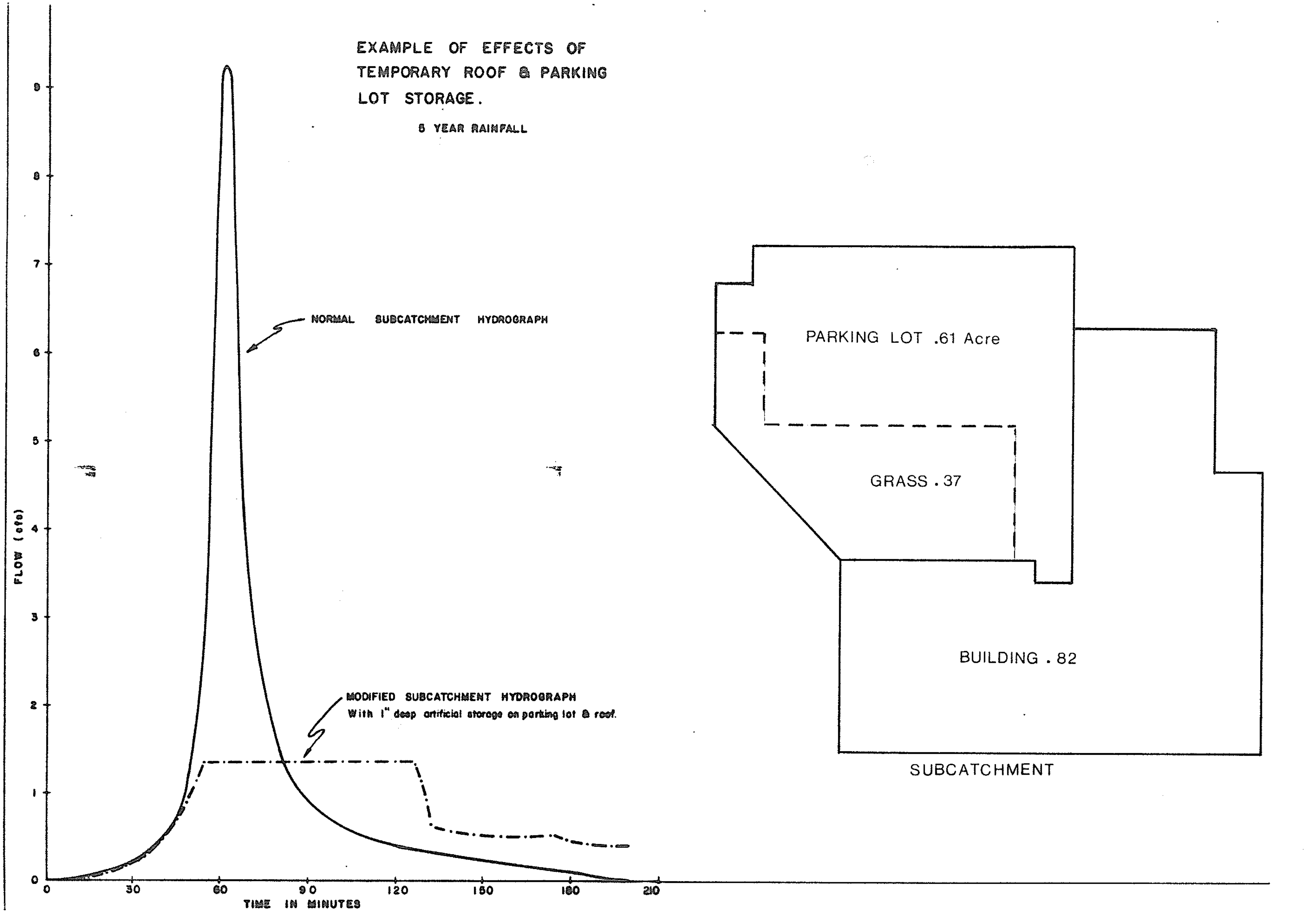

Figure 54 Source: MacLaren, 1974
Combined Rooftop and Parking Lot Storage Hydrograph.
Note the similarity between runoff peaks from these stored waters and the runoff in the native landscape.

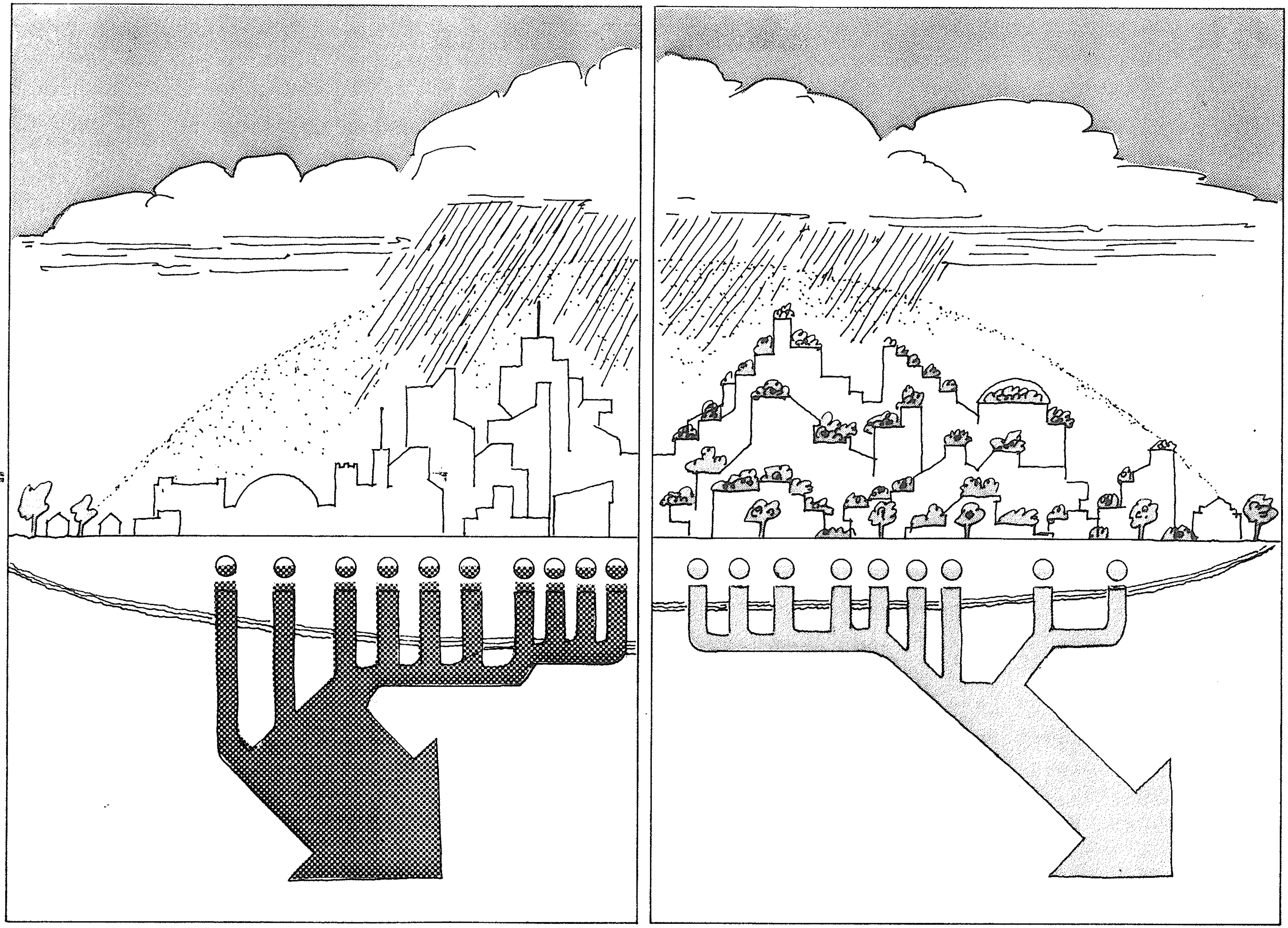

Figure 55

Effects of Combining Rooftop Storage and Roof Gardens required to design the facility in order to assess its usefulness with respect to the benefits derived from a modification of the time distribution of flow (runoff) to the downstream drainage system. Return frequencies of "design storms" would vary the level of protection desired. The greatest beneficial potential is in the reduction of the overall costs of the urban drainage network (James F. MacLaren Limited, 1974). Upstream storage facilities include the following - rooftops, parking lots, property line swales, parks, and on-site ponds.

8.3.1.1 ROOFTOP STORAGE

To date no development in Winnipeg utilizes rooftop storage. Figure 54 indicates, in conceptual form, the benefits to be gained in terms of reduced peak flows, pollutional loadings, amenity and aesthetics from a combination of rooftop storage and roof gardens. As no investigations have yet been undertaken in this area, a detailed study of the benefits of rooftop storage and gardens in the Winnipeg region would be extremely valuable.

8.3.1.2 PARKING LOT STORAGE

At the present time no parking lots exist in Winnipeg that have refined the basic idea of temporary ponding on impervious material during extreme events. Considerable possibilities exist in combination with moisture loving vegetation. However, the major drawbacks of the use of low points for temporary storage is the cost of land and the natural concern of the developer to maximize storage space for vehicles. Underground storage and timed release of stormwaters would seem to offer a solution. One inch ponding in parking lots in combination with rooftop storage as illustrated in Figure 55 indicates the benefits to be derived in terms of reduction of peak flows. The drawbacks include user inconvenience and guidelines would be necessary to outline acceptable depths.

8.3.1.3 PROPERTY LINE SWALES

City of Winnipeg land drainage criteria for new housing sub-divisions encourage "perching" of the house and lot grading to provide positive drainage away from the residence and reduce the possibility of settling and the resultant infiltration of the foundations weeping tiles by stormwaters. Landscape design possibilities have thus been created for intermittent wetland areas with appropriate moisture loving vegetation for storage during extreme events.

8.3.1.4 PARKS AND RECREATION AREAS

As of this writing, no open spaces, with the possible exception of those surrounding stormwater detention ponds, can be said to have been developed specifically to lengthen overland flow and take advantage of the pervious nature of parklands. Considerable opportunity exists in the development of new residential areas and in re-development of older areas. Drawbacks of such temporary ponding include the increase of mosquito habitat.

8.3.1.5 ON SITE PONDS

In addition to the stormwater lakes of residential sub-divisions, on site ponds have been developed to handle runoff from impervious areas at the Data Taxation Centre and the Mint. Considerable opportunity exists for development of such ponds in combination with Industrial Parks, Recreation Complexes and Shopping Plazas. Although the cost of land is a prohibiting factor, study should be undertaken to determine the feasibility of tax incentives to encourage such development.

8.3.2 DOWNSTREAM STORAGE

Downstream retention or detention storage facilities are located downstream from the drainage area, and runoff may be derived from one or several upstream tributary catchments. Such facilities are usually designed to reduce peak runoff and prevent flooding in the main drainage system downstream and are, therefore, supplementary to upstream facilities. Downstream storage facilities are particularly applicable to flat areas of minimum hydraulic head such as the

Winnipeg region. The use of computerized hydrograph methods for design is essential in order to account for the distribution of runoff and the resulting reservoir fluctuations (J.F. MacLaren Limited, 1974). Types of facilities include open channel storage, on-stream ponds and offstream ponds.

8.3.2.1 OPEN CHANNEL STORAGE

Open channel storage is particularly effective in flat areas where the flood wave is relatively slow moving. As the flow increases, the depth and storage increases, resulting in reduced peaks downstream. Natural watercourses in the Winnipeg region are ideal for this form of storage as the characteristic serpentine form of prairie streams provide additional frictional effects.

Bunns Creek (in combination with the Cordite Ditch), the Seine River, Truro Creek and Sturgeon Creek currently provide open channel storage of stormwaters, although encroachments have lowered their potential. The Colony-Omands Creek diversion is unable to provide storage due to encroachments and the shallow nature of the ditch.

8.3.2.2 OFFSTREAM STORAGE

These facilities operate only during peak flows by utilizing side-channel spillways and bear a resemblance to storage of flood waters in natural ox-bows during flood peaks (Figure 56). Such facilities are infrequently inundated and are ideal for multi-purpose uses such as parks and recreational fields. None exist in Winnipeg at present.

8.3.2.3 ONSTREAM STORAGE

On-stream facilities such as ponds and reservoirs are more common than offstream storage. In addition to reducing the peak flow downstream, the ponds act as settling basins reducing pollutional loads. The stormwater impoundments of the Winnipeg residential sub-divisions are onstream facilities, as is the Lot 16 Drain, West of Waverley Avenue (Figure 76).

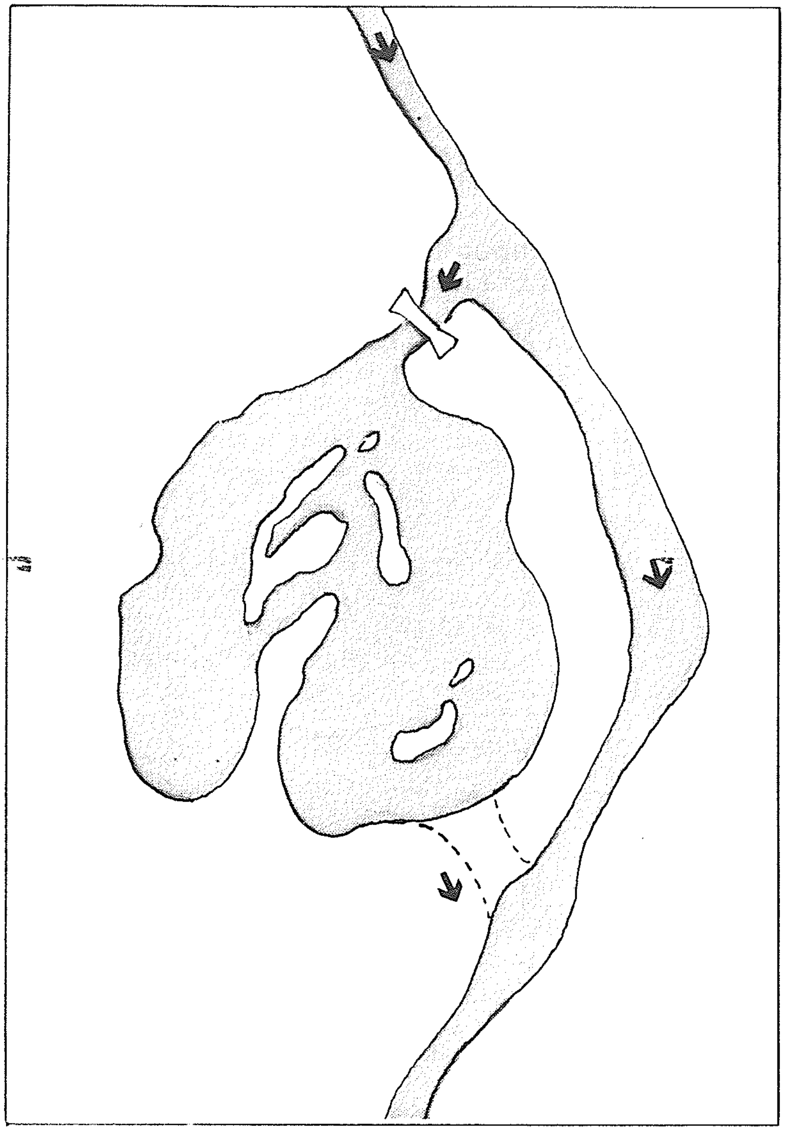

Figure 56
Offstream Storage Replicates Oxbow Hydrology

8.3.3 DUAL USAGE: THE DEVELOPMENT OF PARK WATERWAYS

With the introduction of regional scale planning and the recognition of the value of the streams of Winnipeg for onstream storage, studies were undertaken on the preservation and development of the remaining waterways. One hundred years after F.L. Olmsted proposed his revolutionary design for the Charles River in Boston that transformed a polluted tidal swamp into a public park with temporary storage for runoff, Winnipeg belatedly saw the value of its remaining streams. Studies were undertaken by the City on Baldy Creek, Beaver Dam Creek, Bunns Creek, Sturgeon Creek and the Seine River to preserve these outlets for multi-use as parks, drainage ways and temporary storage facilities.

Plan Winnipeg, 1981, Section L4.3 Natural Drains, notes that the value of the remaining streams is high and that integration of these waterways into the land drainage system is desirable on the basis of economics in addition to their potential for development as linear parkways. Figure 2, however, indicates that the location of all these outlets is, with the exception of Omands Creek, on the fringe of the urban environment. The streams of the inner city have been lost as components of a regional system of drainage or as park linkages for the citizens of Winnipeg.

> The major difficulty in preserving the waterways as drainage outlets is that many of the waterways are on private lands. Conflicts exist between the private owners and the public use of the waterways. The public interest is protected under Provincial legislation including the Water Resources Administration Act, the Water Rights Acts, the Rivers and Streams Act, and the City of Winnipeg Act. This gives the City the right of entry onto private lands to maintain the drainage courses. ...Problems have arisen under the present situation, especially with respect to enforcement and conflicts with private owners (rights of use, encroachment, damage claims). The acquisition of rights-of-way is a mechanism to give the City effective control. The cost of acquisition is high. (Plan Winnipeg, 1981).

In short, although the legal means do exist to protect the waterways, the costs are prohibitive.

*

Chapter 9

THE HISTORIC STREAMS AND WETLANDS REVISITED

9.1 PRESENT CONDITIONS, REHABILITATION AND COMMEMORATIVE OPTIONS

This concluding section outlines the present condition of the original water features, or their remnants, and the opportunities for rehabilitation or, perhaps, commemoration. Throughout the course of this study the various sites illustrated in The Surface Waters of Winnipeg 1874 (Figure 57) were visited and photographed. In many cases, no traces remain to the casual observer, nor are many capable of being captured by photographs due to the characteristic low gradients. Imperceptible dips in roadways, depressions that pond during thunderstorms or sites with an unusual number of manholes are all that remain in some cases. However, in other cases major opportunities exist for development.

9.1.1 NORTHWEST QUADRANT

Of the eleven streams in this quadrant, only four remain including Sturgeon, Truro, Omands and Inksters (now Selkirk).

Sturgeon Creek

Despite the input of agricultural drainage, encroachments, culverting, the loss of all the vegetation noted by Fidler in 1816, a minor re-alignment near its mouth and a major diversion of its waters northwest of the City, Sturgeon Creek is the most intact of the original streams in this quadrant. Attempts by the Provincial Government in the 1970's to return private residential lands abutting the creek mouth to public use failed. The Creek is currently designated as a provincial waterway and carries agricultural drainage from the northwest as well as urban stormwater from retention ponds. Extensive flooding occurred in the 1970's due to overloading of the Creek by agricultural drainage. These waters have since been diverted and culverts on Portage Avenue enlarged (Figures 57 and 58).

Sturgeon Creek offers considerable opportunity for further study as an historical park waterway. The creek was the site of Cuthbert Grant's Mill in the last century and the lands surrounding its junction with the Assiniboine are known to be important Native Indian burial grounds. In the present century storm drainage peak flows have caused extensive erosion problems and a comprehensive plan has never been developed to synthesize the conflicting uses of it as a stormdrain and park space. The stream also offers great opportunity for a specific case study of bio-engineering techniques for river bank stabilization and vegetation management.

McMillans

Traces of this stream are to be seen in a dip in Portage Avenue at Overdale Street and in a small wooded coulee immediately south of the roadway.

Truro (Miry)

Truro exists today and carries waters from private stormwater impoundments. The flood plain of Truro north of Portage Avenue has been preserved and is utilized as a park and for onstream storage (Figures 59 and 60). South of Portage Avenue the flood plains have been encroached upon by recreational development in Bruce Park but much of this area south to its confluence with the Assiniboine is preserved in its natural state.

Scully

A dip in Portage Avenue just west of the Truro Creek culvert is all that remains today of Scully Creek.

Omands Creek

The Omands-Colony Creek diversion of 1880 still exists in the same configuration originally excavated. The upper reach of Colony Creek (now Omands) has been dammed within Brooklands Cemetery to protect downstream development from flood waters from the northwest. The resulting pond illustrates the aesthetic possibilites of integrating engineering solutions with recreational facilities (Figure 61). The diversion north of Portage Avenue has been heavily encroached upon by industrial development and is subject to floods during extreme events. The diversion is capable of only 456 c.f.s. but would be subject, in extreme conditions, to flows up to 950 c.f.s. Three studies have been undertaken by Provincial Water Resources to determine a future course of action. The problem is considerably complicated by the extensive encroachments which exacerbate potential flood conditions by increasing bank instability (Figures 62 and 63).

South of Portage Avenue the reach of Omands Creek proper remains largely in its original state, although encroached upon. To maintain, or improve upon this area and the lands immediately north of Portage Avenue will require continuing surveillance by the City of Winnipeg. In the late 1970's a proposal to build a large complex straddling the coulee of Omands Creek, just north of and adjacent to Portage Avenue, was turned down by the City.

Colony Creek

No trace remains of this stream except for a marked dip in Broadway at Osborne Street and in a parking lot at the front of Colony Street, directly behind the old Great-West Life Building (Figures 64 and 65). Some teluric flow towards the old course of the Creek as it passes under the University of Winnipeg, just east of Wesley Hall, still occurs. During construction in the 1970's, bubbling was observed around newly installed caissons. The approximate site of the former mouth of Colony Creek is marked today by a stormsewer outlet installed in the last century.

Browns Creek

Although no trace remains of Browns Creek, the mouth of the coulee outlet is today marked by a grassed amphitheater surrounding a stormsewer outlet in Stephen Juba Park at the foot of Bannatyne Avenue (Figures 66 and 67). In the 1970's, excavations for new housing in the Centennial District, west of Princess Street in the vicinity of Ross Avenue uncovered the bed of the former Creek, still fed by the flow of groundwater.

Logans Creek

The approximate site of this stream's mouth is today marked by a cairn commemorating Fort Douglas, just north of the Alexander Docks at the foot of Alexander Avenue. A small wooded coulee lies just behind the cairn which may possibly be a remnant of the former streambed.

Pritchard Creek

The Pritchard Boat Yard is built over the final reach of this Creek and only a small indentation in the Red River west of the yards indicates its former mouth.

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According to the owner of the facility, extensive filling occurred over the years to level the site. A nursing home for the aged is located in the final reach of the former stream before it turned northward into the Red River. A considerable drop in elevation occurs as the entrance to the building is approached on the west side, and five manholes protecting the building stand as testimony to the former streambed and the gradients of its course. The streambed west of the Red was built over at the turn of the century after the Colony Creek diversion cut off the major source of its flow.

St. Johns Creek

Traces of the coulee of St. Johns Creek are clearly to be seen in St. Johns Park east of Main Street. Although an earth dyke seals off the mouth of the Creek and a storm sewer carries off floodwaters in the remnant coulee bed, considerable ponding occurs in spring (Figure 68). The coulee of this former stream is of considerable historical interest because Lord Selkirk landed here in 1816 (Ross 1856). A study to determine the potential for re-opening this coulee would be valuable as the construction of the Red River Floodway and the increased protection it affords has decreased the necessity of the earth dyke. In addition, the area including St. Johns Cathedral and churchyard offers great opportunity for the development of an historical interpretive facility.

Inksters Creek (Selkirk)

The remnants of one of the several reaches of this stream now flows through Kildonan park as Selkirk Creek (Figure 69). Clear traces of the streambed of Inksters Creek are to be found in road depressions running parallel to the Red River for half a mile west of Main Street, north of St. Johns Churchyard as far as the Seven Oaks Monument. Slight traces of the depression that marked Inksters Mill Pond and flume to the Red River can still be seen. Considerable historic significance is attached to this site. John Inkster's home, Seven Oaks House, has been preserved as a public resource and a study of the area for development as an interpretive walk is needed.

9.1.2 <u>SOUTHWEST QUADRANT</u>

With the exception of the La Salle River, no perennial streams existed in this quadrant. Of the twenty-one intermittent streams and coulees that originally existed, only five exist today.

Beaver Dam Creek

A fragment of this small intermittent stream, unnamed in the last century, was preserved due to late development in the Charleswood area. Partially impounded, a reach of this Creek serves dual usage as a park waterway and storm drainage outfall. Low banks, culverting and encroachments prevent development of this remnant stream for open stream stormwater retention.

Baldry Creek

Unnamed in the last century, the extensive former coulee of this stream has been excavated and developed into an impoundment system for the residential subdivision of Fort Richmond. The treatment of this conversion is a case study for insensitive and unrefined planning and design. Decidedly ditchlike, the ponds have next to no recreational or aesthetic value and the development has a history of maintenance problems along the lakeshores due, in part, to densities and design concept (Chambers, 1978).

Beaujolais Coulees

Unnamed by Duncan Sinclair in 1874, this extensive coulee has been altered by impoundment for future residential lake oriented development. Proposed extensions to this system are shown in Figure 74. Opportunity exists in the case of Beaujolais Coulee for site specific design study on a residential development utilizing the dual major and minor drainage design concepts.

Westendorf Coulee

This coulee, also unnamed by Sinclair in 1874, has been designated as a Provincial Waterway to prevent encroachments by uncontrolled suburban development. The Province is intent on maintaining this waterway and tributary of the La Salle River for long term regional land drainage planning. Specific study on the Westendorf Coulee has not been undertaken.

La Salle River

This perennial stream running through the Parish of St. Norbert and emptying into the Red River just north of the Floodway has been largely preserved due to its distance from the intensive urban development in the early years of this century. Large tracts of land abutting the stream have been preserved in La Barriere Park and much of the floodplain of the River remains as it was a century ago.

9.1.3 NORTHEAST AND SOUTHEAST QUADRANTS

Of the six streams entering the Red River, on the east side only two, The Seine River and Bunns Creek exist throughout the length of their original bed. A third, Macleods Creek, exists only as a remnant.

Bunns Creek (Taylors)

Bunns Creek was designated by the Province as a Provincial Waterway in the 1970's to protect it from encroachments and preserve it for the dual usage of land drainage and recreational amenity. Although extensive housing has developed along its length, the floodplains of the Creek itself have been preserved. The Cordite Ditch, excavated in the last century, connects with Bunns Creek just east of the Perimeter Highway. Several stormwater impoundments have been proposed for this natural and man-made waterway (Figure 2). Bunns Creek and The Cordite Ditch offer significant opportunity for specific study of the landscape design possibilities inherent in the interconnections between man-made and natural waterways. In this connection F.L. Olmsted's design for the St. Charles River in Boston stands as an important historical design and conceptual model.

MacLeods Creek

This stream, formerly the site of a grist mill during the era of the Selkirk Settlement originally extended for miles in marshes and drainage runways. An early catastrophe of the coming of the C.P.R., the Creek was originally culverted for the construction of the Bergen line at the turn of the century. Subsequently, the Creek has undergone incremental encroachments and filling, until today

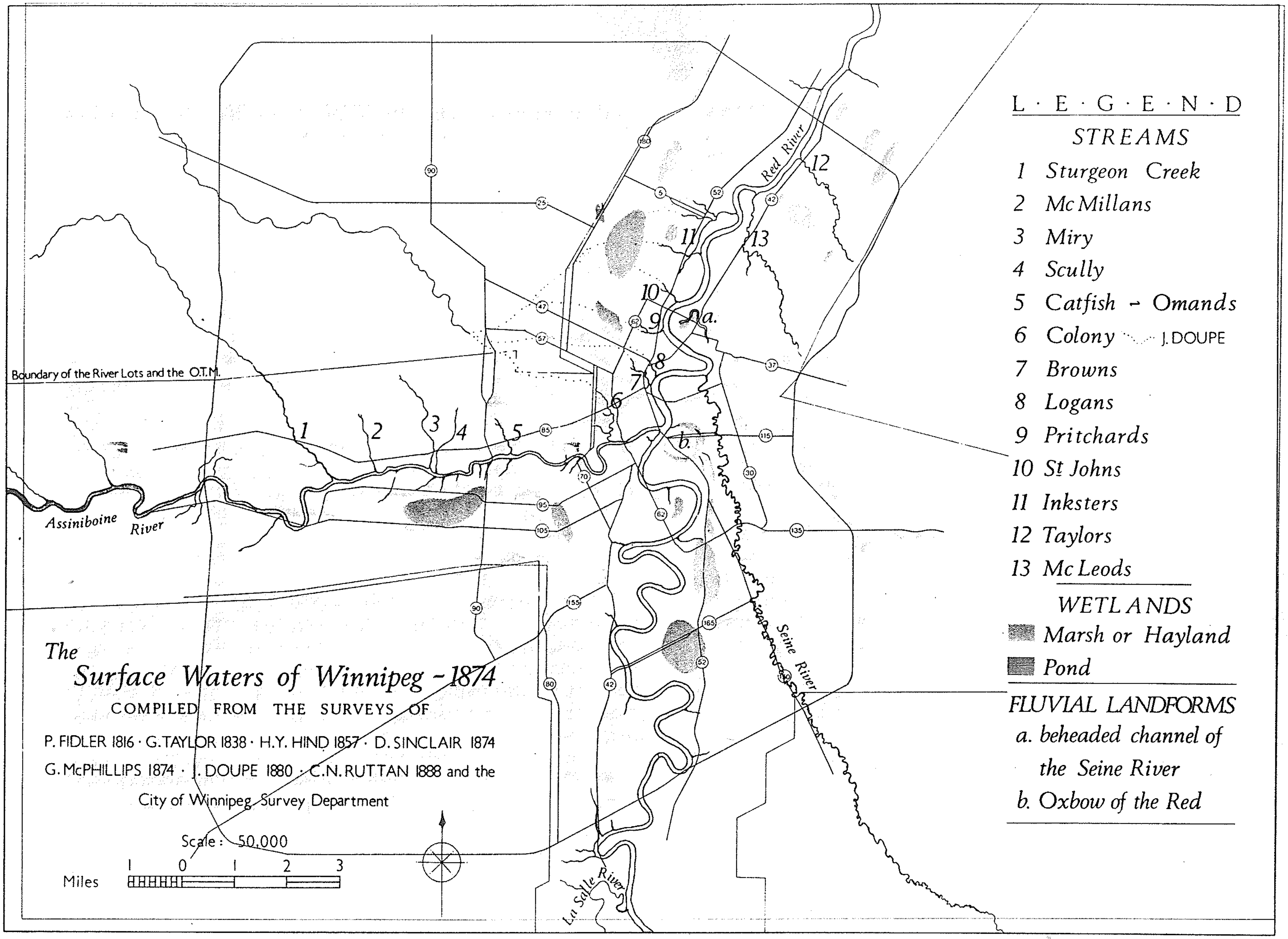

Figure 57

The Surface Water of Winnipeg, 1874, Revisited

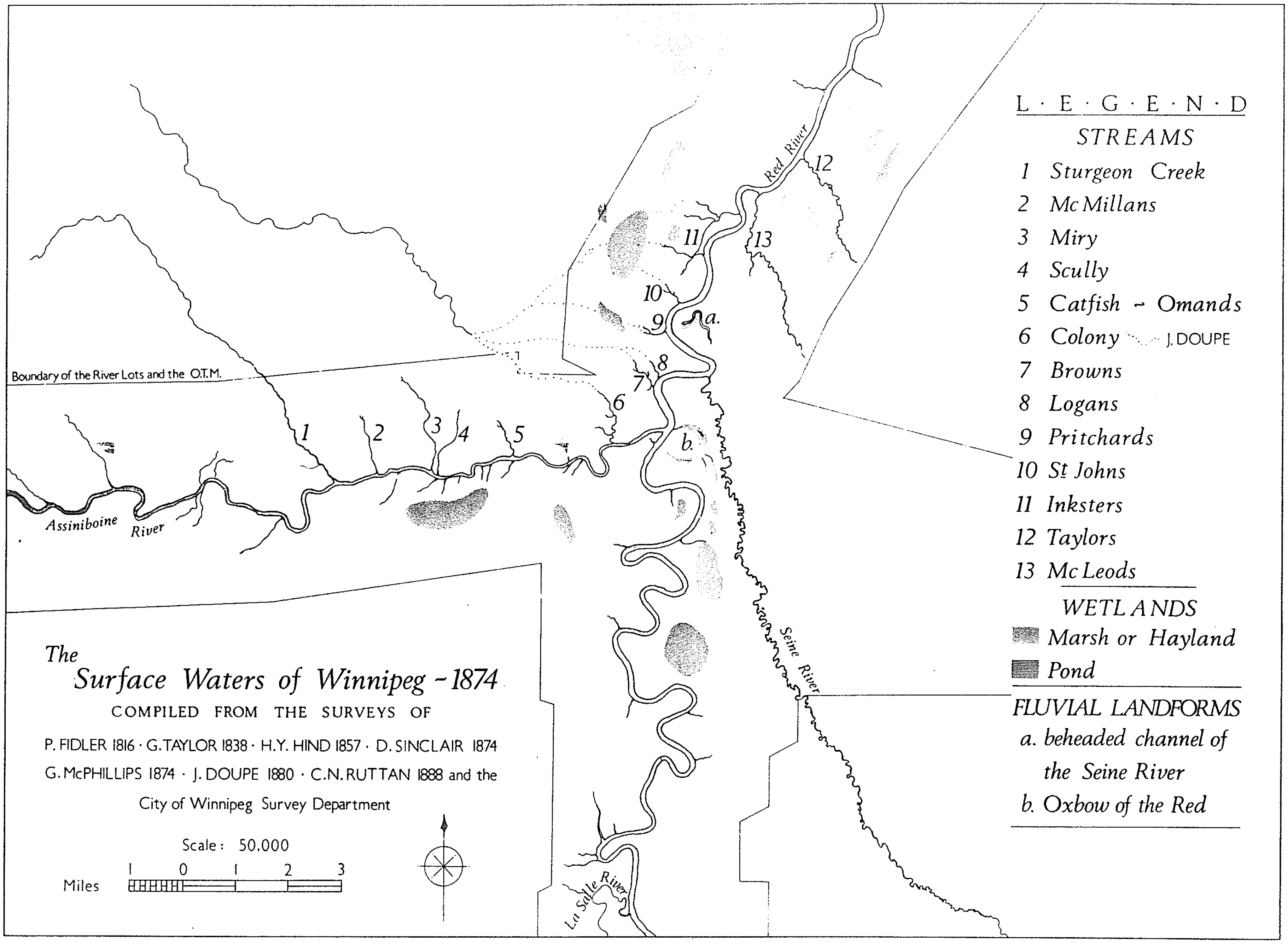

Figure 57

The Surface Water of Winnipeg, 1874, Revisited

Figure 58 Sturgeon Creek and "Grants Mill"
Some attempt has been made to develop this creek as a park waterway. The "mill" is not historically accurate.

Figure 59 Sturgeon Creek Erosion and Bank Stability
Culverting has increased the erosion problems

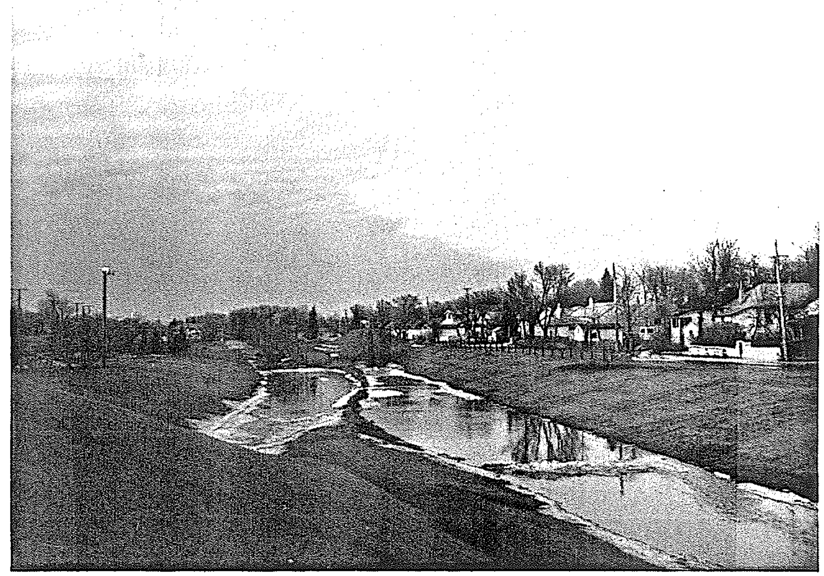

Figure 60 Truro Creek North From Portage
Large amounts of surface runoff can be stored in this preserved floodplain.

Figure 61 Truro Creek North of Portage
The shopping cart in the foreground was typical of all streams visited.

Figure 62
Omands (Colony) Creek Dammed in Brookside Cemetery

Figure 63

Omands-Colony Creek Diversion Current Condition

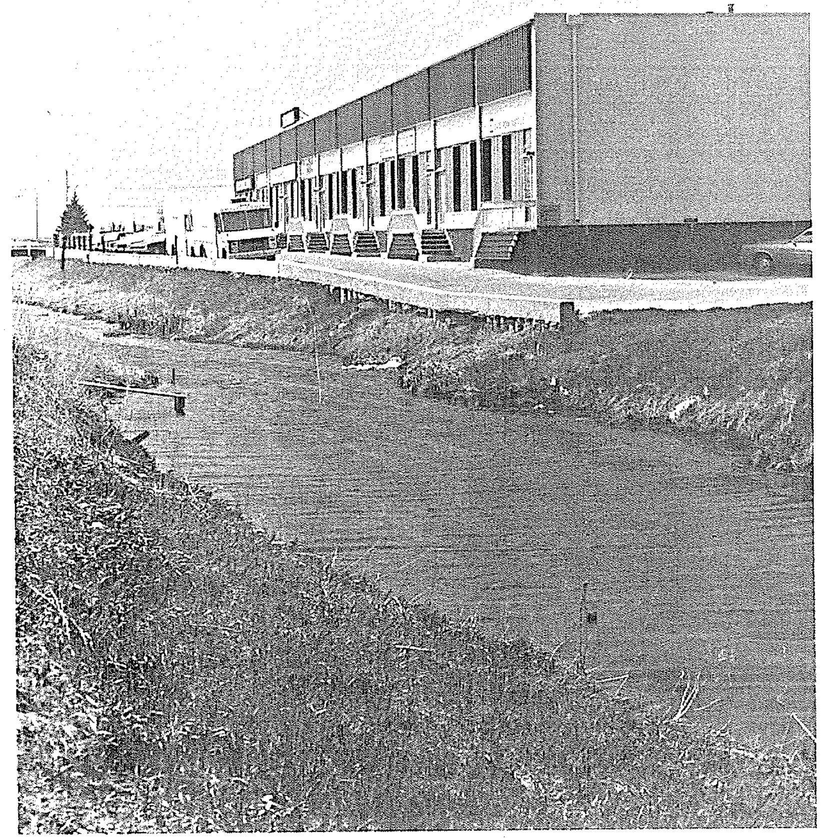

Figure 64
Encroachments on Omands-Colony Creek Diversion

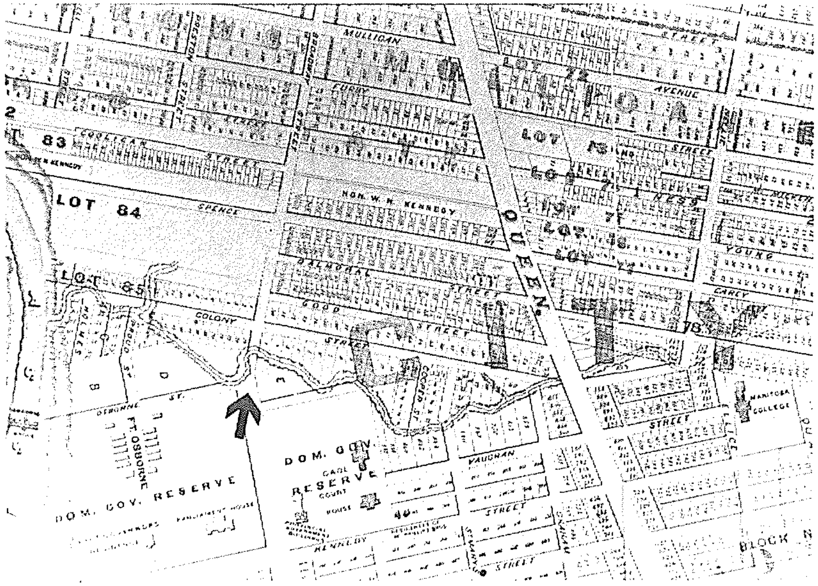

Figure 65 PAM
Colony Creek: Detail McPhillips Brothers, 1883

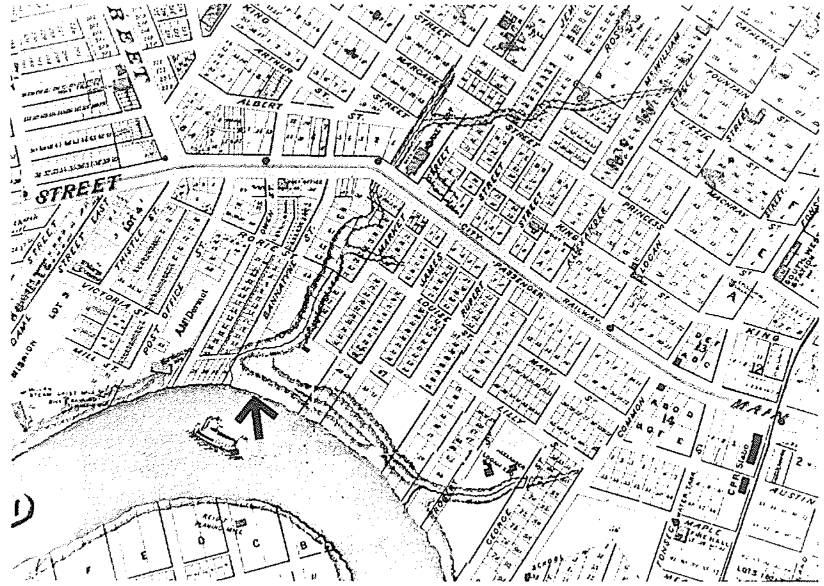

Figure 67 PAM
Browns Creek: Detail McPhillips Brothers, 1883

Figure 66
Broadway and Osborne: The Former Coulee of Colony Creek

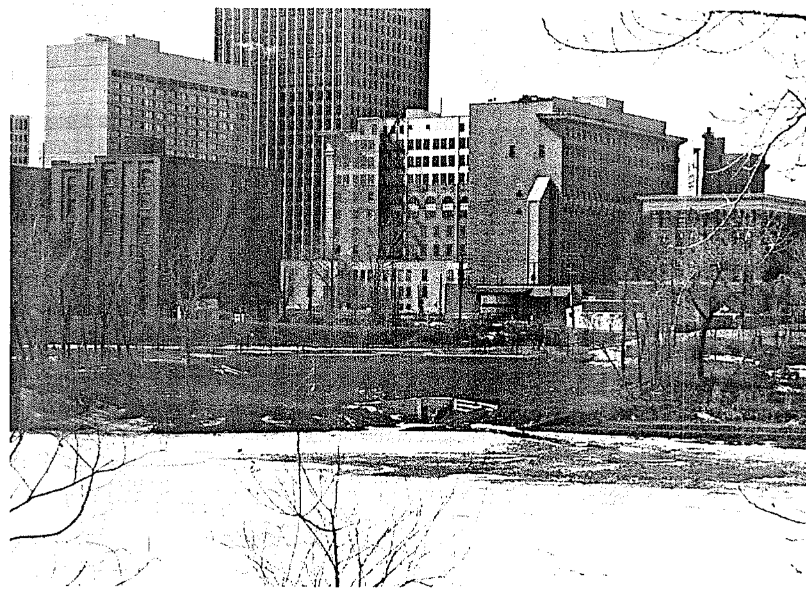

Figure 68
The Former Mouth of Browns Re-opened

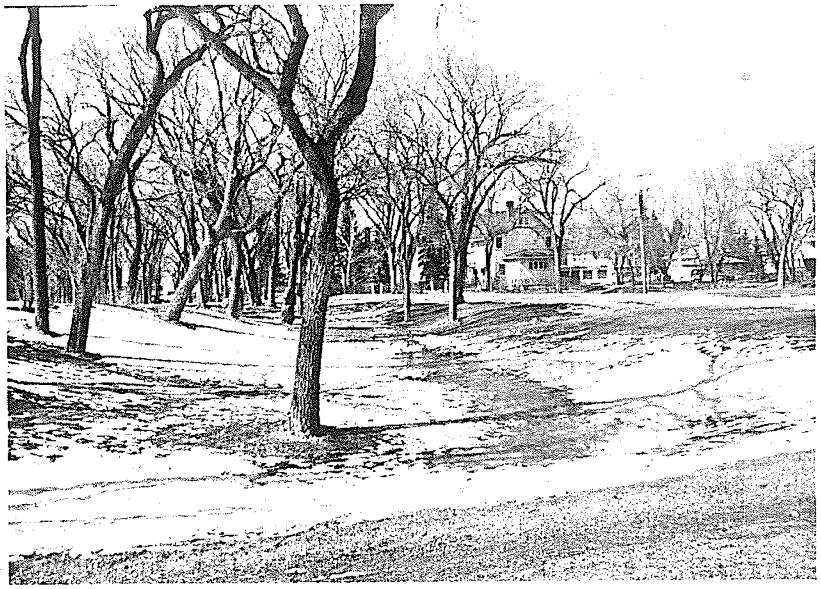

Figure 69
The Remant Coulee of St. Johns Creek

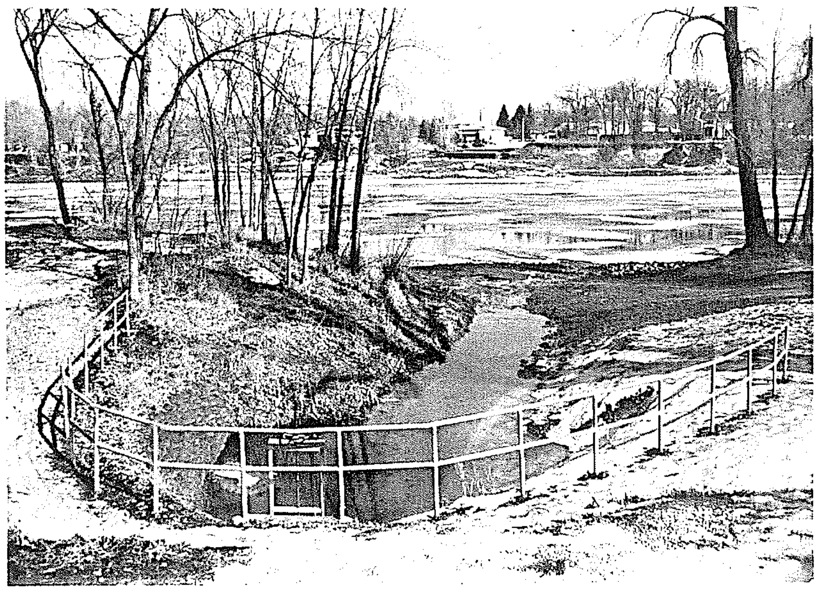

Figure 70
The Mouth of Inksters (Selkirk) Creek in Kildonan Park

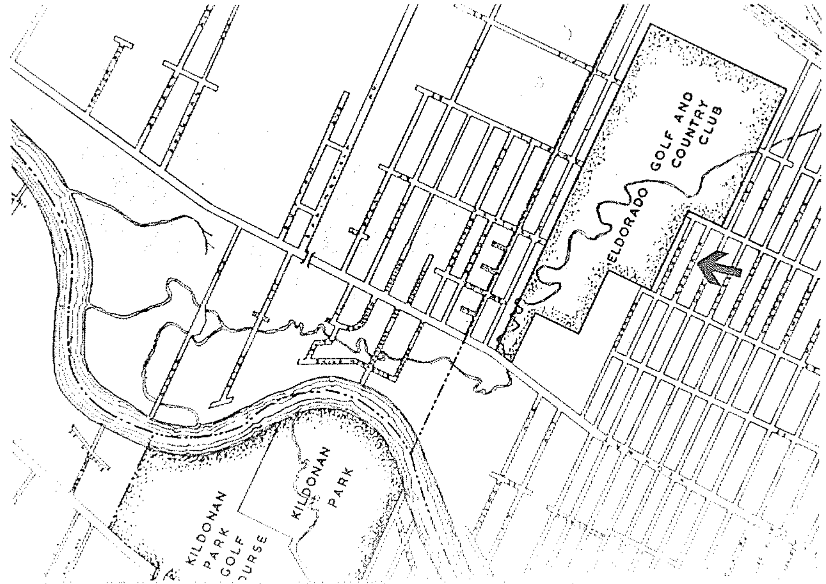

Figure 71 City of Winnipeg
The Former Path of MacLeods Creek

Figure 72
Frozen Stormsewer in the Former Bed of MacLeods Creek

Figure 73
Remnant Mouth of MacLeods Creek

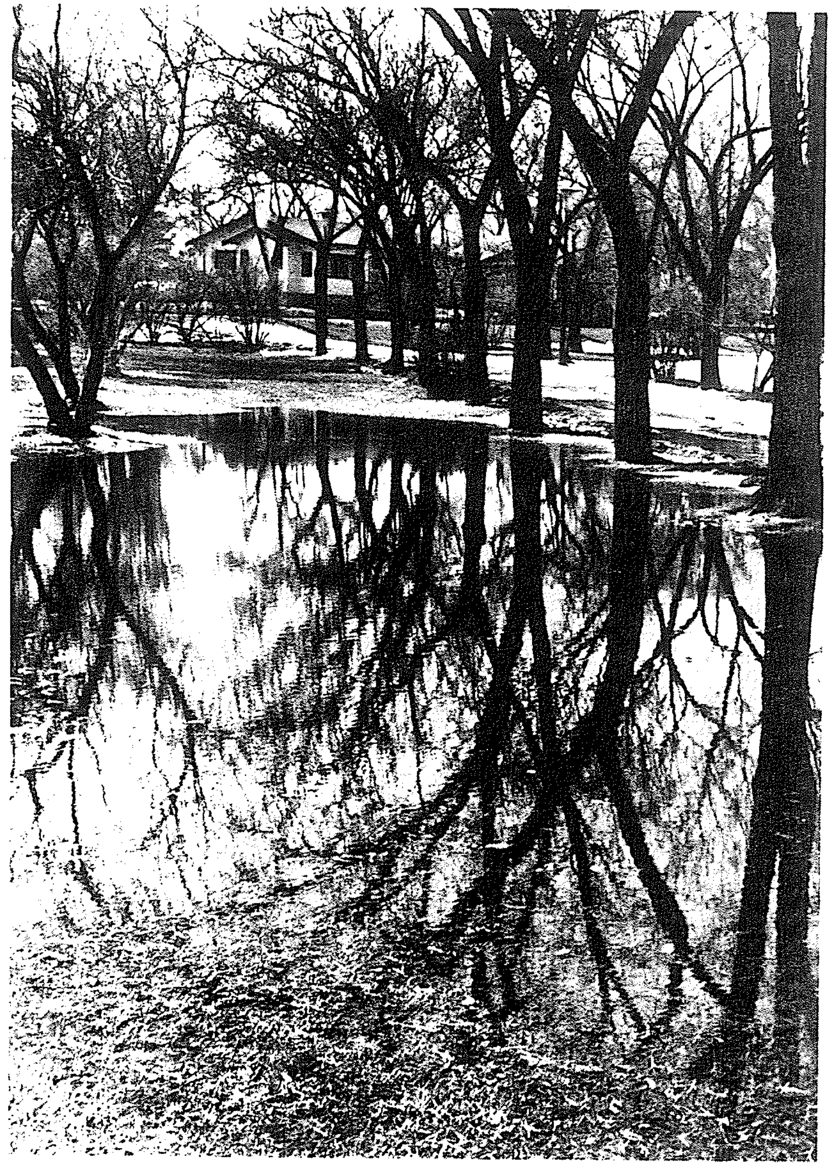

Figure 74
Surface Ponding in Spring in and Oxbow Park

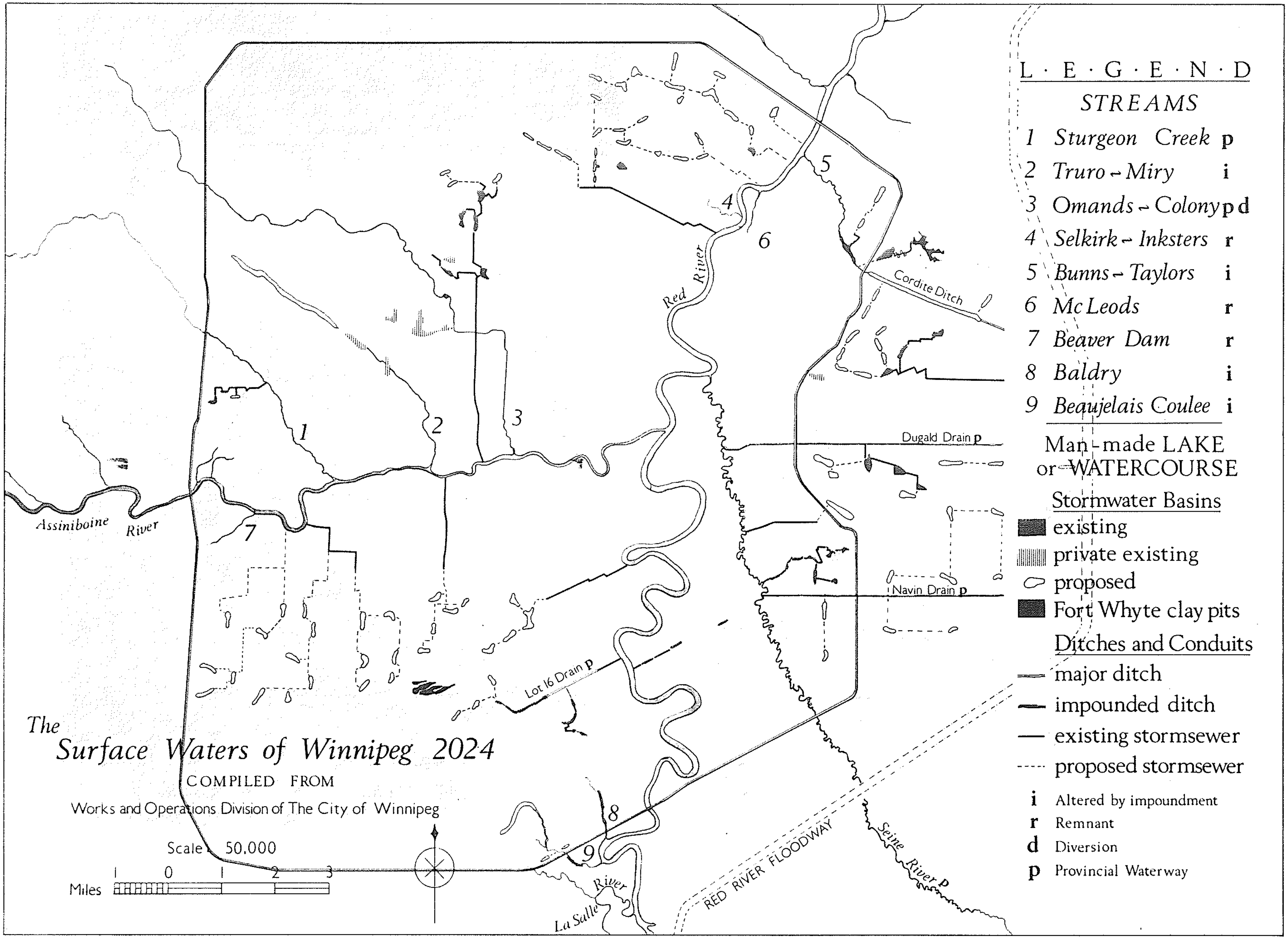

Figure 75

Hopefully the unimaginative and historically insensitive treatment of Winnipeg surface waters will not continue in the way conceived by the City's Water and Waste Division.

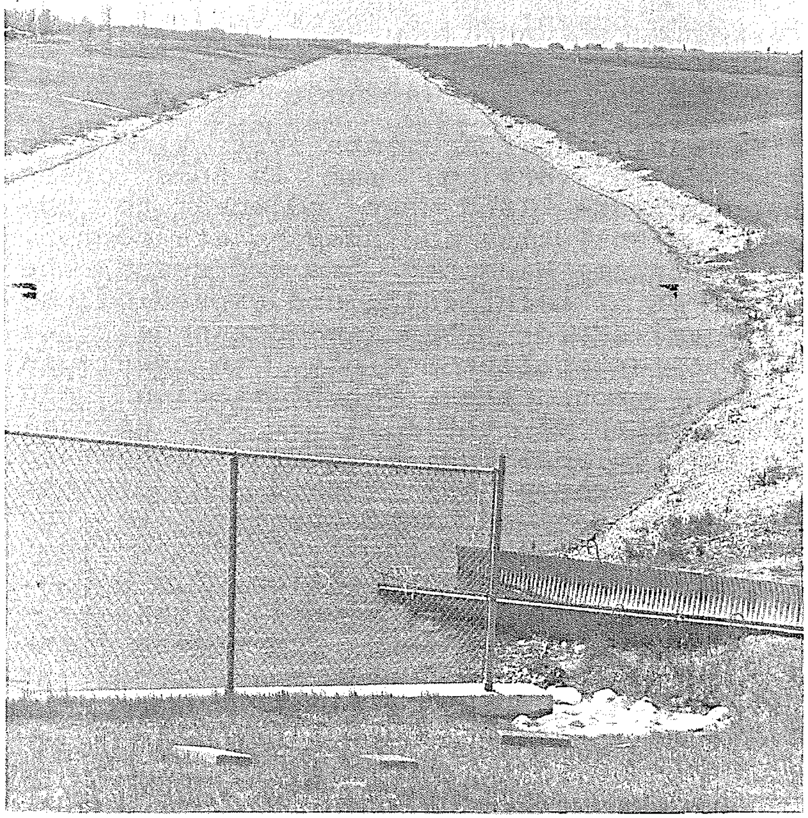

Figure 76
The Lot 16 Drain Looking West
There is no longer an excuse for single function man-made streams. Long range planning could integrate this drain with residential development.

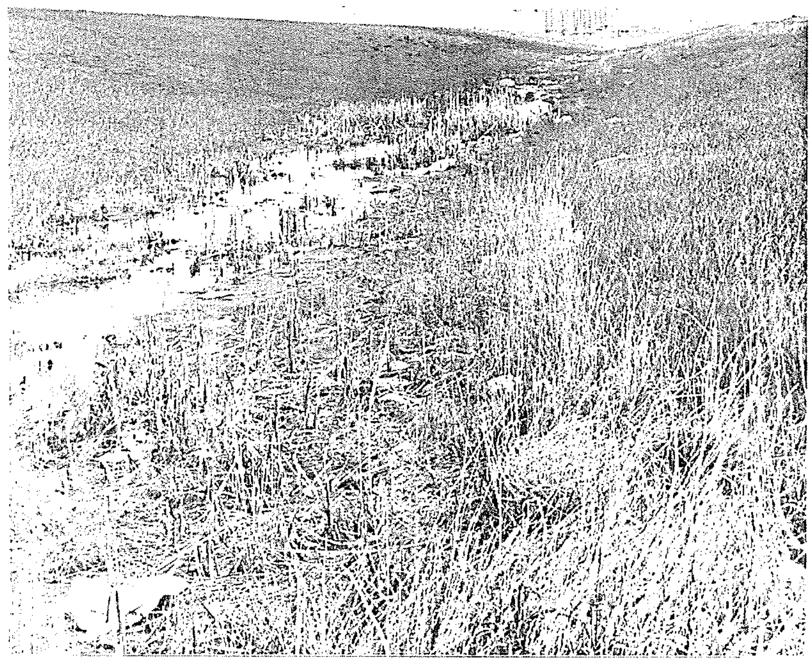

Figure 77
The Lot 16 Drain Looking East
The idea of developing a park waterway linkage system in combination with a land drain has yet to be explored in Winnipeg.

only a small reach remains lying within the Rossmere golfcourse and another short reach at its confluence with the Red. As late as the 1970's, lands abutting the Creek mouth were developed into residential highrise complexes, thus preventing intended park development by the City of Winnipeg. Stormsewer backup and stormdrain problems are common in the residential sub-divisions built over its former course (Figures 70, 71 and 72).

The Seine River (German Creek)

The largest of all the streams in the region after the Red and Assiniboine Rivers, the Seine River was designated by the Province as a Provincial Waterway in the 1970's in recognition of its importance as a regional drain for rural and urban areas.

The flow of the Seine River was first altered by drainage works south of Winnipeg in the last century (Figure 14). Since that time extensive alterations have occurred. The largest of these alterations, and the most radical in terms of the quality of the river and the intesity of flow, has been The Red River Floodway which daily diverts a portion of the waters of the Seine. This has resulted in stagnation and extensive encroachments by vegetation. In the late 1970's, the Waterworks and Waste Department of the City of Winnipeg in conjuction with the Parks and Recreation Division commissioned a study of the Seine for development as a park waterway and natural drain. A number of conflicts in proposed use exist however.

Extensive encroachments over time have resulted in varying, and in some cases inappropriate land uses adjacent to the river. Pollution and dumping are common. The City of Winnipeg has expressed the intention of maintaining and expanding use of the river for urban land drainage. The Manitoba Naturalist Society, in turn, is intent upon the rehabilitation and preservation of the river in its natural state. In addition, a lobby of concerned property owners has formed in protest against perceived inadequacies in the Seine River Park Waterway Study. That study proposed the acquisition of a R.O.W. by the City along the rivers urban reach to be developed as a pedestrian park linkage system. Such a proposal is complicated by the fact that property rights of private owners along the Seine extend to the centre of the river due to the historic boundary between the Parish of St. Vital and the Parish of St. Boniface laid down in the last century.

Extensive study of the Seine River is necessary in light of the complicated conflicts of use and interest involved. If the correct balance is not struck in long range planning strategies for the river, further deterioration can be expected.

The Oxbow of the Red

Despite extensive development within its banks, the Oxbow of the Red is still readily distinguishable. The banks of this former channel of the Red River are outlined by Enfield Crescent and portions of the two topographic lows outlined by McPhillips (1974) are the sites of public parks (Figure 73). Due to low gradients within the Oxbow itself, basement flooding has been a continual problem over the years as has flooding by the Red in peak years. To date, there has been no recognition or commemoration of the nature of this unique land form, and considerable opportunity exists for the development of an interpretive plan.

The Beheaded Channel of the Seine River

This landform can today be traced throughout the residential neighborhood of Elmwood. Fragments of its former outline are preserved in topographic variations in small parks, the Elmwood Cemetery and on Henderson Highway at Carman Avenue. Little opportunity exists for commemoration or rehabilitation of this landform.

9.1.4 IN CONCLUSION

In conclusion I would like to stress that this study, due to its synoptic nature, is intended largely as a background resource paper. I sincerely hope that specific design studies and ultimately new design solutions will arise from the collation of this information. The Winnipeg landscape was and is unique, and imaginative opportunities for the celebration, rehabilitation and commemoration of its' natural and man-made water features are today largely untouched. Historically, as this study has demonstrated, Winnipeg's surface waters have been treated solely as engineering problems. Hopefully this paper is a step towards the development of a more sympathetic and refined approach to land drainage than is demonstrated in Figure 74, The Surface Waters of Winnipeg 2024 compiled from the City of Winnipeg's Water and Waste Division's long range drainage schematics. Land drainage plans should be developed by engineers, regional and urban planners, and landscape architects working as a team. Only such a combination, utopian as it may sound, could do justice to such a rich and troublesome resource. We get only an inkling of the immense urban design possibilities for Winnipeg from such stormwater retention schemes as The Mint and the Data Taxation Centre. The Southdale Lakes, the most refined of the large impoundments (with the exception of Kilcona Park) are at present connected by underground pipes but the possibility exists in future developments for bringing these conduits above ground and creating man-made streams, thereby enriching the landscape. If we cease to regard drains as ditches, and consider them as man-made streams and design them as such, then there can, in the future, be no excuse for such crude unintegrated single function works such as the Lot 16 Drain (Figure 75). The possibilities for treating such features as important park linkages, or integrating them with housing development has not yet been touched. With regards to imaginative urban storm drainage in the inner core of the City, it is not unreasonable to imagine a day when a man-made storm water stream may flow into an intermittant pond, offering the opportunity for passerbys to pause and contemplate buildings, clouds and sky reflected in its still waters.

Abbreviations

WFP	Winnipeg Free Press
MDFP	Manitoba Daily Free Press
PAM	Public Archives of Manitoba
PAC	Public Archives of Canada
PC	Private Collection
WT	Winnipeg Tribune
CWA	City of Winnipeg Archives
ABH	Alvord, Burdick and Howson Report

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Parish of St. James Nos.	1477 35728 1009

Appendix a

A.1 THE CHESBROUGH REPORT JUNE 1882

GENTLEMEN,--Having at your request visited this city and examined into the condition in regard to sewerage I have the honor to submit the following brief statement.

Introduced to my work by His Worship the Mayor and the chairman of the Board of Words, I have in company with the City Engineer visited the different parts of the city, studied its peculiarities, and received from him every assistance in his power to enable me to fulfill the object of my visit.

Following the natural order of subjects, the first question is what do you propose to drain and to what extent? I understand that you wish to drain cellars, water-closets, stables, manufacturing establishments, and everything allowable ordinarily in City Sewers in such a manner that the sewerage may reach an outlet before decomposition can take place; and that whatever system may be adopted shall be capable of extension as necessity may require to the present limits of the city.

All experience thus far proves that the most satisfactory as well as economical mode of effecting such draining is by water carriage through properly constructed sewers; other methods of disposing of city refuse or sewage are practised to a considerable extent in European and American cities necessarily in those that have no sewers at all, or but very few, for in such cases the contents of cesspools, garbage and all other substances must be carried away, generally at so great an expense that the work is not thoroughly done, causing many evils detrimental to public health and comfort. I have taken it for granted that you wish in the future to avoid the necessity of open cesspools, everywhere justly condemned, and to remove every excuse for allowing substances of any kind to remain in the city long enough to purify..

The disposal of your sewage must be in someplace where it cannot again become a nuisance to the city. Fortunately you have a river sufficiently wide and deep and rapid to receive, without becoming offensive, all the sewage that a population twenty times as large as the present could pour into it.

Your sewers should be capable of receiving stormwater, otherwise the streets, which are practically on the level of the sewer, would be flooded and impassable and occasionally cellars at such times would be liable to flooding from the sidewalks.

The direction of the sewers must be governed by the streets, the trunk lines being so placed as to admit of the greatest economy consistent with efficiency in the construction of the entire system. It will be necessary at first to construct outlets and other main sewers larger than immediate necessities would require in order that they may be of sufficient capacity when the system is completed.

The total inclination that can be given to your sewers, beginning at the western limits as recently established is about seventeen feet, and is sufficient with judicious arrangement and an abundant supply of water to keep them clear. Without however, an abundant supply of water, such a system of sewers as that briefly described, and receiving the substances mentioned, would become an intolerable nuisance. It is, therefore, greatly to be desired that the rates to be charged for water may be so adjusted as to encourage rather than repress a free use of it. The rates allowed by the water company's charter for water for flushing the sewers will make that operation very expensive, and seems to me to be very high. It would be a serious calamity if the rates should be maintained so high as to discourage the laboring classes from taking a sufficient supply or lead them to resort to use of impure water.

A study of the record of floods in the Red River in 1816 and since shows that they have overflowed the business portion of the city three times - in 1856, in 1862 and in 1871. Of course, under such circumstances no sewer could prevent cellars from being flooded unless the grades of the streets or the basements of the buildings were raised. It is generally believed that such floods can never take place again. Ordinarily it is not safe to say that what has been will not be again, but in this case there are some well ascertained facts which may justify the popular belief. From information obtained from Hon. A.G.B. Banatyne and others, it is evident that the Red and Assiniboine Rivers are considerably wider in this vicinity now that they were forty of fifty years ago. This would explain why the flooding of this spring, which was as great at Emerson and at points equally high up on the Assiniboine as ever known since the first settlement of the country, was so much lower in the city than the floods of previous years. A map of the Red River between this city and Lake Winnipeg, together with a profile of the same showing the heights of the different floods, and at low water at different points, kindly sent me by Mr. Jas Rowan, indicate that in the flood of 1882 as much water passed down the river as there did in the flood of 1826. It would be imprudent, in my judgement, to establish the grade of any streets as low as the flood line of 1882.

Whatever the future may develop with regard to floods the city authorities could not wisely undertake to prevent cellars from being flooded and should therefore grant permits for their connection with the sewers only upon condition that the owners protect themselves against flooding. There is no good reason why owners of property under such circumstances should not run all risk with regard to the flooding of cellars, than those who have cellars near the sea coast with bottoms below high tide. Precautions necessary to protect cellars against floods, would also protect them from the backwater caused by occasional excessive storms. It may be asked how is the drainage from kitchens, laundries and water closets to be effected in time of floods when celler drains must be closed with valves? This is done under similar circumstances elsewhere by mean or iron pipes, which have connections with the sewers, either independent of the cellar drains or beyond the valves. In the construction of such cellars, great pains must be taken to prevent water from entering them in considerable quantities through their bottoms or sides, as all such water would have to be pumped out during floods. The whole arrangement and keeping of such cellars dry will require constant care and watchfulness to prevent the entrance of sewage, the bad odor of which is likely to remain for months.

It would be impossible at present to make a satisfactory detailed plan of the sewerage for the whole city, because much of the ground is not yet laid out into streets and lots, and most of that which has been done is of such a fragmentary character as to be unsuitable for a judicious arrangement of the sewers. It is greatly to be regretted that your streets could not have been laid out upon some well digested general plan, having reference far more to what would meet the future wants of the public, than the greatest present amount to be obtained in selling the land.

With regard to what has already been done in the way of sewerage it is very desirable, on account of economy and convenience, to make as much use of it as would be safe. It is understood that the wooden sewer on Main Street, together with its outlet and branches were put in as a temporary expedient, and considered subject to such change or abandonment as might be found advisable. Certain other sewers to be laid in Portland concrete, before it will be possible to put in the large main sewers, can be incorporated with the new system, but were it not for these necessities, some of them might be arranged a little differently to advantage. But it is no uncommon thing to make slight changes in the details of sewerage plans to accommodate important unanticipated improvements.

In reference to what is called the separate system of sewage, which has been spoken of as advisable to this city, I do not think it would be wise to recommend it here, because of the needless extra expense it would entail. You must have storm water sewers, and they can be made to carry away the sewage proper without the necessity of other sewers for this purpose, especially with the abundant supply of water spoken of. Besides, it is now generally, if not universally, admitted that the great evil of sewer gas complained of in houses, proceeds principally from the private drains which can be made just as good under the combined system as under the separate.

The present prices of materials and labor required for your sewers seem to me extravagantly high, and must tend to retard their construction, especially in view of the increased taxes consequent upon their extension. For this reason it will no doubt be found desirable to provide temporary large wood-covered ditches or flumes to carry off storm water that could not conveniently be received into the sewers for years to come, and which nevertheless must be kept from flowing over the streets.

In carrying out the views thus briefly expressed, it seems to me advisable to begin with the Main outlet of your sewerage system at the foot of Pritchard Street, thence along that street to Main Street, thence along Main Street to Jarvis Street. I would prefer continuing along Main Street to Portage Avenue but as a temporary wooden sewer is already laid on this street, and can, no doubt be made to serve a useful purpose for some years yet, at least until prices of work fall considerably lower than they are now, it would be expedient to construct the main sewer along Jarvis Street to Princess Street; thence along Princess Street to Donald Street; thence along Donald Street to Portage Avenue; and thence along Portage Avenue eventually to the city limits, but probably not much beyond Spence Street for some years. It will probably be found advisable to begin a branch main on Notre Dame Street at Princess Street, to be laid eventually to the M.S.W. Railway; also another branch main on William Street at Princess Street, to be laid eventually to McPhillips Street; also another on Logan Street to be extended eventually to the M.S.W. Railway. It will, no doubt, be found advisable to put a secondary main on Broadway, with an independent outlet at the foot of that street. One, if not two, large branch mains would be ultimately required north of the C.P. Railway, but perhaps not for several years yet. In the district bounded by Portage Avenue, Notre Dame Street, and the western limits of the city, several secondary branch mains will eventually be needed some leading from Portage Avenue about on the line of Dufferin Street to Sargent Street.

The large sizes of the main and branch sewers necessary to carry off storm water will make them very expensive, it is therefore of great importance to convey storm water in the shortest practicable way to the nearest outlets or channels capable of receiving it, while the ordinary or dry weather sewage be carried to the main outlet where it will be diluted so many times as to cease to be a nuisance. The sizes of these sewers cannot be safely determined without further and careful investigation. By means of the storm water outlets, it will be practicable to make the main sewer considerably smaller and less expensive than would otherwise be necessary. The discharge from these outlets after the first dash is seldom offensive to the smell, and of course when mixed with the current of a river ceases to displease even the eye. It is not likely that a storm outlet discharge into the Assiniboine above the water works will be needed till after the wants of the city shall require its supply to be taken from some other point higher up the river, or from some other source. A storm outlet on Bannatyne Street will probably be found advisable, and possibly one on Logan Street, but there has not been sufficient time yet to make the necessary calculations and comparison of estimates to determine this question. Eventually the main or interceptery sewer will no doubt be continued northward along Main Street when its outlet on Pritchard Street will be used for storm water, and thus permit the continuation of the interceptery sewer to be considerably smaller than would otherwise be necessary.

Owing to circumstances already mentioned regarding streets, and excessive prices of materials and labor, no satisfactory estimates of the probable cost of constructing the entire system of sewerage can be made. It is not likely you will need to carry out the whole of the system for many years. The probable cost of the interceptery main from the foot of Pritchard Street and the necessary storm outlet, at ordinary prices, would be upwards of $150,000.

A great deal of storm water flows within the city limits from without through Colony Creek, and this could be best diverted to the river by improving the existing ditch along or near the C.P. Railway. It would require an enormous expenditure to provide underground sewers for this water, and they cannot be needed for a long while.

Fear has been expressed by several persons that the outlets of sewers into the river will freeze up and prevent any discharge from them. Similar fears were originally expressed with regard to the Chicago sewers, but have never been realized in a single instance. The water of the sewers has always been warm enough to keep their outlets open. I do not see why the result should be different here, provided there is a free but not necessarily extravagant use of water for domestic purposes in all the houses.

The frost penetrates here, seven feet below the surface, in Chicago, at times, six. Whatever outlets may be made to the river should have pipe extentions to below low water mark sufficient to discharge all the dry weather sewage that may reach them. The masonry at the ends of the sewer outlets, and for several hundred feet back, should be frost proof.

The best material for sewers are hard burnt bricks, hydraulic cement mortar and vitrified clay pipes. Where it is not concrete may be substituted, provided due care and skill are exercised in their manufacture. The ordinary kinds of American cement are not suitable for such a purpose and should not be used. I think it would be good policy on the part of the city to encourage the manufacture of a superior quality of vitrified clay pipes in this vicinity.

It will be necessary to ventilate the sewers and this can best be done by means of perforated manhole covers. Other means when available may be beneficial auxiliaries, but without the manholes they are likely to prove inadequate, while those have generally been found sufficient of themselves. This will require a great many manholes but they will be needed for examination, cleaning and flushing.

In the examination of the system projected by the City Engineer, I find his views are substantially in accord with those which have governed me in other cities. Where he has seemed to me at first sight not to have adopted the best location of important sewers, he has given strong local reasons for what he has proposed. Only a careful investigation of the subject, including detailed estimates, a work requiring time, can determine satisfactoraly what ought to be done in such cases.

Respectfully submitted.

E.S. Chesbrough.

Appendix b

B.1 **DESIGN OF DRAINAGE SYSTEMS**

1882-1910

The Adams Modification of the Hawksley Formula:

This was the design basis of the original combined sewer system based on the report presented to City Council, June 8, 1882 by E.S. Chesbrough, the first city engineer of Chicago.

$$\text{Log } D = \frac{2 \text{ Log } A + \text{Log } N - 3.79}{6}$$

D = diameter of the sewer in feet
A = number of acres tributary to sewer
N = the length in which the sewer falls 1 foot

This formula was used from 1882 to 1910 (three years before the combined system in existence today was completed). The formula is said to be based on a 50% runoff from a rainfall of 1" per hour (Alvord, Burdick and Howson, 1943).

This formula did not account for characteristics of perviousness in the drainage area and was, therefore, inadequate for highly impervious urban areas. In use until 1910, the majority of the trunk lines were designed on this basis thus setting the stage for later basement flooding when larger lateral conduits based on the rational formula were introduced upstream.

The Rational Formula 1912-1965

The rational method was first introduced in 1889 in the United States and is still widely used for design of storm sewer systems in the United States and Canada. In 1912 Mr. Aldridge and Col. Ruttan introduced the rational formula to Winnipeg one year before the system was complete.

Q = C I A

Q = peak run-off in cubic feet per second
C = run-off coefficient depending on the characteristics of the drainag area
i = average rainfall intensity in inches per hour
A = drainage area in acres

The rainfall intensity curves used by the City of Winnipeg between 1912 and 1939 were expressed by the formula

$$i = \frac{60}{t + 10}$$

in which t = time of concentration required for all portions of a tributary area to contribute runoff at a given point. In the use of this rational formula the inlet time, or time required for the runoff to reach an inlet feeding into a sewer was taken as 15 minutes. This intensity curve was calculated to provide protection from approximately a two year event (Alvord, Burdick and Howson, 1943).

The percent runoff from pervious areas varied from 40% to 100%, depending upon the type of surface improvement, and from 10% to 20% from unimproved surfaces and grass plots (see Figures).

In 1939 the formula expressing the'intensity of rainfall to be used in the rational formula for the design of the combined sewers was changed to

$$i = \frac{100}{t + 18}$$

This was estimated to provide protection from a two and one half year event and was considered to inadequate (Alvord, Burdick and Howson).

LIMITATIONS OF RATIONAL FORMULA

As development increases upstream of a developed area the system becomes increasingly surcharged with new waters due to increased rates of runoff. In addition, as rainfall intensities are updated and designs altered accordingly increasing vulnerability to basement flooding by back up occurs downstream.

Runoff Coefficient: "C"

"C" is the most uncertain of the variables since several physical aspects must be clumped together. The runoff coefficient characterizes the following variables;

antecedent precipitation
soil moisture
infiltration
ground slope
ground cover
surface and depression storage
shape of the drainage area
overland flow velocity

Inlet Time "t"

The inlet time is the overland flow time for runoff to reach the drainage channel. Due to continual development and changes in degree of perviousness "t" is, over time, very changeable. "t" varies with

the length of flow path
surface slope
surface roughness
antecedent rainfall intensity (hard rains compact soil surfaces)
infiltration capacity
depression storage

According to Watkins 1962, and McPherson, 1969 among others the following limitations apply to the rational method.

1. One of the most serious limitations is the fact that the rational method does not take into account the real storm pattern. This is particularly true of Winnipeg where the showery nature of the precipitation can account for extreme differences in records from different recording stations. Both the time variation of the rate of rainfall and the variation of area and velocity contributing to the flow are therefore nor accounted for.

2. Underlying physical factors affecting runoff are lumped together in a runoff coefficient, "C", and therefore cannot be analyzed or individually modified. For example storage factors such as depressions and detention losses play

a subjective role in selecting the correct runoff coefficient.

3. The runoff coefficient is not constant with time as is usually assumed for application of the rational formula. This is due to antecedent moisture, rainfall and temperature which cannot be accounted for without some knowledge of the storm pattern.

4. A similar problem is also encountered where "C" tends to increase with the design frequency selected, since larger storms generally have antecedent rainfall.

<u>Intensity</u>:

1. With respect to the determination of rainfall intensity, estimates of the inlet time (time between precipitation reaching the intercepting surface and runoff reaching a catch basin) are difficult especially for flat areas. None of the factors influencing the inlet time (perviousness, etc.) can be accurately computed and assumptions of full flowing pipes tends to overestimate the travel time in sewers, leading to an incorrect time of concentration which results in erroneous design.

2. Since the time of concentration varies in each portion of the drainage basin, each part of the pipe network is actually designed by pieces of different storms, from which the rainfall-intensity-frequency curve was derived. This means that the larger the subcatchment area, the more unlikely the concurrent occurrence of design rainfalls for all catchment components. Therefore, only a portion of a network would be at design capacity for a given storm.

3. While the rational method can account for lag effects due to travel time, it does not allow for retardation by storage and momentum of flow in channels. This is particularly significant on the Prairies which are characterized by flat topography with poorly defined drainage ways. On such areas the rational method will only provide, <u>at best</u>, approximate estimates of peak flows (Gray, 1970).

All the above mentioned limiting factors result in the fact that the rational formula upon which the combined and separate systems of Winnipeg were based can only be accurately used for design of pipe networks up to 18" in diameter for relatively small basins of between 2 and 5 acres or, at best, one or two average city blocks.

THE COMPUTERIZED HYDROGRAPH METHOD

Current practice in Winnipeg land drainage planning employs computer hydrographic models. These models are superior to the rational method to simulate runoff from urban areas because of their ability to synthesize physical processes sequentially in time and can, therefore, closely follow the natural phenomena in a design storm. Computer hydrograph methods give, in contrast to the rational method, accurate simulation of runoff from areas larger than 5 acres. Generally, distributed computer hydrography models characterize the drainage basin by dividing it into several sub-catchments and specifying the runoff parameters including infiltration, slopes, roughness, antecedent precipitation and depression storage depth for both pervious and impervious areas. Such models also consider routing of both overland and conduit flow (MacLaren, 1974). The significant savings that are realized by retention facilities, both temporary and permanent, have led to the widespread acceptance of the computer hydrograph methods in large North American centers that have been susceptible to floodings attributed to the undersizing of conduit systems designed according to the rational method. The Environmental Protection Agencies Storm Water Management Model (EPA-SWMM), one of the most comprehensive urban runoff models available (MacLaren, 1974) was adopted by the City of Winnipeg in the late 1970's and is an integral component of the Regional Planning of Land Drainage in both major and minor systems. The model combines sophisticated computer sub-routines to describe runoff quantity and quality and its effect on the receiving water body by means of hydrographs and pollutographs.