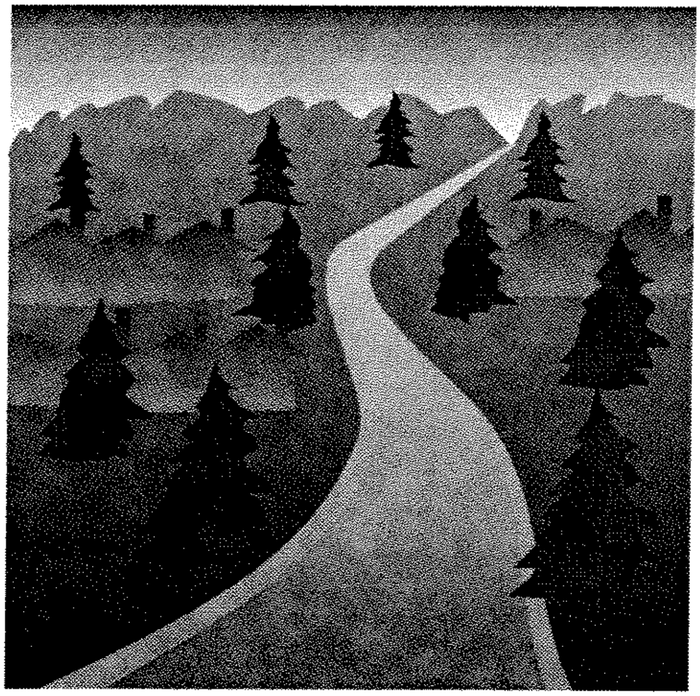
The Corporation of the City of North Bay

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

Chippewa Creek

Watershed Management Study



PROCTOR & REDFERN LIMITED

CHIPPEWA CREEK
WATERSHED MANAGEMENT STUDY
FINAL REPORT

Prepared for:

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

Prepared by:

Proctor & Redfern Limited

34 Commerce Crescent

North Bay, Ontario

P1B 8G4

In Collaboration with:

Near North Laboratories   Ortech International   Trow Engineering   Settlement Surveys Ltd

December 1996   **EO 94408**

EXECUTIVE SUMMARY

The North Bay-Mattawa Conservation Authority and the City of North Bay have undertaken a Management Study for the Chippewa Creek Watershed. An ecosystem-based planning approach which integrates the assessment of the existing conditions within the watershed with requirements of the Environmental Assessment Act was used in this study. The Chippewa Creek Watershed Study was conducted under the direction of a multi-organizational committee, a consultant team, and a public liaison committee.

The study was undertaken in three Phases. The results of the three phases were presented to the public over the course of the study to solicit input on the background review and assessment of existing conditions (Phase 1), the development and evaluation of watershed alternatives (Phase 2) and the development and preparation of the watershed management plan (Phase 3).

The Watershed Management Plan

The watershed management plan proposes a series of recommendations, for each subwatershed of Chippewa Creek, which meet the goals and objectives developed by the Watershed Study Steering Committee, the Public Liaison Committee, the public and the Study Team. The following are the Chippewa Creek Goals and Objectives:

1. Enhance and protect the ecological integrity of the Chippewa Creek watershed.
2. Reduce or eliminate flooding damage potential within the Chippewa Creek watershed.
3. Prevent and control detrimental erosion and sedimentation.
4. Enhance the human use of Chippewa Creek and the watershed corridors.
5. Encourage environmentally sensitive development within the Chippewa Creek watershed.
6. Promote public awareness and implementation of the watershed plan by decision-makers, property owners and the public.
7. Ensure that the Chippewa Creek Watershed Goals and Objectives are implemented.

The implementation of the Watershed Management Plan is being recommended through official plan and preliminary secondary planning for the watershed plan and through secondary plans and draft plans of subdivision for stormwater management plans. For the purposes of implementation Chippewa Creek was divided into four subwatersheds; the Upper Chippewa Creek, the Lower Chippewa Creek (main branch), Johnston Creek, and Eastview Tributary.

The recommendations were developed by identifying watershed linkages and relationships and opportunities upon the completion of Phase 1 and evaluating a range of watershed management and planning alternatives to determine the preferred ecological, hydrologic and social/recreational at the end of Phase 2.

The completion of Phase 1 included the recommendation that archaeological site inventory and field work be undertaken of any portions of Chippewa Creek or its watershed area prior to any management or development projects that would disturb the earth's surface.

Upper Chippewa Creek Subwatershed

Ecological Recommendations

The Upper Creek Wetland Complex is the only Provincially Significant Wetland within the watershed and is largely confined to a narrow riparian zone along the main channel and several tributaries of the upper watershed. The corridor afforded by the wetland complex combined with the adjacent wooded areas provides excellent potential for a diverse natural ecosystem in this area. The Upper Chippewa Wetland should be protected where possible and managed according to the 1996 Ontario Provincial Planning Policy Statement (Recommendation B.1). It will be the responsibility of the City of North Bay to develop appropriate guidelines and assessment requirements for Provincially Significant Wetlands and their adjacent lands by way of Official Plan policy. The remaining wetlands within the watershed are considered to be locally significant. It is recommended, and it is one of the preferred ecological alternatives, that the function of locally significant wetland areas be maintained (Recommendation B.2). The protection of wetland area in the Ski Club Road Marsh and Tower Drive Complex wetlands is encouraged.

One of the most important constraints of this area is the cold water fish habitat. In order to protect cold water fish habitat it is critical to maintain a riparian (stream-side) vegetation buffer strip of 30 metres from the creek bank or the 25 year floodplain whichever is greater. The buffer area will be regarded as a "no development" or environmental protection area, with the exception of utility corridors, roadways, and recreational trails (Recommendation A.1).

Proposed developments for areas within 30 metres of the creek bank, from the headwaters to Airport Road, should be required to demonstrate no impact, or minimal impact on surface water quality and the resident fish community (Recommendation A.2).

The extensive forest cover within the upper watershed provides important corridors for wildlife migration. One of the preferred ecological alternatives is the protection of significant forest areas. The maintenance of large interior forest is encouraged

(Recommendation C.1). Development should be prohibited in areas where slopes average more than 15% over a distance of 100 meters (Recommendation C.2).

Hydrologic Recommendations

The highest level of recharge and baseflow generation is in the headwater areas where sand and gravel overburden provide high permeability to precipitation. The upper-watershed is characterized as having low alkalinity, elevated iron levels, relatively low suspended solids, and low heavy metal concentrations.

A storm water management pond, sediment and control plans for all the gravel pits (Recommendation D.1) and agricultural Best Management Practices (BMPs) are all recommended for the upper watershed.

Social/Recreational Recommendations

The upper watershed is outside the "Urban Service Boundary" and will not experience intense development pressure. It is recommended that an extension to the "Chippewa Way" (link between schools, parks, YMCA and some service clubs) along the creek to its intersection with Highway 11 and a City transit route be planned and formally recognized in Secondary Plans (Recommendation F1 and F2).

It is recommended that any extension to Chippewa Way consider linkages to Duchesnay/Kate Pace Way pathway loop and linkages to the east end of the City be realized in the future (Recommendation F3). It is also recommended that the route of Chippewa Way north of Airport Road capitalize on natural heritage features (post glacial shorelines and deposits) and that interpretive kiosks be located to describe how landscape features were created (Recommendation F4).

Lower Chippewa Creek Subwatershed

The ecological resources in the lower watershed are very limited due to urbanization. Riparian vegetation in the lower reaches is mostly comprised of manicured lawns, Manitoba Maples and scrub vegetation in scattered clumps. Physical attributes and water quality conditions of the lower-watershed fish community indicate limited potential for warm water fish. For the purposes of protecting the existing fish community and surface water quality, a buffer of 7.6 metres is to be established in the Lower Chippewa Creek area (Recommendation A.4).

Future works in the lower watershed should implement natural channel design and biotechnical slope stabilization principles in an effort to naturalize and stabilize the creek channel. For those areas, in the Lower Chippewa Creek south of Airport Road, where redevelopment is proposed within 30 metres if the creek channel, a site specific environmental impact report of the needs for, and feasibility of natural channel remediation should be undertaken (Recommendation A.5). A Revegetation and Creek

Naturalization Plan should be developed for the area between Airport Road and Memorial Drive, particularly Thompson Park, and any other open space areas along the creek corridor (Recommendation A.6). For the purposes of enhancing the riparian zone and fish habitat in the Lower Chippewa Creek area, it is recommended that revegetation or tree planting be conducted on publicly owned lands, within 7.6 metres of the creek channel, that are unvegetated or areas lacking shrub or tree cover (Recommendation A.7).

Hydrological Recommendations

In the lower watershed, potential for flooding occurs in areas where urbanization has encroached on the floodplain. Generally, water quality within the lower-watershed shows typical urban land use impacts. A significant impact on the lower watershed originates in the Eastview and Johnston Tributaries. Concentrations of heavy metals are relatively high in water from this tributary compared with concentrations in other areas of the watershed.

The following hydrologic alternatives are recommended for the lower watershed; a stormwater management pond, flood proofing where required, disconnection of roof leaders, oil/grits in all large parking areas as well as service and gas stations and retrofit BMPs as redevelopment occurs (Recommendation D.5).

Social/Recreational Recommendations

The lands directly abutting the creek in the lower watershed are almost owned entirely by public agencies. Social recreational alternatives have already been substantially implemented. In addition to these alternatives being implemented it is recommended that the Chippewa Creek pathway be expanded to link to Trout Lake and to include heritage sites where feasible (Recommendation F6). In order to improve the water quality for swimming opportunities within the Amelia Beach area it is recommended that the City undertake infrastructure needs assessment and repair deficient storm and sanitary sewer systems (Recommendation F7).

Eastview and Johnston Creek Subwatersheds

Ecological Recommendation

The impact of elevated suspended solids and heavy metals from Johnston Creek is noticeable by the presence of an inveterbrate community dominated by species characteristic of "degraded-waters". The preferred ecological alternatives for this area are; maintain the functions of the Ski Club Marsh and Tower Drive Marsh wetland (Recommendation B.3), protection of mature forests, protection of significant wildlife corridors, establish buffers along the creek corridor, biostabilization of slopes.

Hydrologic Recommendations

Very significant increases in five year return flow rates are expected through the headwaters of Johnston Creek. Similarly the potential for erosion is very high in this area. Three stormwater management ponds, infiltration trenches and swales and grass swales in developing areas of the eastern portion of the escarpment, oil grit separators in the developing industrial areas, restrict the development of service and gas stations in the eastern portion of the escarpment and compact development forms in the eastern portion of the escarpment are all the recommended hydrologic alternatives for the escarpment area near Johnston Creek (Recommendation D.2 and D.3).

Social/Recreation Recommendations

The lands directly abutting the creek in the escarpment section of the watershed, adjacent to Johnston Creek, are largely undeveloped, but they are experiencing development pressure. Lands of recreational value should be acquired during the development approval process.

Implementation, Monitoring and Community Involvement

The successful implementation of the plan is dependent on a coordinated and cohesive strategy of the City and Conservation Authority programs in conjunction with input from a community environmental advisory committee. Section G describes the roles of the community environmental advisory groups and the role of the City in implementing the watershed policies through the development applications approvals process.

The successful implementation of the Chippewa Creek Watershed Management Plan will ensure the responsible management of watershed resources and an ecosystem based approach to future planning within the watershed.

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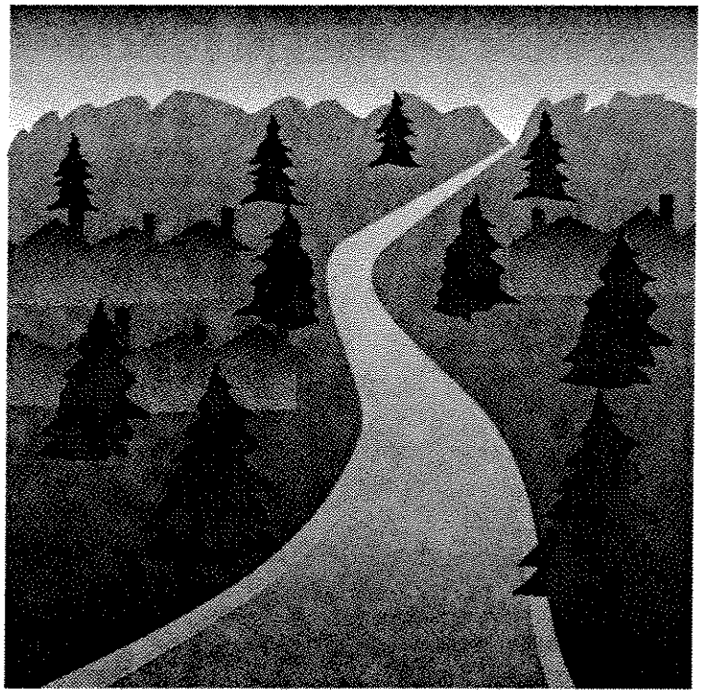
CONSERVATION AUTHORITY

Chippewa Creek

Watershed Management Study



Phase 1 Report

PROCTOR & REDFERN LIMITED

1.0 INTRODUCTION

1.1 Background

The North Bay-Mattawa Conservation Authority and the City of North Bay are extending the concept of water management and land use planning on a watershed basis to the Chippewa Creek Watershed. This initiative recognizes the need for ecosystem-based planning, long-term management, and rehabilitation of degraded natural resources within a changing watershed environment.

The watershed ecosystem is a dynamic integrated system that responds to changes, whether they be natural or human induced. The planning and management of a watershed must, therefore, also be dynamic and integrated in order to deal with changes in an environmentally sensitive manner. The Chippewa Creek Watershed Study provides an integrated approach to the assessment of existing conditions within the watershed, and to the development of a comprehensive Watershed Management Implementation Plan. This study follows the direction provided in the Provincial Watershed Management documents: "Water Management on a Watershed Basis: Implementing an Ecosystem Approach" and "Integrating Water Management Objectives into Municipal Planning Documents" (June 1993). The present approach also addresses the requirements of the Environmental Assessment process and recognizes other relevant legislation.

The primary objective of the Chippewa Creek Watershed Management Study is to provide a comprehensive evaluation of watershed issues and concerns, and to develop an integrated management plan that recognizes the interests of watershed stakeholders and the public.

The Phase 1 portion of this report provides a review and assessment of the existing abiotic, biotic, and cultural conditions of the Chippewa Creek Watershed. Furthermore, the report outlines opportunities and constraints relevant to the future planning and management of the watershed. The Background Review & Assessment Report is the first of three reports, and represents Phase 1 of the Chippewa Creek Watershed Management Study.

This study has been jointly funded by the North Bay-Mattawa Conservation Authority and the City of North Bay.

1.2 Watershed Management Study Team

Watershed Management Planning is intended to be a team effort that considers the interests and concerns of stakeholders within the watershed, and combines those interests and concerns with a comprehensive evaluation of watershed resources. The Chippewa Creek Watershed Study Team is composed of a multi-organizational steering committee, a consultant team, and a public liaison committee.

1.2.1 Steering Committee

The Chippewa Creek Watershed Study is being conducted under the direction of a multi-organizational steering committee. Table 1.2-1a provides a list of representatives serving on the Chippewa Creek Watershed Management Study Steering Committee.

Table 1.2-1a
Chippewa Creek Watershed Management Study
Steering Committee

Representative	Organization
William Beckett	North Bay-Mattawa Conservation Authority (NBMCA)
Dr. David Rees	North Bay-Mattawa Conservation Authority
Paula Scott, Secretary	North Bay-Mattawa Conservation Authority
Eva Wardlaw	NBMCA/City of North Bay
Bob Gray	NBMCA
Morley Daiter	City of North Bay
David Robinson	City of North Bay
Jamie Houston	City of North Bay
Jeffrey Celentano, Chair	City of North Bay

Peter Bullock	City of North Bay
Frank Driscol	Ministry of the Environment and Energy (MOEE)
Gordon Miller	Ministry of the Environment and Energy
Dave Moraldo	Ministry of Natural Resources (MNR)
Lorne Merritt	Ministry of Natural Resources
David King	Ministry of Municipal Affairs (MMA)
Mike Morrison	North Bay District Health Unit (NBDHU)
Peter Brown	Canadore College

The steering committee met numerous times throughout the study to provide direction to the consultant team and to review various draft reports. The following outlines the meetings held during the study process:

Table 1.2-1b
Chippewa Creek Watershed Management Study
Steering Committee Meetings

Meeting	Topic	Date
Meeting # 1	Study Initiation and Site Walk	August 25, 1994
Meeting # 2	Presentation of Phase 1- Background Review and Assessment Report	January 17, 1995
Meeting # 3	Discussion of Goals and Objectives	April 18, 1995
Meeting # 4	Presentation of Phase 2 Report - Watershed Management Alternatives	November 1, 1995
Meeting # 5	Presentation of Phase 3 Report - Watershed Implementation Plan	October 16, 1996
Public Meeting	Presentation of Final Draft Report	November 27, 1996

A more detailed chronology is provided in Appendix A-1.

1.2.2 Consultant Team

The study work program was managed and conducted by a team of consultants lead by Proctor & Redfern Limited. Table 1.2-2 outlines the key members of the consultant team and indicates their respective study component responsibilities.

Table 1.2-2
Chippewa Creek Watershed Management Study
Consultant Team

Team Member	Firm	Study Component
Gerry Strachan, P.Eng.	Proctor & Redfern Limited	Project Management
Gary Epp, M.Sc., Ph.D.	Proctor & Redfern Limited	Project Leadership/Ecological Resources
David Bannister, P.Eng.	Proctor & Redfern Limited	Hydrology
Ian Kilgour, B.E.S., MCIP	Proctor & Redfern Limited	Environmental Planning/Public Consultation
Michael Roy, B.Sc.	Proctor & Redfern Limited	Aquatic Resources
Edward Soo, P.Eng.	Proctor & Redfern Limited	Hydrology
Robert Dobbin, O.A.L.A.	Proctor & Redfern Limited	Recreational Planning
Michael Puccini	Near North Laboratories	Water Quality
John Parrish, M.A.	Ortech International	Fluvial Geomorphology
Peter Richards, P.Eng.	Trow Engineering	Hydrogeology
Brian Grant, P.Eng.	Trow Engineering	Hydrogeology
John Pollock, Ph.D.	Settlement Surveys Ltd	Archaeology

The consultant team reported directly to the steering committee during the study meetings noted above and was responsible for the preparation of the Watershed Management Study Report.

1.2.3 Public Liaison Committee

Watersheds and the water they convey are a public resource. It is important, therefore, that the public be involved in the management of the watershed. In an effort to bring the public directly into the study process, the Chippewa Creek Watershed Study Steering Committee solicited membership from the public for the formation of a Public Liaison Committee (PLC).

A list of the PLC members and minutes from their first meeting are provided in Appendix A-2.

1.3 Study Scope and Approach

The Terms of Reference for the Chippewa Creek Watershed Management Study were prepared in collaboration with the Chippewa Creek Watershed Study Steering Committee. A copy of the Terms of Reference are provided in Appendix A-3.

The Chippewa Creek Watershed Management Study followed a three (3) phased approach. Phase 1 - the Background Review and Assessment of Existing Conditions, Phase 2 - the Development and Evaluation of Watershed Alternatives, and Phase 3 - the Development and Preparation of the Watershed Management Plan.

Figure 1.3-1 provides an outline of the study program showing study phases and major tasks.

Phase 1 of the study is critical to the understanding of watershed processes and linkages between the natural and human components of our environment. During this phase, existing information regarding the various components of the watershed was reviewed and assessed to provide a comprehensive overview of the state of Chippewa Creek. The watershed was assessed for its hydrogeological, fluvial geomorphological, hydrology, water quality, ecological, and archaeological resources.

STUDY OUTLINE

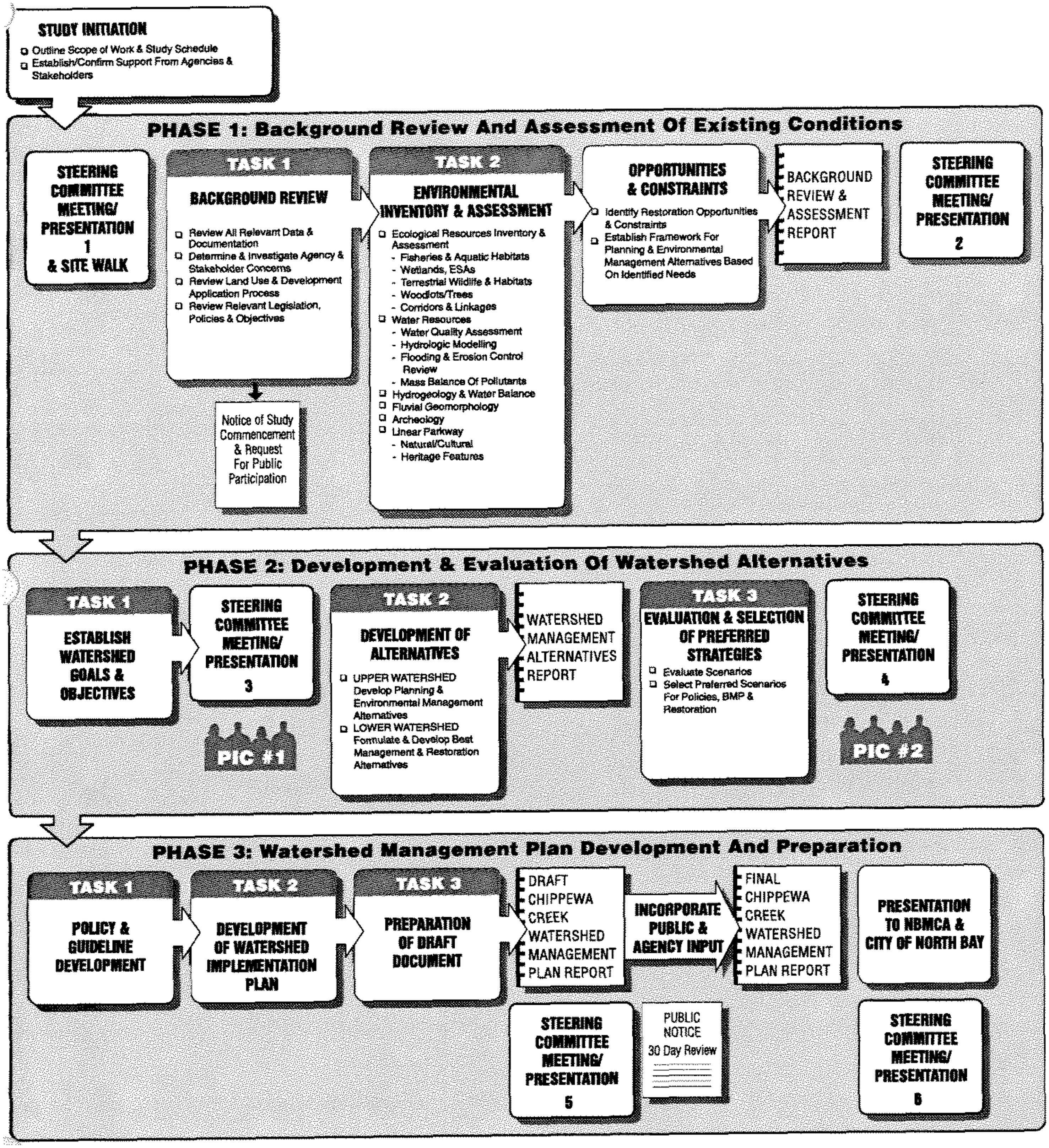


Figure 1.3-1

Following the assessment of existing conditions, opportunities and constraints were identified for the long-term planning of the watershed. This step in the study provides the framework for the development of watershed alternatives leading to the preparation of the watershed plan.

The completion of Phase 1 was marked by the preparation and presentation of the Phase 1 Background Review and Assessment Report.

The first step in Phase 2 was the establishment of Watershed Goals and Objectives based on the opportunities and constraints, and needs identified in Phase 1. The Goals and Objectives were established cooperatively between watershed stakeholders participating as members on the study's Steering Committee.

Once the watershed goals and objectives were established, alternatives for planning and management of the watershed were developed. Alternatives included re-establishment of fish habitat, revegetation of creek banks and floodplain areas, or construction of artificial wetlands. The alternatives were then evaluated for effectiveness and consistency with the goals and objectives. Finally, a preferred overall strategy was selected from which the watershed management plan was developed.

Phase 2 of the study was completed following the preparation of the Phase 2 Watershed Management Alternatives Report and selection of a preferred watershed strategy.

Phase 3 provided the link between the watershed strategy and the implementation of the strategy. The primary tasks of Phase 3 involved the drafting of policy and guideline recommendations consistent with the preferred strategy, and then the development of the Watershed Implementation Plan. The plan was finalized after a thirty day public review period in keeping with the requirements of the Environmental Assessment process.

During the study process the Watershed Management Study Steering Committee reviewed, participated in, and provided comments on the study's progress and the development of the management plan.

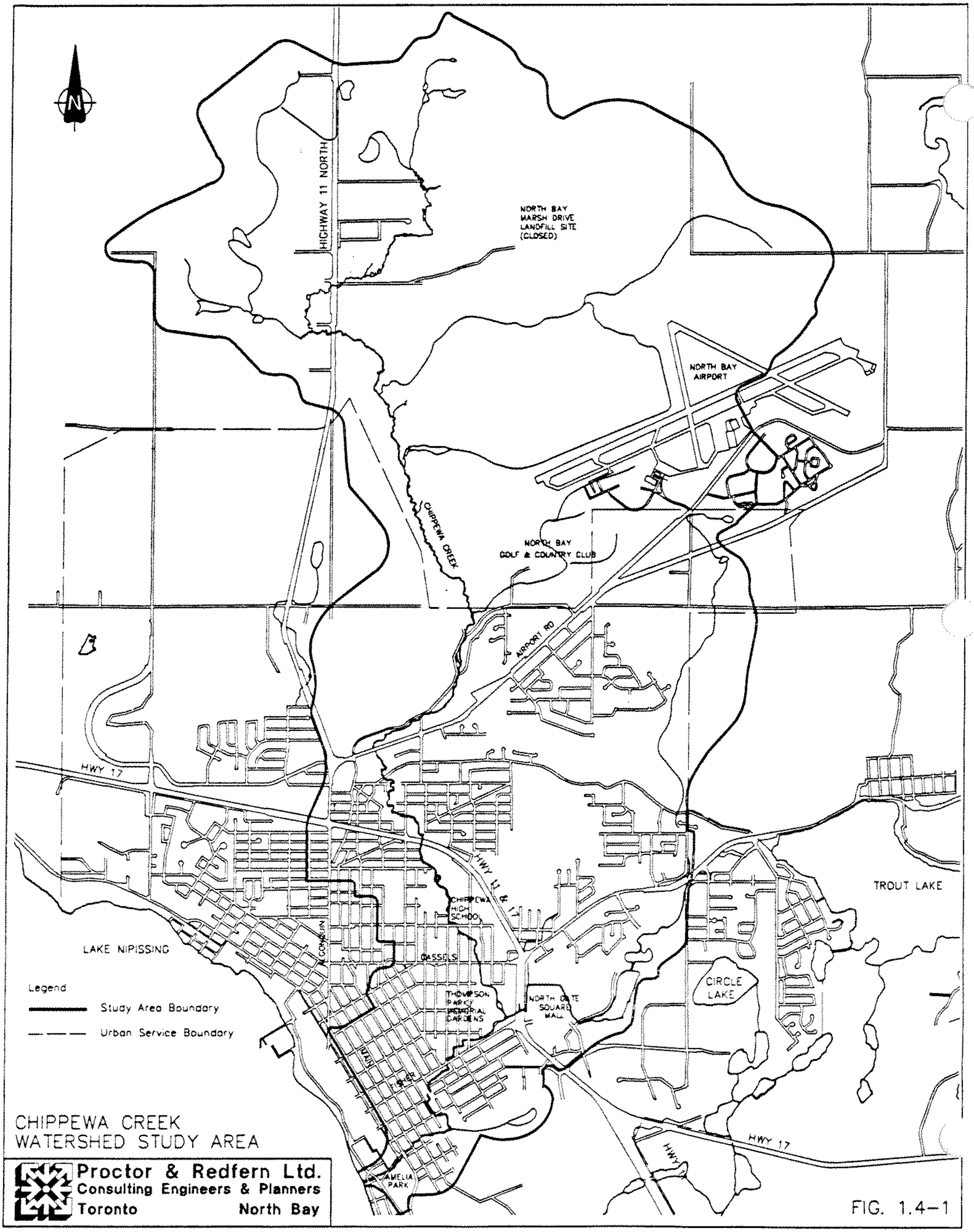
The public participation program began with the establishment of a contact list (mailing list), including all key stakeholders within the study area, community associations, elected officials, businesses, ministries and external agencies and other public interest groups. The contact list is provided in Appendix A-4 and was maintained throughout the study. Parties on the contact list were mailed a Notice of Study Commencement, in December, 1994.

As noted in the previous section, a Public Liaison Committee was formed to provide direct input to the Steering Committee during the study process.

The first Public Information Centre (PIC) # 1 was held to provide and receive information on this Phase 1 Report. A brochure was prepared, which described the study findings to date, invited the public to the PIC and provided names and phone numbers of study contacts, and the location and times of the PIC.

The following PICs were held to solicit comments on the selection of the preferred strategies and to assemble areas of concern that needed to be addressed in the Final Report.

After approval of the Final Chippewa Creek Watershed Management Report an advertisement announcing the filing of the Watershed Plan was placed in the local newspaper. The public was given the opportunity to review the final document between November 1, and December 2, 1996.


N
HIGHWAY 11 NORTH
NORTH BAY
MARSH DRIVE
LANDFILL SITE
(CLOSED)
NORTH BAY
AIRPORT
CHIPPEWA CREEK
NORTH BAY
GOLF & COUNTRY CLUB
AIRPORT RD
HWY 17
HWY 11 & 17
CHIPPEWA
HIGH
SCHOOL
TROUT LAKE
LAKE NIPISSING
ALGONQUIN
CASSELS
CIRCLE
LAKE
THOMPSON
PARK
MEMORIAL
GARDENS
NORTH GATE
SQUARE
MALL
MAIN
FISHER
HWY
HWY 17
AMELIA
PARK
Legend
Study Area Boundary
Urban Service Boundary
CHIPPEWA CREEK
WATERSHED STUDY AREA
Proctor & Redfern Ltd.
Consulting Engineers & Planners
Toronto
North Bay
FIG. 1.4-1

1.4 Watershed Description

Chippewa Creek is located north of Lake Nipissing in North Bay, Ontario. The creek, its tributaries, and drainage area are contained entirely within the municipal boundary of the City of North Bay. Figure 1.4-1 shows Chippewa Creek and its watershed boundary.

The creek's headwaters originate above the North Bay escarpment, flowing south down the face of the escarpment, through North Bay's urban area, and finally discharging into Lake Nipissing. Five main tributaries flow into the main channel of the creek, including Johnston's Creek at the lower reaches of Chippewa Creek. The total drainage area of the Chippewa Creek watershed is 40 sq. km. The upper-watershed area, above the escarpment, is primarily undeveloped land, whereas the lower-watershed is mostly urbanized land.

Section 2.0 of this report provides greater detail regarding features of the Chippewa Creek Watershed.

1.5 Existing Land Use and Development Application Status

1.5.1 Existing Land Use

A detailed inventory of land use within the watershed is being compiled with a Geographic Information System (GIS). When data entry is completed GIS users will be able to query:

1) percentage, km^2 of specific land uses within the watershed.

2) percentage, km^2 of (private, public, quasi-public) various ownership within the watershed.

3) percentage, area of future development areas and potential number of development units.

What we know now in Phase I of this study is that just over 50% of the watershed within the Urban Service Boundary is developed (see Figure 1.5-1). The remainder of the lands are designated for primarily residential uses. The undeveloped urban service area of the watershed can be described as four areas.

1) Tower Drive/Airport Road

2) Thibeault Hill/Cedar Heights

3) Airport Road/Golf Course Road

4) Hillview Subdivision Area

See Figure 1.5-1.

The ownership of these lands is dominated by one owner. This provides for some unique opportunities to be investigated. These will be investigated further in Phase II of the study.

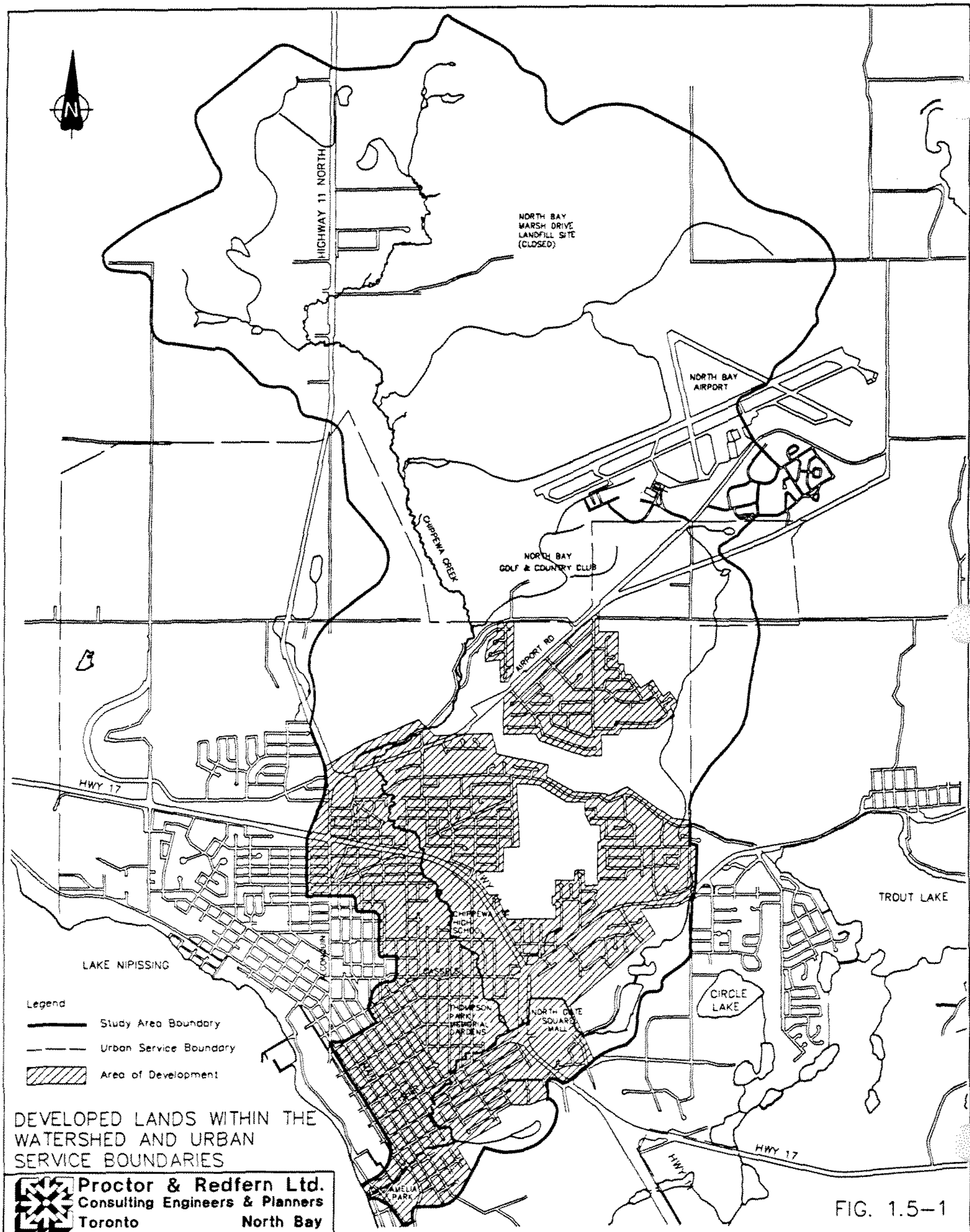
The land uses inside the urban service boundary, which abut Chippewa Creek, vary within the developed portion of the watershed.

Lake Nipissing to Cassells Street

Open space and parkland dominate this portion of the creek. Some private residential land still abuts the creek. These residential parcels are slated for conversion to open space over the next decade.

Cassells Street to High Street

This section of the creek consists of primarily residential uses with no public access.



DEVELOPED LANDS WITHIN THE WATERSHED AND URBAN SERVICE BOUNDARIES

FIG. 1.5-1

High Street to Ramsey (O'Brien)

This section of the creek is abutted primarily by institutional lands (Chippewa High School, Centennial Public School and Cité des Jeunes). There are some residential, industrial and commercial uses in the vicinity of the Bypass (Highways 11 and 17). Erosion control and linear parkway development (bike and walking trails) have been completed.

Ramsey to Airport Road

This section of the creek is almost entirely open space. Erosion control work and linear parkway development, bike and walking trails, have been completed within this open space area.

Airport Road to Golf Course Road

Commercial, Industrial, and Multi-Residential land uses dominate this section of the creek. Predominantly, these uses directly abut the creek's steep embankments.

Golf Course Road to Berkely (Highway 11 North)

Land use in this section of the creek is primarily rural in nature. These uses consist of:

1) Residential Subdivision (Kenwood Hills);

2) Rural Residential;

3) Golf Course;

4) Airport;

5) Marsh Drive Landfill Closed;

6) Aggregate Extraction; and

7) Highway Commercial.

1.6 Work on Chippewa Creek

Since the amalgamation of Widdifield Township with the City of North Bay in 1968, there have been a number of projects carried out on Chippewa Creek that impact positively on water quality. These include:

- Chippewa Creek Trunk Sanitary Sewer by the City of North Bay (1978)
- Leachate collection system by the City of North Bay (1988)
- Repair a total of 36 cross-connections between the sanitary and storm water systems, located by smoke testing, by the City of North Bay (1990 to 1994)
- Bank Stabilization on Johnston Creek by the North Bay-Mattawa Conservation Authority (1987)
- Bank Stabilization on the Eastview Tributary by the North Bay-Mattawa Conservation Authority (1989)
- Bank Stabilization on the Main Bank of Chippewa Creek carried out in phases by the North Bay-Mattawa Conservation Authority (1989 to 1994 and continuing)
- Purchase of approximately 150 properties in the Chippewa Creek floodplain by the NBMCA,. Several of these properties had plumbing which directly outflowed to Chippewa Creek (1976 to 1994 ongoing).
- Policing of various construction projects, that impact on Chippewa Creek, by the Ministry of Natural Resources and the NBMCA (ongoing).
- Public awareness of water quality of Chippewa Creek and its impact on Lake Nipissing by the North Bay-Mattawa Conservation Authority, City of North Bay and Lake Nipissing Partners in Conservation (ongoing).

The Ministry of the Environment and Energy has analyzed water quality samples on Chippewa Creek since 1970. Although these samples can be affected by such things as weather conditions, the following table, clearly shows a trend of water quality improvement. The table provides the 5 year averages of total suspended solids at the mouth of Chippewa Creek,

		Total Suspended Solids (Mg/litre)		
Period	No. of Sample	Average	Maximum	Minimum
1970-1974	28	38	500	5
1975-1979	43	22	145	2
1980-1984	51	23	276	2
1985-1989	41	11	69	1
1990-1995	18	20	123	0

1.7 Relevant Legislation Policies and Objectives

The following summary of federal and provincial legislation and policies are relevant to the implementation of watershed management objectives and recommendations. Although not an exhaustive list, the majority of legislation and policies relating to watershed planning are included.

Table 1.7-1
Watershed Planning - Legislation and Policy

Legislation/Policies	Agency	Application
Federal Canada Fisheries Act R.S.C. 1985	Department of Fisheries & Oceans (DFO) & Ministry of Natural Resources (MNR)	• Alteration to fish habitat • Deposition of deleterious substances
Provincial Environmental Protection Act	MOEE	• Water quality impairment • Waste management
Environmental Assessment Act	MOEE	• Site specific projects • Class Environmental Assessments

Legislation/Policies	Agency	Application
Lakes & Rivers Improvement Act	MNR	• Channel diversions/damming • Flow regime alterations
Public Lands Act	MNR	• Shoreline Alterations
Conservation Authorities Act	Conservation Authorities	• Fill, construction and alteration to waterways regulations
Planning Act and Provincial Policy Statement	• Ontario Ministry of Municipal Affairs • Local Municipalities	• Land Use • Floodplain planning • Wetlands • Protection of Natural Heritage Features
Drainage Act	Ontario Ministry of Agriculture and Food	• Construction and maintenance of municipal outlet drains
Local Improvement Act	Local Municipalities	• Sewer works and river bank protection works
Wetland Policy	Ontario Ministry of Natural Resources	• Alteration to and/or development adjacent to Provincially Significant Wetlands
Trees Act and Woodlands Improvement Act	Ontario Ministry of Natural Resources/Municipality	• Development, management and improvement of treed areas
Ontario Water Resources Act	• MOEE	• Approval and development of municipal servicing and water taking applications.

The specific relevance of the above legislation to the objectives of this study will be discussed further in future phases.

2.0 ENVIRONMENTAL INVENTORY AND ASSESSMENT

The following sections provide a review and assessment of the existing physical, chemical, biological, and cultural resources in the Chippewa Creek Watershed. Specific resources investigated included: hydrogeology, fluvial geomorphology, hydrology, water quality, ecological resources, archaeology, and the linear park system.

2.1 Hydrogeology & Water Balance

The watershed is topographically bisected by a bedrock ridge, which rises over 70 m in elevation above the predominantly level area in the City of North Bay, adjacent to Lake Nipissing. The lower watershed area is primarily urbanized, covering an area of approximately 9 km^2, while the upper area is primarily rural (with some suburban area) with an undulating topography.

Local geologic mapping (Northern Ontario Engineering Geology Terrain Study 101, p. 80) identified several distinct sub-areas within the watershed boundaries. The lower elevations adjacent to Lake Nipissing are mapped as a glaciolacustrine plain, with a silty sand to clayey silt soil cover and occasional bedrock knobs. Within the higher elevation areas of the watershed, the northernmost area is identified as a glacial outwash plain, covered primarily by sand and gravel. This area extends southward in a narrow band within the Chippewa Creek valley area, bounded to the west by a prominent bedrock ridge (with a thin drift of sandy till) and to the east by a more gently sloping discontinuous sandy glacial outwash plain, with some bedrock outcroppings and shallow glacial till deposits. Bedrock within the entire study area is comprised of granitic and metamorphosed sedimentary rock of the Precambrian age. Overall, the local topography and the watershed boundary appears to be strongly bedrock controlled.

Surface water courses (i.e. tributaries) leading to the main Chippewa Creek channel are numerous throughout the water shed, particularly in the northern headwater area. The number of tributaries are less frequent in the lower elevation reaches, and along the western bank of the upper Chippewa Creek channel. The higher frequency of tributaries in the upper sand and gravel areas is attributed to the higher permeability of these soil materials, combined with the undulating subsurface bedrock topography. In this setting, it is not practical to identify distinct widespread groundwater recharge and discharge areas, since groundwater discharges to the channel tributaries are dependent on localized recharge from lands between the tributary channels (i.e. recharge is local to the tributary it supports). Also, it is assumed that groundwater recharge from each sub-area within the watershed reports to the Chippewa Creek channel as "baseflow", without a significant groundwater transfer between sub-areas.

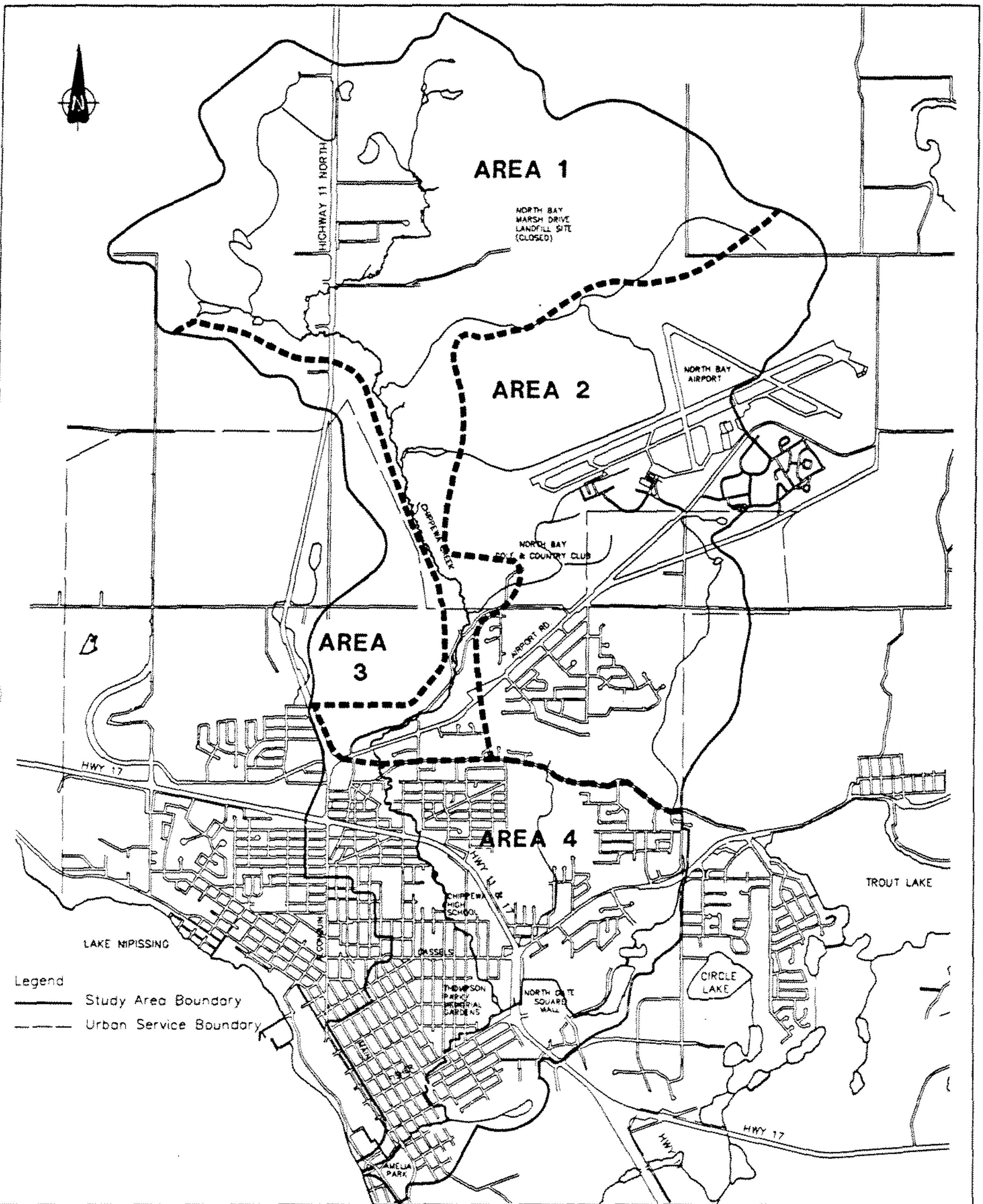
The highest level of recharge and baseflow generation is interpreted to be in the headwater area, which is characterized by deep sand and gravel sequence with a high permeability water table aquifer and numerous tributaries leading to the main Chippewa Creek channel. This area has been identified as Area 1.

The second highest contributor to baseflow is interpreted to be the eastern flank of the watershed, characterized by a discontinuous sand and till overburden of variable thickness.

Minor water table aquifers in this area are interpreted to contribute to the overall baseflow for the basin. This sub-area is identified as Area 2.

The western flank of the Chippewa Creek channel is characterized by a thin, discontinuous layer of glacial drift. This area does not support a significant water table aquifer within the overburden, and recharge to the bedrock aquifer (and subsequent discharge to Chippewa Creek) is likely limited. Overland runoff will be the primary contribution from this area, identified as Area 3.

The lower elevation area, occupied by the urbanized position of the City of North Bay is underlain by sands and silts, and some silty delays. Although this area is primarily urban, some recharge to the local water table is anticipated, and discharges will report to the creek and (closer to the lake) to Lake Nipissing. This area is interpreted to contribute the second lowest level of baseflow generation.



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CHECKED BY	Hydrogeology & Water Balance	SCALE N.T.S.	DATE DEC. 1994
		DRAWING NO.	Figure 2.1-1

The results of the water balance model (see Appendix B) indicate that Area 1 contributes an estimated 55% to 66% of the annual baseflow volume for the basin via the local aquifers within that area (or 3.64 x 10^6 m^3/year to 1.21 x 10^6 m^3/year). Area 3 is estimated to contribute very little to the annual baseflow runoff volume (0% to 1%).

2.2 Fluvial Geomorphology

The fluvial geomorphology of Chippewa Creek was assessed through: a review of air photos, topographic maps and background documents; field observations and reconnaissance; detailed field work; and, interpretation of the collected information. Based on the geology and topography, the creek and basin can be divided into three zones, the area above the escarpment, the urban area below the escarpment, and a transition area which includes the escarpment. Sites for detailed field work were distributed in each zone (Appendix C).

The upper zone or area above the escarpment is predominantly rural with an old landfill and aggregate operations. There are numerous small tributaries which drain this upper area. The main channel has a gradient of 0.8% near the headwaters and increases to 1.8% above the escarpment. The sinuosity of the creek is approximately 1.10 indicating a fairly straight channel. The bed material is fairly coarse (large gravel and cobbles) which is expected given the sand and gravels from the glacio-fluvial deposits and close proximity to bedrock. The banks are fairly stable due to a low height and good riparian vegetation. Bank erosion through most of the area is fairly minor, due mostly to undercutting of the sand and gravel banks when the bed of channel is on bedrock. Erosion is more significant along the "Landfill Tributary" where most bank vegetation has been removed. Above average sediment loading is occurring from the aggregate operations. This excessive sediment can put the creek out-of-balance, in that there is more sand and gravel than the creek can effectively move. This can lead to the formation of mid-channel bars which increase the stress on the banks.

The transition zone is the smallest area and due mainly to the steep slope and presence of bedrock is the most stable area. The combination of steep slopes and bedrock results in a stable form able to withstand alterations to the surrounding land use without experiencing much degradation. The gradient through the transition area varies from 1.1% to 3.6% and has a sinuosity of 1.05. The lower part of this transition zone is experiencing some bank erosion. The location is south of Golf Club Road where the northern bank is about 3m to 4m high with a 30° to 40° slope. The material is mainly coarse sand and gravel and with the removal of vegetation, is prone to erosion. This erosion appears to be natural, through some minor bank undercutting and likely freeze-thaw processes. Field observations revealed two areas south of Golf Club Road, contributing sediment to the creek. The first area is an abandoned development with exposed sandy soil which is being drained directly into the creek. The second area is a property which is placing fill at the top of the bank, where any precipitation event will result in sediment running into the creek. This sediment is not directly effecting this portion of the creek as the gradient is to steep. The sediment is being moved downstream into the urban area.

The lower part of the drainage basin, within the urban area, has a gradient of 0.4% near Lake Nipissing to 0.8% near the escarpment. The sinuosity is 1.15 indicating a more sinuous channel. The bed material is generally sand and gravel and bank properties are variable given the urban setting. Generally, the banks are 1m to 2m high, moderate to steep slope, composed of finer material (silt to fine sand) with fair vegetative cover. Sedimentation has been a problem as the material from upstream is deposited in the channel as the slope decreases. The problem is further enhanced by the numerous bridges and in-channel structures which alter flow velocities and disrupt pool-riffle patterns. The result is an inconsistent channel form and pattern given the slope and discharge of the creek. Recent works to the channel and banks in the lower area have been successful in stabilizing the banks and reducing sediment loadings. Small areas of erosion and sedimentation were observed downstream of the recently completed works. The erosion is attributable to mid-channel bars and in-channel structures which alter the flow distribution.

At the four detailed study sites, collected information enabled the determination of hydraulic geometry relations and threshold conditions for the transport of bed material. The results are summarized in Tables contained in Appendix C. For the sites located on the main channel, velocity was the most sensitive parameter in hydraulic geometry relations. Hydraulic geometry relations provide an understanding of the function of the creek and how it responds to increases in flow or discharge. As discharge of the creek increases it is accompanied by a larger increase in flow velocity than increases in channel width or depth. This indicates that the creek is capable of moving more sediment as well as larger sizes of sediment. The threshold values for the movement of bed material are just below the calculated bankfull velocity at three of the four sites. This represents a stable channel condition. The site where the threshold value was lower was in the urban area, near Second Street. This site had a sand bed which was being transported during field work. The bed material is likely a periodic deposit as it will likely be completely moved during a high flow event, only to be deposited again once flows subside.

From the collected information, Chippewa Creek appears to be relatively stable. There are some local areas which are experiencing erosion and sedimentation which should be addressed before further degradation occurs. The recently completed works in the urban area have stabilized some bank erosion and reduced sediment loadings. The most sensitive areas are urban tributaries which are the first to experience more frequent higher flows, through increased runoff. These tributaries are often entrenched which reduces the area to dissipated the energy from high flows. Further, these areas generally have sand beds which are easily transported. These conditions will lead to bank erosion and channel instabilities.

Appendix C provides additional information regarding the fluvial geomorphology of Chippewa Creek.

2.3 Hydrology

Chippewa Creek is a developing watershed that has now experienced many of the characteristics of urbanization, including flooding, erosion, sedimentation and degradation of water quality. Much of the urban portion of the City of North Bay drains into Chippewa Creek. The City's Official Plan identifies further areas of urbanization, mostly in and near the escarpment. This can only increase the adverse effects that past urban development has had on the creek system, unless measures are taken to address these impacts.

The purpose of this section of the report is to:

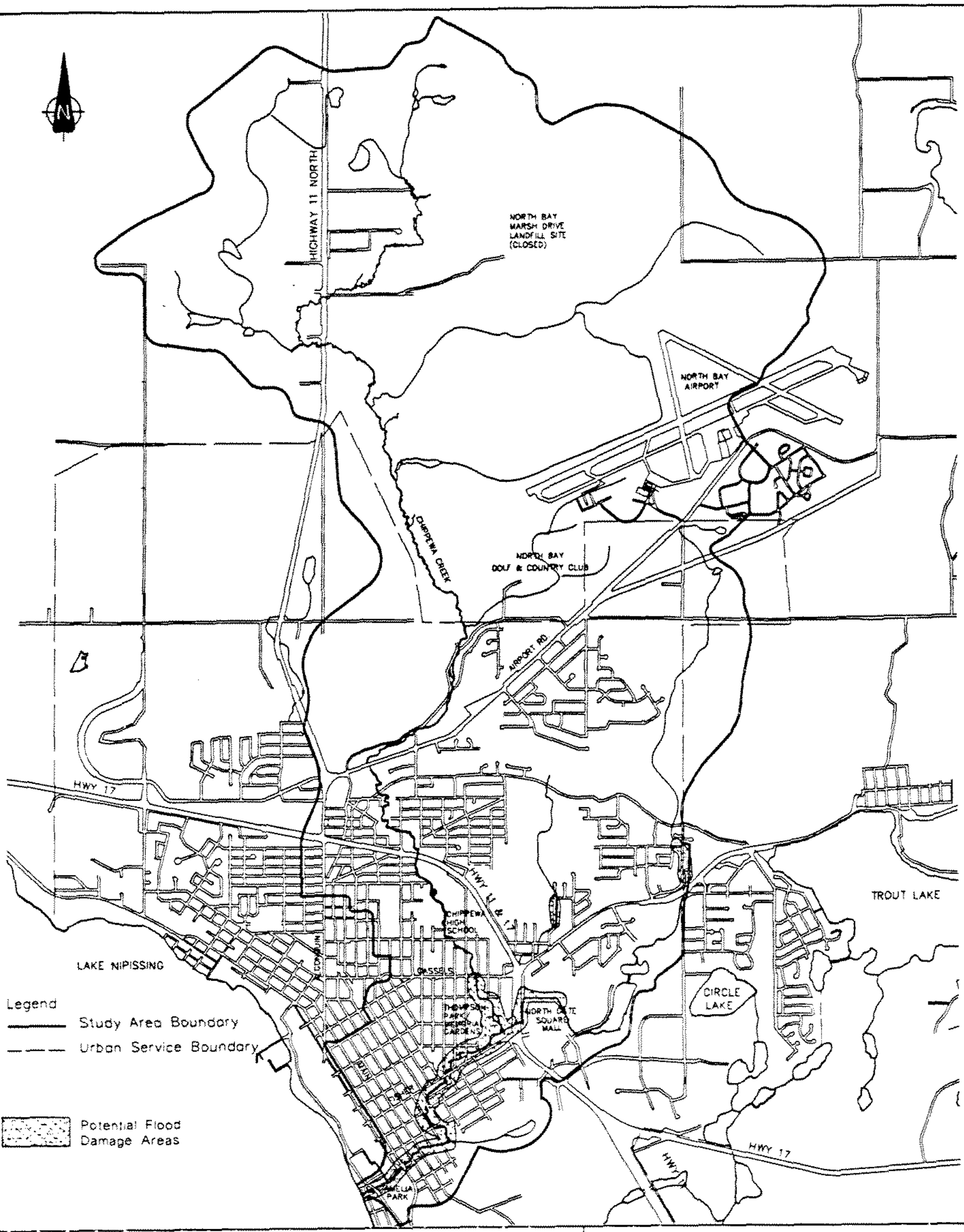
- identify the present hydrologic characteristics of the watershed (quality and quantity)
- estimate the effects of uncontrolled, future urbanization

2.3.1 Data Review

In assessing the watershed's hydrology, a review of past reports and available background data was carried out. This involved a review of existing watershed information which included available mapping (topology, or otherwise), Schedule 2 - Land Use Plan from the North Bay Official Plan, existing land use planning documents (such as the Chippewa Creek Flood and Erosion Control Study by Northland Engineering, 1984, and the Urban Development Strategy Study by Proctor & Redfern, Oct. 1993), historic rainfall data from the AES rain gauge at the Jack Garland Airport, and historic water quality data collected from the North Bay-Mattawa Conservation Authority (NBMCA), Ontario Ministry of the Environment and Energy (MOEE), Gartner-Lee Associates, and Near North Laboratories.

A summary of the salient points contained in this information is as follows;

There is the potential for flooding along Chippewa Creek, particularly in the lower sections of the creek, downtown, where urbanization has encroached upon the creek floodplain. The sections of creek where flooding has been identified to potentially occur are shown on Figure 2.3.1. These areas were identified from the NBMCA's floodplain mapping that assumes full, uncontrolled development of the watershed's urban area as defined by the Official Plan at that time (1984).



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CHECKED BY	Potential Flood Damage Areas	SCALE N.T.S.	DATE DEC. 1994
		DRAWING NO.	Figure 2.3-1

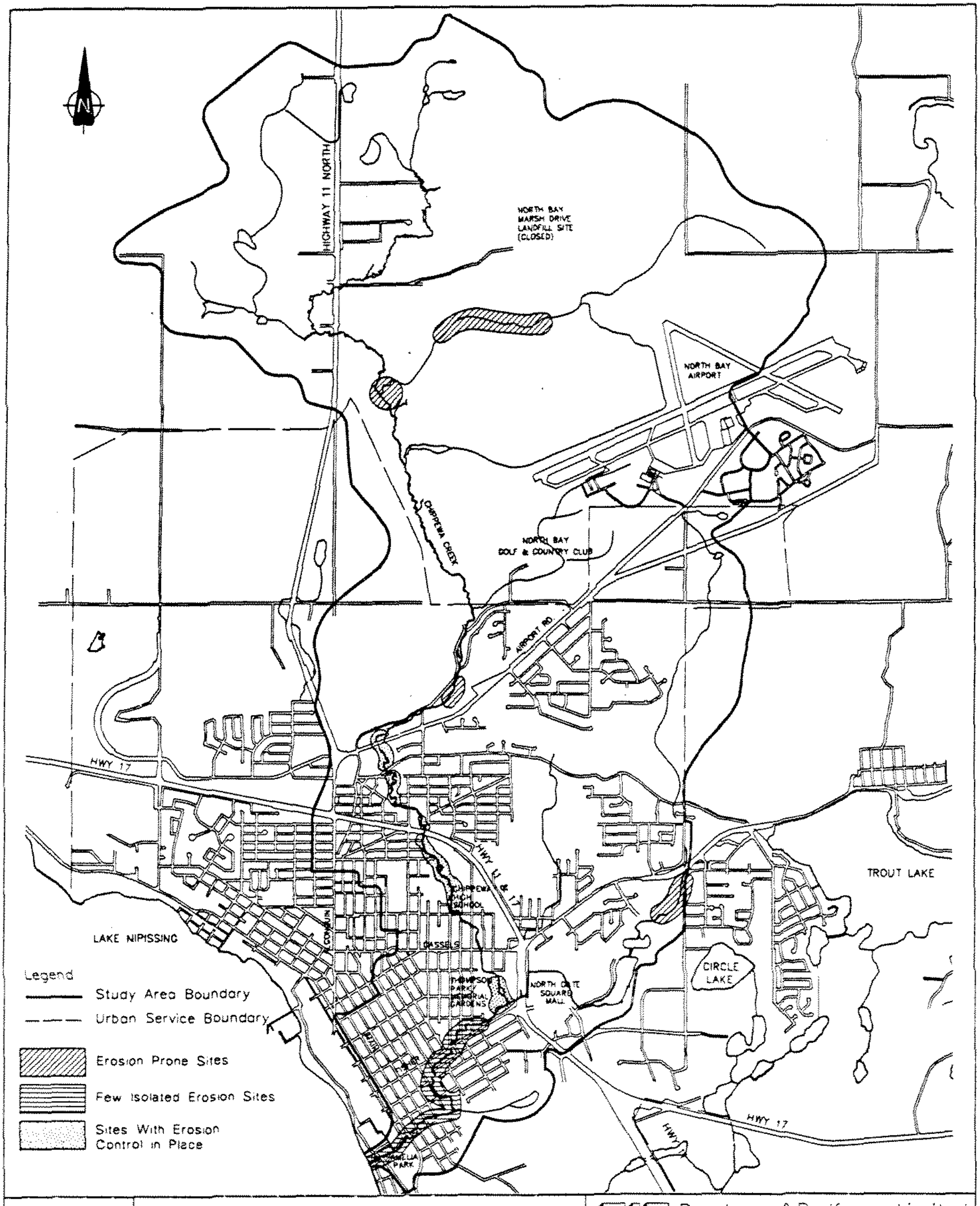
- The creek channel has experienced erosion and sedimentation, again particularly in the lower reaches. Erosion control has been used throughout the watershed, generally in the form of armouring the creek channels. The most recent works have more natural channel attributes. Figure 2.3.2 shows those areas that have experienced erosion and where erosion control has been used to address the erosion. A complete description of the creek's fluvial geomorphology is contained in section 2.2 of this report.

- Water quality data for Chippewa Creek was reviewed from a number of sources, particularly water sampling that the MOEE, carried out years ago, plus the sampling results from this study, by Near North Laboratories. A review of the water quality data suggests no strong trends, in most parameters, as a function of degree of urbanization. For this reason, additional data was reviewed from the USEPA's National Urban Runoff Program (NURP).

2.3.2 Hydrologic Conditions

The focus of Phase 1 for this study is to gain an understanding of the watershed functions, including the existing hydrology of the Chippewa Creek. This section describes the watershed hydrology and how baseline conditions for the watershed were established.

Hydrologic estimates of flow rates throughout the creek system has been done by Northland Engineering in 1984 as part of the Chippewa Creek Flood and Erosion Control Study for the NBMCA. In that study, hydrologic modelling was used to establish the design flow rates, along with flow frequency calculations. The flow hydrographs measured in the creek during a number of storm events were used to calibrate the hydrologic model using the HYMO program. This was the hydrologic program of choice through the late 1970s and early 1980s by hydrologists in Ontario because it is an unit hydrograph program that has the capability to generate and route flow hydrographs through a watershed, including reservoir routing. The program has its limitations, however, and one significant limitation is that it was established, in 1973, to model rural watersheds in Texas. Significant modification to program parameters is required to create a model for urban areas where the hydrologic response is much faster and where there can be



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Chippewa Creek Watershed Management Study - Phase 1

Erosion Prone Sites and Sites with Erosion Controls in Place

Proctor &Redfern Limited
Consulting Engineers & Planners
Toronto North Bay

SCALE N.T.S. DATE DEC. 1994

DRAWING NO. Figure 2.3-2

significant areas that are paved. The program uses the Soil Conservation Services (SCS) relationships for runoff potential that can significantly underestimate runoff potential in small or urban watersheds by overestimating initial rainfall abstraction losses.

The HYMO model, set up by Northland for Chippewa Creek, was calibrated and was appropriate for the purposes of their study in 1984. The watershed, however, is proposed to become more urbanized and updating the hydrologic model to better estimate urban runoff is desirable. Since that time, the HYMO model has been twice updated (OTTHYMO, 1982 and INTERHYMO, 1989) and many of the shortcomings in estimating flow hydrographs from urban areas have been improved.

The input to the original hydrologic model was updated, through this study, and converted to run on the INTERHYMO.89 program. Many of the updated hydrologic parameters (impervious ratios, etc.) were estimated from the old model input parameters and from the latest available mapping. This was first done for existing conditions and the updated model was calibrated to the measured historic flow hydrographs used in the calibration of the 1984 Northland Engineering report model. There is insufficient data to extract the different rainstorm intensities as was measured above and below the escarpment from the report, so the storm shown on the 1984 report figures was distributed over the entire watershed.

In order to reproduce the flow hydrographs measured in the creek, the runoff potential of the existing urban areas had to be reduced. Further scrutiny of the watershed indicated that much of the urban area is not completely serviced with storm sewers and that ditches and swales are frequently used to direct flows over significant distances before being discharged to a storm sewer inlet. Many of the urban areas within the watershed could be classified as suburban for this reason. With the exception of the downtown area, the existing urban areas are modelled having a much longer length ratio than what would otherwise be used in a fully serviced urban area having curbs and gutters instead of swale and ditches. Consequently, the updated model gives reasonable agreement with the flow hydrographs used for calibration in 1984. A detailed description of the model calibration is appended to this report.

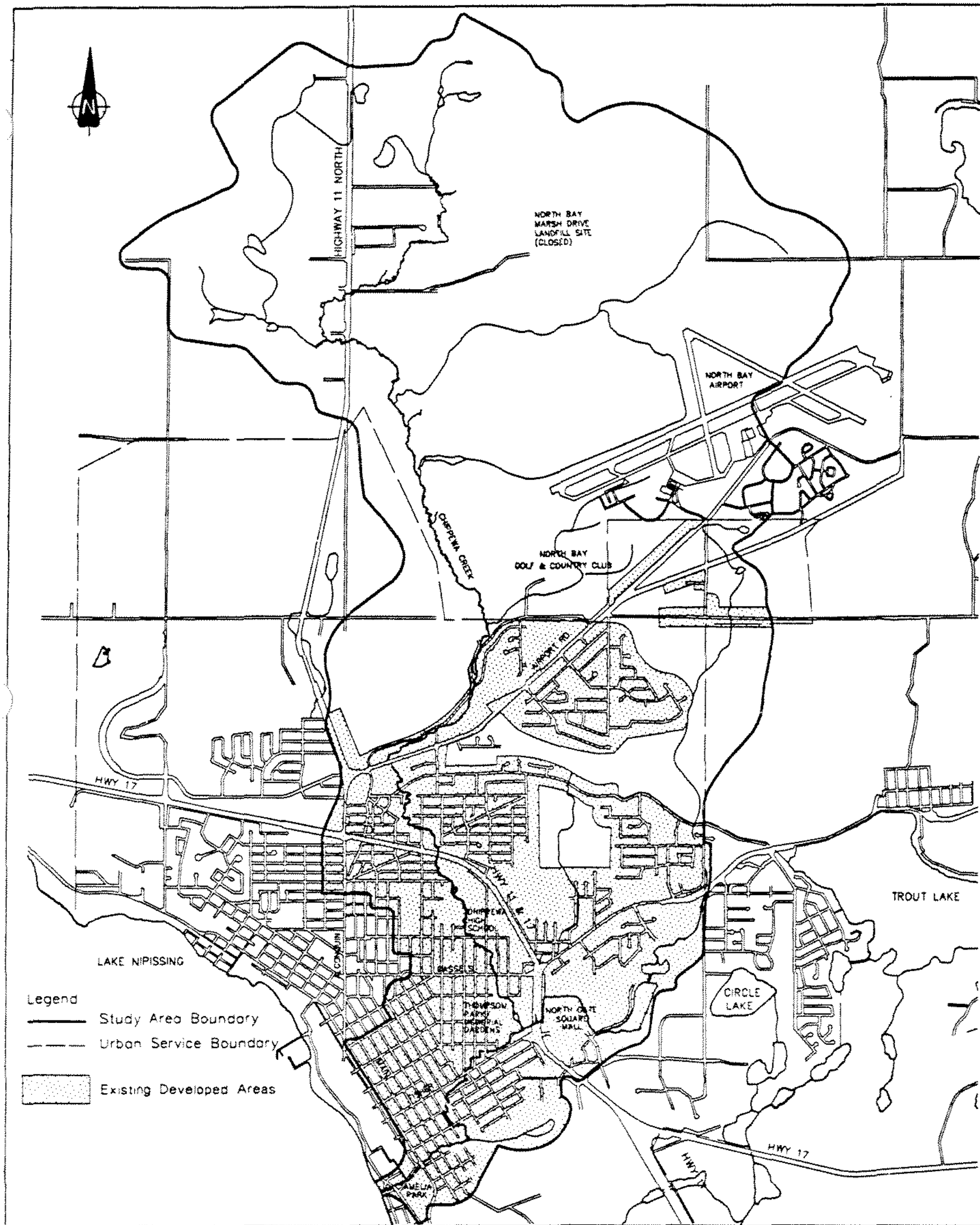
Design flow rates were estimated for three hydrologic conditions:

1. existing conditions,
2. future conditions (full urban development of the balance of the urban area identified in Official Plan that is not now developed), and
3. ultimate conditions (improving those existing areas with suburban servicing to full urban services).

Existing conditions are essentially the 1984 conditions to which the hydrologic model was calibrated. Some development has occurred since this time, but it does not appear to have been significant enough to affect the overall runoff potential to a large degree. With the exception of the downtown area (subarea 22), the watershed is classified as either suburban or rural. Figure 2.3.3 shows the areas considered to be developed under existing conditions.

The future watershed conditions assumes infilling within the urban areas not presently developed with full urban servicing, i.e. having curb and gutter. No stormwater management has been accounted for in this scenario (but will be incorporated in Phase II of this study), hence the developing areas are for the most part uncontrolled, for comparison purposes. The urban areas were assumed to have an effective length slightly longer than the "default" values to better keep the design flows more in comparison with the calibrated model for existing conditions. Figure 2.3.4 shows the areas slated for development according to the Official Plan. Much of the development is in the escarpment area.

Recognizing the significant difference in runoff potential between suburban and urban areas and recognizing that it is common for municipalities to improve the services in the older areas, a third, ultimate condition was investigated. In this case, the inefficiencies calibrated into the suburban areas (longer length ratios) were adjusted to reflect curb and gutter drainage.



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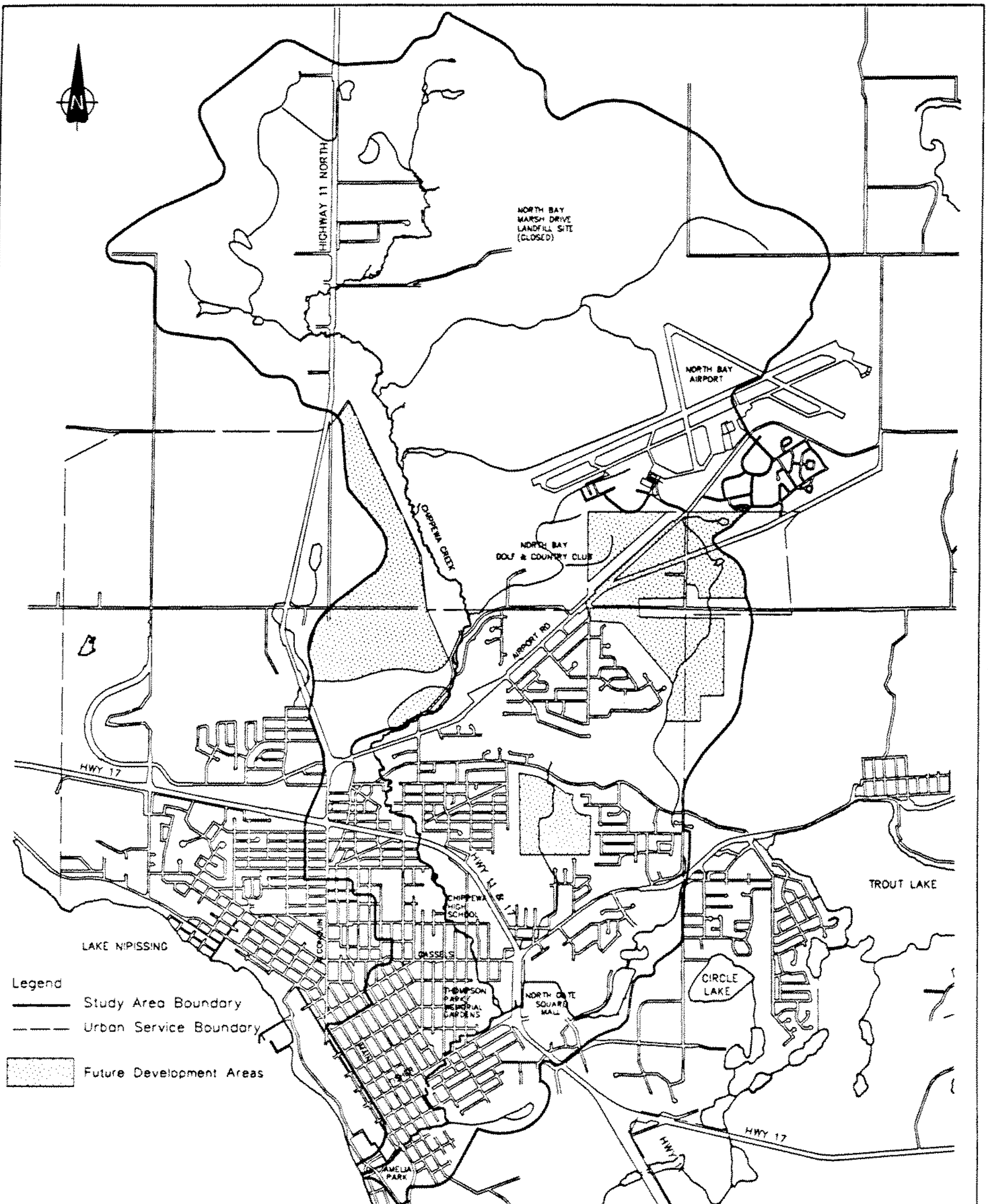

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CHECKED BY	Future Development Areas	SCALE N.T.S.	DATE DEC. 1994
		DRAWING NO.	Figure 2.3–4

The relative changes in flow rates are illustrated on Figure 2.3.5, while Table 2.1 shows the design flow rates for the existing, future, and ultimate development conditions.

Generally, the flow rates downstream of the escarpment dramatically increase, by approximately 300% to 1200%, because of the urban development potential near the escarpment. This change in flow rates decreases as one moves downstream into the urban areas. Near the lake, the design flows increase approximately 20% to 30%. The largest flow increases (3800%) are on the Johnston Creek branch because it has the most development potential in relation to the size of its watershed.

Furthermore, the most downstream reaches of the Chippewa Creek system would subsequently experience addition increases in flow rates should the existing suburban storm drainage systems be improved (ditch to sewer) after the upstream development takes place. However, these increases are relatively small in comparison to those caused by urbanization of the undeveloped areas.

2.3.3 Water Quality Impacts

Section 2.4 of this report describes the quality of the surface water sampled in the Chippewa Creek watershed. Although most of the contaminants sampled were scrutinized for trends (level of contamination versus level of urbanization), the most effort was placed upon the suspended solids concentrations. This was done for a number of reasons.

Many of the contaminants in urban runoff become associated with the suspended solids, or are suspended solids themselves. The effectiveness of some of the best management practices in removing suspended solids is well documented and understood in comparison to other contaminants. Because this considers a variety of contaminants, the intention is to use suspended solids as a general indicator of water contamination for the purposes of this study.

Table 2.1 - Comparison of Flows (Existing, Future as per O.P., and Ultimate)

Location in Chippewa Creek Watershed	Subarea	Drainage Area	1:2 Year Event (Ptot = 21.72 mm)											
			Existing Conditions				Future Conditions				Ultimate Conditions			
			% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.
		(ha)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)
Chippewa Creek at Airport Road	1 to 7	2595.2	20	0.07	15.58	0.20	41	2.16	6.25	0.86	41	2.22	6.17	0.83
Main branch upstream of confluence point with Eastview and Johnston	1 to 10	2900.9	10	1.77	6.08	0.80	16	2.45	6.58	1.39	16	2.76	6.58	1.39
Eastview Tributary drainage area	11 to 14	282.3	50	1.18	6.25	4.55	69	3.14	6.25	8.63	69	3.28	6.25	8.71
Johnson Creek at Ski Club Road	15 to 16	282.3	11	0.02	11.00	0.31	58	2.15	6.33	5.97	58	2.63	6.17	6.02
Johnston Creek drainage area	15 to 19	575.0	44	2.34	6.08	2.97	68	4.02	6.17	6.23	68	4.76	6.17	6.22
Johnston routed thru Delaney Lake	15 to 19	575.0	44	0.16	12.08	2.13	68	0.51	10.00	5.31	68	0.51	9.83	5.29
Eastview + Johnston drainage area	11 to 19	857.3	44	1.19	6.25	2.92	69	3.16	6.33	6.40	69	3.31	6.25	6.41
Chippewa, Eastview, Johnston confl.	1 to 20	3799.6	± 20	3.10	6.17	1.36	± 30	5.39	6.50	2.59	± 30	5.83	6.50	2.59
Mouth	1 to 22	4089.7	± 25	5.33	6.17	1.97	± 35	6.08	6.67	3.11	± 35	6.67	6.75	3.13

Location in Chippewa Creek Watershed	Subarea	Drainage Area	1:5 Year Event (Ptot = 28.96 mm)											
			Existing Conditions				Future Conditions				Ultimate Conditions			
			% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.
		(ha)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)
Chippewa Creek at Airport Road	1 to 7	2595.2	20	0.26	14.58	0.71	41	3.39	6.25	1.58	41	3.49	6.17	1.54
Main branch upstream of confluence point with Eastview and Johnston	1 to 10	2900.9	10	2.63	6.08	1.54	16	4.32	6.58	2.32	16	4.78	6.58	2.32
Eastview Tributary drainage area	11 to 14	282.3	50	1.83	6.25	6.68	69	4.51	6.25	12.06	69	4.87	6.17	12.16
Johnson Creek at Ski Club Road	15 to 16	282.3	11	0.08	10.17	0.93	58	3.11	6.25	8.45	58	3.71	6.08	8.52
Johnston Creek drainage area	15 to 19	575.0	44	3.45	6.08	4.70	68	6.16	6.17	9.04	68	7.05	6.17	9.01
Johnston routed thru Delaney Lake	15 to 19	575.0	44	0.32	10.75	3.78	68	0.80	9.83	8.06	68	0.80	9.75	8.04
Eastview + Johnston drainage area	11 to 19	857.3	44	1.84	6.25	4.73	69	4.59	6.25	9.37	69	4.94	6.25	9.39
Chippewa, Eastview, Johnston confl.	1 to 20	3799.6	± 20	4.60	6.08	2.37	± 30	8.62	6.50	4.01	± 30	9.38	6.42	4.02
Mouth	1 to 22	4089.7	± 25	7.94	6.17	3.23	± 35	9.33	6.75	4.75	± 35	10.19	6.67	4.78

Table 2.1 - Comparison of Flows (Existing, Future as per O.P., and Ultimate)

Location in Chippewa Creek Watershed	Subarea	Drainage Area	1:25 Year Event (Ptot = 36.83 mm)											
			Existing Conditions				Future Conditions				Ultimate Conditions			
			% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.
		(ha)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)
Chippewa Creek at Airport Road	1 to 7	2595.2	20	0.61	13.92	1.58	41	4.50	6.17	2.68	41	4.56	6.17	2.63
Main branch upstream of confluence point with Eastview and Johnston	1 to 10	2900.9	10	3.80	6.08	2.66	16	6.04	6.58	3.64	16	6.68	6.58	3.65
Eastview Tributary drainage area	11 to 14	282.3	50	2.64	6.25	9.29	69	6.21	6.25	16.02	69	6.70	6.17	16.15
Johnson Creek at Ski Club Road	15 to 16	282.3	11	0.17	9.67	1.97	58	4.19	6.25	11.39	58	5.15	6.08	11.48
Johnston Creek drainage area	15 to 19	575.0	44	4.80	6.00	6.97	68	8.24	6.17	12.40	68	9.98	6.17	12.36
Johnston routed thru Delaney Lake	15 to 19	575.0	44	0.52	10.50	5.98	68	1.15	9.67	11.39	68	1.15	9.50	11.34
Eastview + Johnston drainage area	11 to 19	857.3	44	2.68	6.25	7.07	69	6.40	6.25	12.90	69	6.87	6.17	12.92
Chippewa, Eastview, Johnston confl.	1 to 20	3799.6	± 20	6.68	6.08	3.81	± 30	12.12	6.42	5.88	± 30	13.26	6.33	5.89
Mouth	1 to 22	4089.7	± 25	10.95	6.17	4.94	± 35	13.32	6.67	6.86	± 35	14.20	6.67	6.89

Location in Chippewa Creek Watershed	Subarea	Drainage Area	1:50 Year Event (Ptot = 40.00 mm)											
			Existing Conditions				Future Conditions				Ultimate Conditions			
			% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.
		(ha)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)
Chippewa Creek at Airport Road	1 to 7	2595.2	20	0.80	13.83	2.02	41	5.02	6.17	3.21	41	5.06	6.08	3.16
Main branch upstream of confluence point with Eastview and Johnston	1 to 10	2900.9	10	4.45	6.08	3.21	16	6.90	6.58	4.27	16	7.48	6.50	4.27
Eastview Tributary drainage area	11 to 14	282.3	50	3.02	6.25	10.43	69	6.95	6.17	17.68	69	7.51	6.17	17.82
Johnson Creek at Ski Club Road	15 to 16	282.3	11	0.21	9.50	2.49	58	4.69	6.25	12.65	58	5.78	6.08	12.75
Johnston Creek drainage area	15 to 19	575.0	44	5.54	6.08	7.98	68	9.40	6.17	13.84	68	11.32	6.17	13.79
Johnston routed thru Delaney Lake	15 to 19	575.0	44	0.61	10.75	6.98	68	1.28	9.58	12.81	68	1.28	9.33	12.76
Eastview + Johnston drainage area	11 to 19	857.3	44	3.08	6.25	8.11	69	7.18	6.25	14.41	69	7.72	6.17	14.42
Chippewa, Eastview, Johnston confl.	1 to 20	3799.6	± 20	7.82	6.08	4.49	± 30	13.88	6.33	6.72	± 30	14.96	6.33	6.73
Mouth	1 to 22	4089.7	± 25	12.39	6.17	5.72	± 35	15.15	6.67	7.79	± 35	16.08	6.67	7.83

Table 2.1 mparison of Flows (Existing, Future as per O.P., and Ultimate,

Location in Chippewa Creek Watershed	Subarea	Drainage Area	1:100 Year Event (Ptot = 50.67 mm)											
			Existing Conditions				Future Conditions				Ultimate Conditions			
			% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.
		(ha)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)
Chippewa Creek at Airport Road	1 to 7	2595.2	20	1.61	12.92	3.88	41	6.75	6.17	5.34	41	6.91	6.08	5.28
Main branch upstream of confluence point with Eastview and Johnston	1 to 10	2900.9	10	6.38	6.08	5.40	16	9.86	6.50	6.71	16	10.74	6.50	6.72
Eastview Tributary drainage area	11 to 14	282.3	50	4.47	6.17	14.58	69	9.73	6.17	23.50	69	10.09	6.17	23.67
Johnson Creek at Ski Club Road	15 to 16	282.3	11	0.41	9.25	4.62	58	6.56	6.17	17.15	58	7.87	6.08	17.27
Johnston Creek drainage area	15 to 19	575.0	44	8.04	6.00	11.78	68	13.78	6.08	19.01	68	15.67	6.17	18.94
Johnston routed thru Delaney Lake	15 to 19	575.0	44	0.94	10.58	10.71	68	1.68	9.67	17.91	68	1.68	9.58	17.85
Eastview + Johnston drainage area	11 to 19	857.3	44	4.57	6.17	11.98	69	10.12	6.17	19.74	69	10.50	6.17	19.76
Chippewa, Eastview, Johnston confl.	1 to 20	3799.6	± 20	11.69	6.25	7.12	± 30	19.65	6.33	9.87	± 30	21.12	6.25	9.89
Mouth	1 to 22	4089.7	± 25	16.76	6.08	8.71	± 35	21.32	6.58	11.27	± 35	22.92	6.58	11.31

Location in Chippewa Creek Watershed	Subarea	Drainage Area	Timmins Storm Event (Ptot = 193.0 mm)											
			Existing Conditions				Future Conditions				Ultimate Conditions			
			% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.
		(ha)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)
Chippewa Creek at Airport Road	1 to 7	2595.2	20	26.95	13.08	64.53	41	26.01	12.08	68.52	41	25.88	12.08	68.36
Main branch upstream of confluence point with Eastview and Johnston	1 to 10	2900.9	10	30.34	12.00	69.90	16	32.05	9.25	73.47	16	32.59	7.33	73.61
Eastview Tributary drainage area	11 to 14	282.3	50	14.02	7.17	100.39	69	19.15	7.08	124.01	69	19.96	7.08	124.39
Johnson Creek at Ski Club Road	15 to 16	282.3	11	5.75	11.00	71.03	58	13.13	7.17	103.86	58	14.09	7.08	104.13
Johnston Creek drainage area	15 to 19	575.0	44	20.90	7.08	96.24	68	33.12	7.08	115.16	68	34.72	7.08	114.84
Johnston routed thru Delaney Lake	15 to 19	575.0	44	15.15	9.75	94.80	68	22.06	9.33	113.91	68	22.12	9.33	113.58
Eastview + Johnston drainage area	11 to 19	857.3	44	25.27	9.17	96.63	69	34.66	9.00	117.23	69	35.57	7.25	117.13
Chippewa, Eastview, Johnston confl.	1 to 20	3799.6	± 20	53.51	9.08	76.84	± 30	68.89	9.08	84.21	± 30	69.91	7.33	84.30
Mouth	1 to 22	4089.7	± 25	65.95	9.17	82.35	± 35	82.89	9.08	89.20	± 35	83.46	9.08	89.32

Although there is a trend that indicates suspended solids concentrations increase in the Chippewa creek watershed as the level of urbanization increases, this trend is not a strong one. High suspended solids concentrations have been measured in the upstream, rural areas of the watershed. This can be attributed to the very sandy soils in the headwater area, particularly near the landfill, where activities associated with the landfill and natural stream erosion may be causing the soils to wash away or to be transported onto roadways, that become suspended solid loads in the creek. This suspended solids load is transported efficiently through the steep escarpment area and generally does not increase due to channel erosion, as the channel is relatively stable here. The suspended solids loads then decrease in the lower reaches of the creek where the gradients are much milder, the velocities are lower and the creek drops some of its load. This is offset by the suspended solids load from the urban areas, therefore resulting in a relatively constant load throughout the length of the creek.

We believe the suspended solids load in the headwater areas are, for the most, part inert and benign, being comprised mostly of sand washed away from the rural areas. Although the levels do not greatly increase as one moves downstream, we believe the nature of the solids change to show more urban type contamination (i.e. heavy metals, B.O.D., etc.). The deleterious effects of urbanization upon water quality would, therefore, be primarily a function of the proportion of the watershed that is urban, despite the relatively constant concentration of suspended solids over the length of the creek.

The degree of urbanization increases as one progresses downstream through the urbanized areas. At present, the mouth of the creek drains lands that are approximately 25% urban and will increase to approximately 35% in the future. This suggests an increase in the level of contamination within the suspended solids load of approximately 40% over present levels. Furthermore, this increase in urban pollutant concentrations would become much more pronounced upstream where the proportion of future urban areas is larger, particularly on the Eastview and Johnston Creek tributaries. Amplifying the apparent effects upon water quality here are the potential increases in wet weather flow rates, due to urbanization, that will accompany the higher pollutant concentrations.

2.4 Water Quality Assessment

2.4.1 Historical Documentation Review

Being the most predominant watershed within the municipal boundaries of North Bay, Chippewa Creek's historical water quality observations extend back to the late nineteenth century (1891). It was once considered a potential source for North Bay's drinking water (Steer, 1990). From the tests that were conducted, its existing bacteria flora appeared to be too abundant for safe human consumption. Attention was later turned to Trout Lake, which is now North Bay's drinking water supply. Most of the historical data on Chippewa Creek were documented by the Ontario Ministry of the Environment and Energy (OMOEE) through its provincial water survey program. This program was initiated in the seventies, and continued up to 1991 when it was discontinued for budgetary reasons. Recent water quality monitoring by the City of North Bay focused on leachate impacts in the vicinity of the Marsh Drive landfill site. The Ontario Ministry of Health (OMOH) undertook several extensive coliform bacteria surveys from 1965 through to 1990. In addition, several short term studies were conducted by the faculty and students of Nipissing University and Canadore College.

2.4.2 Documentation Selection

Exclusions Rationale

The sources for historical water quality data of Chippewa Creek are varied. The data obtained from Nipissing University and Canadore College were discounted due to the lack of control data

recorded during analyses. Though many of the analyses conducted would be considered valid, the
majority of the analysts were undergraduates and have since left the facilities.

The data collected by the OMOH were discounted for two reasons: 1. provincial policy changes; the OMOH reports consisted of fecal coliform monitoring data. The use of fecal coliform as an indicator for human contact safety has since been substituted with the Escherichia coli (E.coli) test. 2. the data measured were related to recreational criteria rather than Provincial Water Quality Objectives. The rationale documented by the OMOH indicates that the E.coli bacteria is a more representative coliform bacteria to indicate the possible presence of contamination by a sewage source. The presence of E.coli in Chippewa Creek is a concern because the creek discharges into Lake Nipissing close to the Marathon Beach public swimming area.

Data collected by the OMOEE before 1985 were not included as several influential changes in the water quality of Chippewa Creek have occurred. These changes were a result of infrastructure improvements (sewage trunk lines) and urban development.

Inclusion Rationale

Two principle sources, the OMOEE and the City of North Bay, were used to assess the present water quality of Chippewa Creek.

Prior to this watershed management study, the OMOEE had conducted water quality studies on the main channels of Chippewa Creek. Samples were collected from the creek at the Golf Club Road bridge and at the mouth where it discharges into Lake Nipissing. These data were deemed acceptable as the OMOEE maintains an extensive quality control data library and participates in provincial and national laboratory proficiency evaluations.

The City of North Bay conducted studies on Chippewa Creek in association with the Marsh Drive Landfill. The data, which dates back to 1986, were provided by the OMOEE and interpreted by the consulting firm Gartner Lee of Ontario. The other study included a series of urban storm water outfall surveys of E.coli levels along Chippewa Creek. These samples were processed by a local private laboratory, Near North Laboratories Inc.

2.4.3 Parameter Rationale

Various studies have been conducted on Chippewa Creek in relation to specific water quality investigations. The OMOEE conducted its studies in order to build a data base in which natural variation could be observed. This data base has also been used to determine the degree of periodical impacts of specific events on the creek's water quality. The City of North Bay conducted its Marsh Drive Landfill study to delineate the leachate plume from the landfill and determine its impact on Chippewa Creek's water quality. The data that the city is currently collecting will be used to determine the effectiveness of the leachate collection system now in operation. The City of North Bay has conducted a series of E.coli analyses programs to determine the presence of fecal related contamination within the urban core storm water conveyance system. In support of these investigations and the Watershed Management Study, the following parameters were included for sample analysis. See Table 2.4.1 for a description of the criteria from the Ontario Provincial Water Quality Objectives (PWQO).

Alkalinity as CaCO3

Alkalinity is the combined measurement of the bicarbonates, hydroxides, carbonates, and other bases present in water (APHA, 1985). The carbonate and bicarbonate groups are generally the principle agents which buffer the impact of acidic inputs into a watershed (OMOEE, 1981). Acidic inputs can come from natural sources such as the biological decomposition of organic material (organic acids) and from industrial sources such as acid rain. The principle source of carbonates and bicarbonates is the weathering of rocks (Wetzel, 1983). One of the main considerations when judging water quality is to assess the occurrence of pH depressions. The alkalinity of water helps ensure the maintenance of normal pH levels, and buffers the input of contaminants which may depress pH levels (OMOEE, 1981). According the PWQO, alkalinity is important in relation to the toxic effects of some elements present in the water (e.g. lead). In accordance to the PWQO 1994, the alkalinity of water should not be decreased by more than 25% of its natural level. Water bodies having an alkalinity of less than 15 mg/L CaC03 have a potential for acidification (OMOEE, 1981).

Chloride (Cl)

Chlorides readily dissolve into solution and are naturally found in the environment (Gartner Lee, 1993). Excessive amounts of chlorides introduced into the environment can, by their corrosive nature, harm metallic pipes and structures, as well as growing plants (APHA, 1985). Due to their usual ability to move freely in ground water, chloride levels are used to identify the influences of wastewater and industrial sources, road contaminations, septic infiltrations (Wetzel, 1983) and landfill leachate plumes (Gartner Lee, 1993).

Conductivity (Cond)

Conductivity is the ability of dissolved ions in water to carry an electrical current. This parameter is used to indicate the presence of ions which may not have been measured by more specific analyses. Sudden increases in conductivity may indicate that a contaminant has been introduced into the water course (APHA, 1985).

Oil and Grease

Solvent extractable Oils and Greases include mineral petroleum hydrocarbons and their derivatives, animal fats, vegetable oils, soaps, greases and waxes (OMOEE, 1989). Mineral greases can be from the lubricants used in machinery and vehicles. A typical source of animal and vegetable fat/oil is domestic cooking. These substances are harmful to the aquatic environment where they can form a barrier on the surface of the water which prevents the exchange of gases between the water and the atmosphere. Oil/grease can also prevent the absorption of oxygen by aquatic organisms and can inhibit photosynthesis by plants (Miller, 1982). In ideal circumstances, the presence of oil and grease should not be visible nor detectable by analysis (OMOEE, 1994).

Table 2.4.1

Ontario Provincial Water Quality Objectives

Ontario Ministry of the Environment and Energy, 1994

Parameter	Hardness Levels	Criteria
Alkalinity		should not decrease more than 25% of the natural concentration
Ammonia		0.02 mg/L (under certain temperature and pH conditions, see publication)
Chloride		none, excessive levels may result in the leaching of metals
Conductivity		none
Copper	0-20 mg/L >20 mg/L	1 ug/L 5 ug/L
Hardness		none, determined by the measurement of calcium and magnesium, levels should be >80 mg/L as $CaCO_3$
Iron		0.3 mg/L
Lead	<30 mg/L 30-80 mg/L >80 mg/L	1 ug/L 3 ug/L 5 ug/L
Oil and Grease		no visible sheen, <1 mg/L
pH		6.5 - 8.5 pH units
Suspended Solids		none, levels should not exceed 15 mg/L
Temperature		natural thermal regime should not be altered so as to impair aquatic life
Zinc		20 ug/L

pH

The parameter pH is the ionic measurement of the activity of the hydrogen ions in a solution. Hydrogen ions are the principle ions contributing to the acidity of water. The pH ratios (hydrogen to hydroxide) are measured on a scale of zero to fourteen. Seven on the scale is considered pH neutral. Less then seven, the water is considered acidic and greater than seven the water is considered basic (APHA, 1985). The major concern in having a water pH lower than 6.5 is the increased ability of heavy metals to dissolve into the water. Some of the dissolved metals then become biologically available for absorption by aquatic organisms (OMOEE, 1981). The pH of a water course should be maintained between 6.5 - 8.5 pH units in accordance with the recommendations of the PWQO.

Solids - Total Suspended (TSS)

TSS are particulates which are suspended in a water course at greater than 1.5 microns in size. Erosion of creek banks and sediment disturbances contribute to suspended solids (OMOEE, 1981). Excessive suspended solids can stress aquatic organisms by covering feeding areas, irritating gill membranes and smothering spawning beds (Migel, 1974). For the municipality of North Bay (Bylaw 4-87), suspended solids should not exceed 15 mg/L in an effluent that is discharged into a storm sewer or drainage ditch.

Temperature °C

Temperature is a measurement of the heat contained in the water. Temperature influences the biota and the water quality in a water course. For example, an organism adapted to survive at a colder temperature of less than 10 oC may not survive in temperatures of greater than 18 oC. As well, the toxicity of pollutants in the water will alter with a change in temperature. Temperature also influences the ability of oxygen to dissolve in water. An increase in temperature results in a decrease of oxygen dissolved in the water (Andrews, 1972).

Metals

Calcium and Magnesium: Hardness (Ca), (Mg)

Calcium and magnesium are referred to as alkaline metals. Their presence in aquatic ecosystems contributes to hardness which can influence the toxicity of heavy metals present in the water (APHA, 1985). Ideally, in an aquatic ecosystem, hardness should be 80 mg/L as $CaCO_3$ or greater (OMOEE, 1994).

Copper (Cu)

Copper is a metal which, under certain conditions such as contact with soft water (pH <7), can be toxic to the aquatic environment. Copper toxicity is of particular concern to aquatic organisms as it can affect survival, growth, and reproduction; cause tissue damage, decreased oxygen consumption and cause distress behavior. The toxicity of copper decreases as hardness and organic content increases (Nriagu, 1979). The toxicity of copper may increase when hardness levels are below 20 mg/L of $CaCO_3$ (OMOEE, 1994).

Iron (Fe)

Iron is one of the principle elements found in water. In its oxidized form, iron can impair water quality by precipitating onto aquatic plants, thus interfering with the plants' ability to photosynthesize. Iron oxides can also stress some aquatic organisms through irritation of their gill membranes (Migel, 1974). The current guideline (PWQO) states that iron should be less than 0.3 mg/L but natural background levels often exceed this value.

Lead (Pb)

Lead, especially when in soft water (pH<7), can be toxic in an aquatic environment depending on its chemical form (Harrison, 1984). Lead is especially a concern if the water hardness is less than 80 mg/L as CaCO3, and it should not be detectable in levels above 1 ug/L when water hardness is less than 30 mg/L (OMOEE, 1994). Urban sources of lead may include the combustion of fossil fuels; industrial, mine and smelter discharges; and the leaching of lead from old lead plumbing (APHA, 1985).

Zinc (Zn)

The maximum acceptable level of zinc in the aquatic environment has recently been revised and lowered by the OMOEE. Zinc can be introduced into aquatic systems by the degrading of galvanized iron and dezincification of brass. Zinc may also result from industrial waste pollution (APHA, 1985). The maximum acceptable level of zinc in an aquatic ecosystem is 20 ug/L. (OMOEE, 1994)

Other Parameters -- Historical

The following water quality parameters were not included in the 1994 Chippewa Creek Watershed Management Project. However, these parameters are referenced in the historical data.

Aluminum (Al)

The toxicity of aluminum in aquatic ecosystems has been well documented. The severity of its toxicity is pH dependent: as pH is depressed in the ecosystem the leachability and the toxicity of aluminum is increased. To ensure that its toxic effects are minimized, aluminum should not exceed 15 ug/L in water (OMOEE, 1994).

Ammonia Un-ionized (NH_3)

Low levels of ammonia are typical in the aquatic environment and are usually found in the non-toxic ionized form (Wetzel, 1983). As pH and temperature increases, ammonia becomes un-ionized and increasingly toxic to certain aquatic organisms (OMOEE, 1994). Ammonia may be toxic to fish because it reduces the oxygen carrying capacity of the blood (OMOEE, 1981). The PWQO recommended level of un-ionized ammonia is 0.02 mg/L or less to protect aquatic ecosystems.

Nickel (Ni)

Used widely in the manufacturing of stainless steel and plating (McGraw, 1992) and batteries (Hammond, 1993), nickel may be leached into the environment. Nickel, when present in soft waters ($pH<7$), can be toxic to aquatic organisms and should not exceed 25 ug/L (OMOEE, 1994).

Oxygen (O2), Dissolved

The presence of dissolved oxygen is essential for both animal and plant aerobic aquatic organisms (Wetzel, 1983). The concentration of dissolved oxygen in water is influenced by the presence of photosynthetic plants, light penetration, the degree of turbulence and the amount of decomposing dead matter in the water (Andrews, 1972). Also, temperature has an affect as colder waters are able to hold more oxygen than warmer waters. Hence, oxygen is more quickly depleted in warmer waters than cold (OMNR, 1994). According to PWQO, oxygen levels should be no lower than 5 mg/L. Dissolved oxygen analysis in a good trout stream usually indicates 5 to 10 ppm (Migel, 1974). Water stagnation and excessive decay of plants can lead to the reduction of oxygen in an aquatic ecosystem. In turn, this reduction of oxygen can result in a die off of aquatic organisms (Wetzel, 1983).

Phenols

Low levels of phenols can contribute to the tainting of fish (OMOEE, 1978). Though phenols can exist naturally in the environment, to prevent spoiling of recreational fish, levels should not exceed 1 ug/L (OMOEE, 1994).

Solids - Total Dissolved (TDS)

Dissolved solids are solids measured at less than 1.5 microns in size and are the quantity of material that remains as a residue after the water is removed from a filtered portion of sample by evaporation. Dissolved solids may also be calculated from a conductivity measurement. This test does not determine specific chemical substances (APHA, 1985).

2.4.4 Sampling Site Criteria

Historical Sampling Sites

The OMOEE has maintained, until recently (program cancelled), two sampling locations. One site is located at the mouth of Chippewa Creek at Lake Nipissing (Mouth Site). Measurements at this site determine the contribution of the Chippewa Creek watershed to Lake Nipissing's aquatic ecosystem. The second location is the Golf Club Road bridge (Mid Escarpment Site). These sampling locations allow for the geographical differentiation between the upper escarpment and lower escarpment portions of the watershed. Not all contaminants will be transported throughout a water course (e.g. Suspended Solids).

The City of North Bay has maintained the monitoring of seven surface sampling sites within the Chippewa Creek watershed. These sites are all located in the vicinity of the Marsh Drive landfill site. These sampling locations are principally used to determine the impact of the landfill leachate plumes on the water quality of Chippewa Creek. Two of these sites correspond with this watershed management study's sampling sites. City of North Bay Site # S30 is located just before the landfill and corresponds with the Pre-Landfill sampling site (this study's site #11) and sampling location City of North Bay Site # S90 corresponds with the Landfill Tributary sampling site (this study's site #10). Sampling location City of North Bay Site # S10 corresponds with the Upper Escarpment sampling site (this study's site # 9). City of North Bay landfill sampling sites are taken from the Marsh Drive Landfill 1992 Annual Monitoring Report.

Watershed Management Study Sampling Sites

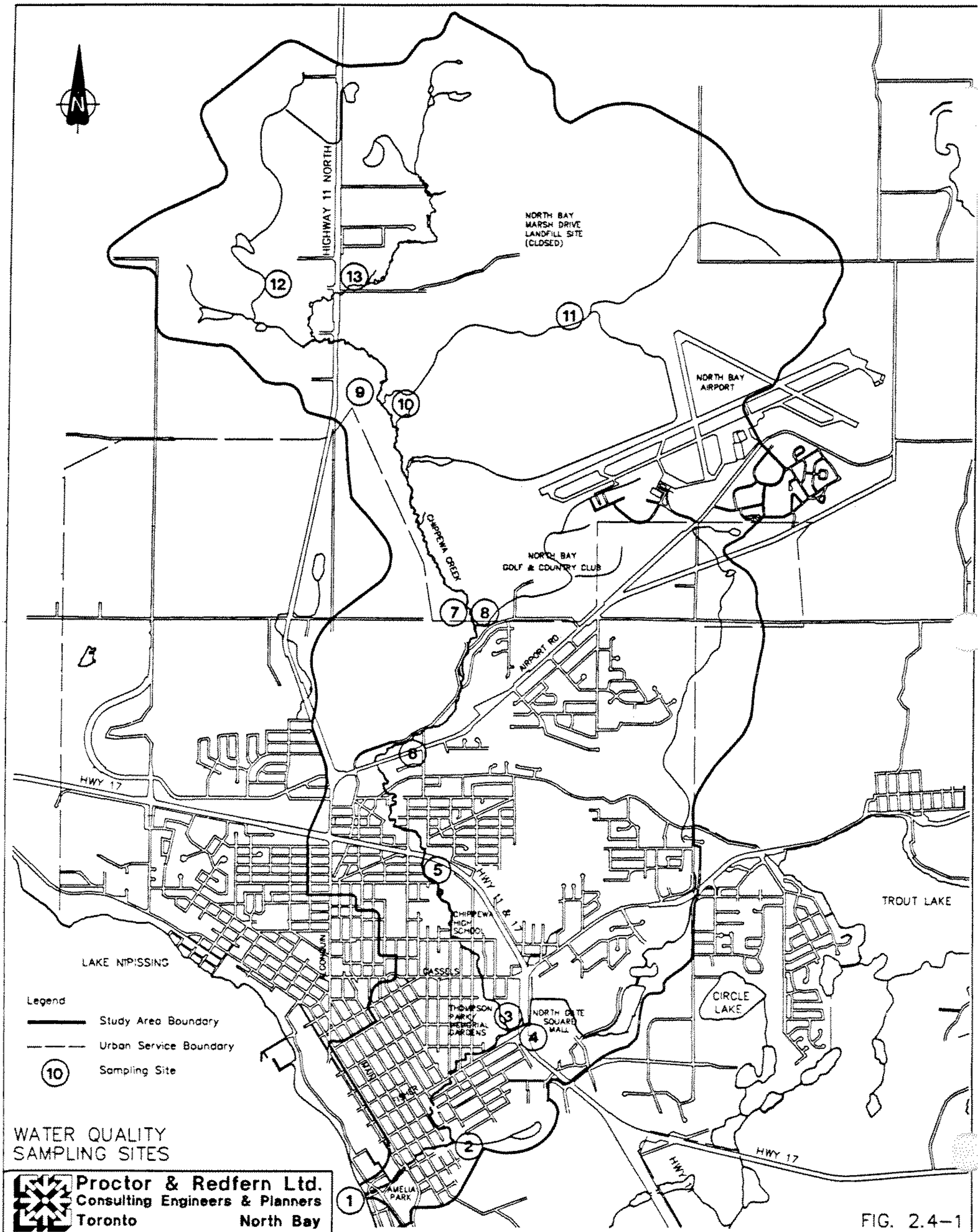
Selection Rationale

All sampling sites (see Figure 2.4.1) are located mid channel of the creek. With the exception of the Bottom Escarpment sampling site (Site #6), the site locations were chosen based on greatest stream depth (typically less than one meter) and greatest distance from rapids. The Bottom Escarpment Site #6 was an area of continuous rapids and shallow stream depth.

The reason for avoiding rapids is that higher stream velocities can transport larger solids a short distance and cause misleading analytical results (i.e. elevated Suspended Solids), and small falls can contribute to air/water mixing which may cause elevated readings of dissolved oxygen and non-representative readings of temperature. Straight stream bank locations were selected to ensure samples were from areas with a constant stream velocity across its profile. Urban area sampling sites were examined for the presence of storm outfalls. Sampling sites were chosen upstream of any outfalls to prevent measurements being taken in an area of inadequately mixed storm water. All tributary sampling sites were chosen to represent the various sub-watersheds and to evaluate the potential impact each may have on Chippewa Creek.

Sampling Site Description and Representation

For sketches and sampling site descriptions, see E-1.



WATER QUALITY SAMPLING SITES

FIG. 2.4-1

2.4.5 Sampling Protocol

All samples were collected mid-stream and 8" to 12" below the water surface. The sampler always approached the site from downstream and faced upstream during sample collection. Sampling containers were pre-rinsed several times with creek water. The rinsings were emptied downstream from the point of sampling. The containers were inserted into the creek in an inverted position, turned upright, filled to overflowing and then capped. Randomly selected duplicate samples were taken during the course of this study. Appropriate containers, prepared by the laboratory, were used for the collection of solids, general chemistry, and metals. All metal samples were preserved with nitric acid. Samples were transported to the laboratory the same day. Sampling began on May 5, 1994 and was carried out once every two weeks within the lower watershed. Sampling of the upper escarpment commenced on May 17, 1994 above Mid Escarpment and up. As of the 31 of May, all sites were sampled every two weeks up to and including the 10 of August, 1994.

2.4.6 Field Measurements

Field analyses were conducted for pH, conductivity, and temperature. Field measurements were taken using a calibrated Corning Check Mate Personal Meter.

2.4.7 Laboratory Analyses

Collected samples were transported to the laboratory the same day and chemistries requiring immediate analysis were conducted within 24 hours of the sampling period. Chloride and pH analyses were conducted by probe. Alkalinity was determined by potentiometric titration. Iron, zinc, calcium and magnesium were determined by acid digestion and atomic absorption analysis. Copper and lead were determined by graphite furnace analysis. Hardness was calculated from the calcium and magnesium determinations. TSS were determined gravimetrically and total oil and grease measurements were determined by solvent extraction. All analyses were conducted according to the recommendations of Standard Methods for the Analyses of Water and

Wastewater, 15th edition. All analyses in the laboratory were conducted with blanks, spikes, replicates, and control standards as required.

2.4.8 Dry Weather Water Quality Assessment

In the following descriptions, water quality data is discussed per individual sampling site location. The 1994 data are listed in Table 2.4-2. Historical data are listed in E-2. For a graphic summary of the sites by individual parameters, see E-3. The graphs read in descending order downstream (from left to right) from the wetland site #12 at the upper end of the escarpment down to the mouth site #1.

Historical data for dry flows were available for the following sites: Pre-Landfill Tributary, Landfill Tributary, Upper Escarpment, Bottom of Escarpment and the Mouth. Graphs comparing historical trends in these areas are presented in E-4.

Psychiatric Tributary Site #13

Located north of the City of North Bay, this area was first sampled during 1994. This sampling site was introduced into the study at a later period (June 28, 1994). It was sampled three times over the spring and summer season. Alkalinity was low (< 20 mg/L) and the pH was within the range of 6.4- 6.8. Chloride levels measured in this area were low (<5 mg/L) with the exception of one sampling occasion when the level measured was 18 mg/L. According to PWQO, copper concentrations were within the limits given that hardness levels were consistently greater than 30 mg/L. The June 28 sampling event measured levels of lead concentrations of 10 ug/L. Measured iron concentrations exceeded the PWQO of 0.3 mg/L but were relatively consistent around 1 mg/L. Zinc concentrations were within the PWQO with a maximum level of 20 ug/L. TSS remained around 4 mg/L with the exception of one sampling event in which a level of 18 mg/L was measured. The oil and grease measured was below detectable limits based on a single sampling event.

Table 2.4.2

Chippewa Creek Water Quality Data 1994 - present
Compiled 8/4/97 by Near North Laboratories Inc., North Bay, Ontario

Site	Date	Source	Rain mm	Alk mg/L	pH	Ammonia mg/L	Temp oC	Cl mg/L	Dis O2 mg/L	Tot P mg/L	Turbid NTU	Copper mg/L	Iron mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Al mg/L	Mg mg/L	Ca mg/L	Cond uS/cm	Hard mg/L	S. Solids mg/L	D. Solids mg/L	Nitrate mg/L	Phenol mg/L	COD mg/L
Mouth	05/05/94	NNL	2.4	21	7.29			60.1				0.013	0.700	<0.005		0.018		2.560	6.560	211	27	9				
Mouth	05/31/94	NNL	12.0	24	7.40			67.6				0.008	1.060	<0.005		0.019		2.600	11.200	222	38	11				
Mouth	06/14/94	NNL		22	7.07			47.8				0.012	3.180	0.008		0.046		1.700	11.400	175	35	123		0.73		
Mouth	06/28/94	NNL		28	8.70			43.7				0.005	1.760	0.020		0.030		2.600	12.700	216	42	9				
Mouth	07/12/94	NNL		25	7.13			84.8				0.011	2.260	<0.005		0.033		2.440	11.600	280	38	20				
Mouth	07/27/94	NNL		37	8.92			33.1					1.730	<0.005		0.046		3.080	10.800	382	40	5				
Laurier	05/05/94	NNL	2.4	44	6.91			795.0				0.008	4.080	<0.005		0.021		5.480	18.100	705	68	7				
Laurier	05/31/94	NNL	12.0	65	6.78			888.9				0.005	8.680	<0.005		0.034		2.600	27.300	1070	78	68				
Laurier	06/14/94	NNL		68	7.05			876.1				0.007	4.670	0.032		0.021		5.660	34.400	1248	111	13		8.08		32
Laurier	06/28/94	NNL		67	6.98			380.0				0.005	1.360	0.022		0.049		8.200	37.400	1269	119	16				
Laurier	07/12/94	NNL		72	7.07			490.0				0.011	8.160	0.008		0.017		4.222	46.200	1342	128	14				
Laurier	07/27/94	NNL		67	7.04			844.0					12.800	<0.005		0.037		7.140	88.000	2020	134	34				
Thompson	05/05/94	NNL	2.4	19	7.14			35.6				0.006	0.684	<0.005		0.014		2.000	4.000	164	19	9				
Thompson	05/31/94	NNL	12.0	13	6.98			34.9				0.018	3.280	0.009		0.082		2.880	8.600	190	38	191				
Thompson	06/14/94	NNL		19	7.14			28.9				0.011	2.620	0.022		0.042		2.200	8.100	131	32	108		0.78		20
Thompson	06/28/94	NNL		19	7.00			20.4				0.007	1.670	0.020		0.042		1.900	8.300	134	31	28				
Thompson	07/12/94	NNL		20	7.29			38.8				0.008	1.080	<0.005		0.034		1.880	8.800	213	29	10				
Thompson	07/27/94	NNL		34	6.49			26.0					1.380	<0.005		0.043		2.840	8.300	288	35	12				
Johnston	05/05/94	NNL	2.4	32	7.10			173.8				0.008	1.140	<0.005		0.038		3.680	12.800	828	80	4				
Johnston	05/31/94	NNL	12.0	<1	4.10			107.8				0.001	7.410	0.036		0.161		3.740	16.200	340	83	129				
Johnston	06/14/94	NNL		37	6.80			88.1				0.010	1.640	0.037		0.040		8.440	16.600	309	69	12		0.81		162
Johnston	06/28/94	NNL		38	6.86			88.1				0.008	1.320	0.022		0.030		3.200	16.300	321	64	4				
Johnston	07/12/94	NNL		38	7.04			158.0				0.010	1.810	<0.005		0.016		3.080	16.200	390	61	4				
Johnston	07/27/94	NNL		40	7.10			120.0					1.360	<0.005		0.030		3.940	12.200	487	44	4				
Dudley	05/05/94	NNL	2.4	16	7.28			30.2				0.009	0.468	<0.005		0.018		1.800	8.400	136	29	11				
Dudley	05/31/94	NNL	12.0	26	6.89			28.8				0.008	7.300	0.026		0.102		3.800	10.300	166	41	208				
Dudley	06/14/94	NNL		19	7.14			251.0				0.010	2.410	0.018		0.080		2.100	8.200	127	32	90		0.68		168
Dudley	06/28/94	NNL		18	7.09			16.8				0.005	1.820	0.024		0.017		1.900	8.800	118	30	8				
Dudley	07/12/94	NNL		19	7.32			28.8				0.008	2.180	<0.005		0.026		1.430	7.870	364	28	16				
Dudley	07/27/94	NNL		30	7.40			46.8					1.880	<0.005		0.047		2.730	8.200	220	32	6				
Bottom Es	05/05/94	NNL	2.4	12	7.21			20.0				0.008	0.454	<0.005		0.020		1.680	6.880	102	24	13				
Bottom Es	05/31/94	NNL	12.0	18	7.21			24.8				0.004	1.380	<0.005		0.033		1.830	7.900	120	26	67				
Bottom Es	06/14/94	NNL		14	7.14			17.8				0.008	2.380	0.017		0.040		1.700	8.200	105	27	86		0.76		
Bottom Es	06/28/94	NNL		16	6.90			10.0				0.005	1.710	0.019		0.012		1.800	7.800	89	25	13				
Bottom Es	07/12/94	NNL		17	7.38			17.0				0.008	1.820	<0.005		0.019		1.290	6.630	73	22	13				
Bottom Es	07/27/94	NNL		26	7.43			24.8					1.870	<0.005		0.280		2.270	8.030	169	32	6				
Mid Escp	05/17/94	NNL		6	6.89			6.3				0.008	0.857	0.011		0.046		0.830	4.100	63	14	60				
Mid Escp	05/31/94	NNL	12.0	11	6.80			11.2				0.008	1.160	<0.005		0.034		1.880	6.100	76	20	29		0.32		
Mid Escp	06/14/94	NNL		11	7.00			12.3				0.014	2.300	0.016		0.030		1.700	6.700	79	34	64				
Mid Escp	07/12/94	NNL		17	7.20			15.8				0.006	2.000	<0.005		0.016		1.230	4.770	61	17	16				
Mid Escp	07/27/94	NNL		21	7.36			16.6					2.010	<0.005		0.022		1.840	6.680	104	26	6				
Old Trib	05/17/94	NNL		28	7.46			30.8				0.009	0.952	0.006		0.038		2.200	12.800	216	44	9				
Old Trib	05/31/94	NNL	12.0	34	7.21			60.1				0.008	3.380	<0.005		0.048		3.600	16.000	242	66	44		2.01		
Old Trib	06/14/94	NNL		40	7.09			66.2				0.006	2.080	0.014		0.109		3.400	18.500	208	60	6				
Old Trib	06/28/94	NNL		37	7.11			25.7				0.005	1.420	0.020		0.022		2.900	16.600	187	69	2				
Old Trib	07/12/94	NNL		34	7.70			38.0				0.008	1.410	<0.005		0.028		2.800	14.700	217	48	2				
Old Trib	07/27/94	NNL		40	7.67			53.7					1.840	<0.005		0.032		3.200	11.600	279	42	4				
Top Escp	05/17/94	NNL		3	6.28			12.3				<0.001	0.518	0.011		0.082		0.900	0.606	66	6	7				
Top Escp	05/31/94	NNL	12.0	6	4.65			38.3				<0.001	1.040	<0.005		0.024		1.210	6.300	149	18	85				
Top Escp	06/14/94	NNL		8	6.88			28.8				0.010	1.880	0.009		0.031		1.200	6.600	111	19	10				
Top Escp	06/28/94	NNL		8	6.46			12.6				0.006	2.270	0.019		0.027		1.000	4.700	75	16	9				
Top Escp	07/12/94	NNL		8	6.67			17.0				0.004	2.370	<0.005		0.014		0.840	3.840	88	13	4				
Top Escp	07/27/94	NNL		14	6.88			28.8					2.870	<0.005		0.021		1.490	6.240	129	18	6				
L.F. Trib	05/17/94	NNL		8	6.78			1.3				0.018	1.480	0.010		0.031		0.810	6.400	42	17	72				
L.F. Trib	05/31/94	NNL	12.0	16	6.78			2.8				0.014	7.210	<0.005		0.044		3.800	10.200	63	41	697				
L.F. Trib	06/14/94	NNL		13	6.88			2.8				0.014	3.200	0.005		0.047		2.100	7.700	64	28	184				
L.F. Trib	06/28/94	NNL		17	6.85			2.7				0.007	1.420	0.019		0.032		1.700	7.600	67	26	18				
L.F. Trib	07/12/94	NNL		18	7.20			4.4				0.007	1.840	0.008		0.020		1.440	6.850	76	21	9				
L.F. Trib	07/27/94	NNL		29	7.36			8.3					1.880	<0.005		0.022		2.620	8.860	108	32	18				
Pre L.F.	05/31/94	NNL	12.0	17	6.79			3.0				0.015	8.290	<0.005		0.048		4.600	12.300	86	50	812		0.64		
Pre L.F.	06/14/94	NNL		18	6.64			1.9				0.014	2.970	<0.005		0.028		1.700	7.600	60	26	168				
Pre L.F.	06/28/94	NNL		12	6.60			1.8				0.016	3.200	0.022		0.028		1.700	7.800	62	28	66				
Pre L.F.	07/12/94	NNL		6	6.80			4.4				0.009	1.670	<0.005		0.028		1.400	6.200	64	19	24				
Pre L.F.	07/27/94	NNL		23	6.86			6.1					2.660	<0.005		0.027		2.310	7.670	87	29	28				
Wetland	05/31/94	NNL	12.0	3	6.07			32.4				<0.001	1.770	<0.005		0.022		1.070	4.300	120	15	9		0.06		
Wetland	06/14/94	NNL										0.014	0.800	<0.005		0.027		1.000	3.800		14					
Wetland	06/28/94	NNL		7	6.09			19.1				<0.001	4.680	0.009		0.046		0.870	5.400	121	17	9				
Wetland	07/12/94	NNL		8	6.55			30.2				0.009	4.760	<0.005		0.019		0.860	4.190	98	14	69				
Wetland	07/27/94	NNL		13	6.90			65.0					5.810	<0.005		0.038		1.400	6.260	180	22	9				
Payc Trib	06/28/94	NNL		6	6.28			2.6				0.002	0.830	0.010		0.020		0.790	3.700	33	12	5				
Payc Trib	07/12/94	NNL		6	6.43			3.6				0.008	0.830	<0.005		0.014		1.030	3.070	40	12	18				
Payc Trib	07/27/94	NNL		12	6.83			17.8					1.370	<0.005		0.020		1.400	4.470	76	17	9				

Wetland Site #12

Located northwest of the city of North Bay, this area was first sampled during 1994. This site was sampled five times over the spring and summer season. Alkalinity was low (< 20 mg/L), and pH was consistently within the range of 6.5 -7.0. Chloride levels (19 - 55 mg/L) in this area were slightly higher when compared to the other northern channels of Chippewa Creek. Copper concentrations showed a slight variability at the upper acceptable limit of 1 ug/L. The events of elevated copper coincided with slight drops in the hardness levels. Lead concentrations were less than 5 ug/L (which is desirable under PWQO since the level of alkalinity is <20 mg/L). Iron concentrations exceeded the objective of 0.3 mg/L and were consistently around the 5 mg/L mark. Zinc concentrations fluctuated above and below the objective of 30 ug/L. TSS levels were around 9 mg/L with the exception of one sampling event in which 59 mg/L were measured. Oil and grease was relatively low or undetectable throughout the monitoring season for this sampling site.

Pre-Landfill Tributary Site #11

Located northeast of the City of North Bay, this area was first sampled during 1985. (Gartner Lee, Sample site S20.) Historically the pH of the site ranged consistently between 6.7 - 7.7. In 1994, the pH values ranged from 6.5 to 7.0. Historically, un-ionized ammonia typically measured less than the PWQO objective of 0.02 mg/L. Chloride levels were relatively low (<10 mg/L) with the exception of two occasions when the levels were between 10-15 mg/L. Copper concentrations were not measured until 1994. The levels of copper exceeded the PWQO of 5 ug/L (hardness >20mg/L) and were typically around 15 ug/L. Hardness levels ranged from 26 mg/L or greater with one exception. Lead levels were first measured during 1994, and were typically undetectable with the exception of one event. The June 28, 1994, sampling event measured levels of lead concentrations of 22 ug/L. Iron concentrations historically exceeded the objective of 0.3 mg/L but were relatively consistent around 1 mg/L. During 1994, iron levels during dry weather flows were typically around 3 mg/L. Zinc concentrations exceeded the water quality objectives with a maximum measured level of 29 ug/L. TSS were measured during 1994 and ranged from 24 to 156 mg/L. Oil and grease was 6 mg/L during one sampling event and non-detectable during the other.

Landfill Tributary Site #10

Located east of Highway 11 North, this area was first sampled in 1988 by Gartner Lee (Sample site S60). During the 1994 monitoring season, this site was sampled seven times. The alkalinity of this site was low (<20 mg/L) with the exception of one sample measuring 29 mg/L. The pH during 1994 was relatively neutral to slightly below pH 7. Historically the pH for this site was greater than seven. The chloride levels measured during 1994 were relatively low (1 - 4 mg/L) which were typically lower than the historical data. Copper values measured during 1994 ranged from 7 to 16 ug/L which exceeded the PWQO of 5 ug/L (Hardness >20 mg/L). Lead was detectable during the early 1994 sampling season with levels ranging from 5 to 19 ug/L. Iron levels exceeded the objective of 0.3 mg/L historically and during 1994. Zinc levels typically exceeded the PWQO of 20 ug/L with a maximum level measured of 42 ug/L. The dry weather flow of TSS typically exceeded 15 mg/L. Oil and grease was detectable at a level of 2 mg/L in one sample.

Upper Escarpment Site #9

Located northeast of the City of North Bay, this area was first sampled during 1988. (Gartner Lee, Sample site S80.) Historically the pH of the site ranged from 6.4 -7.2. In 1994, the pH ranged from 6.3 to 6.9. Historically, un-ionized ammonia levels remained below the objective of 0.02 mg/L. Chloride levels typically ranged between 15 -30 mg/L, which is consistent with historical data. Copper concentrations were not measured until 1994 and they exceeded the PWQO of 5 ug/L (hardness >20mg/L) only once. Hardness levels ranged from 66 mg/L to 148 mg/L. Lead was first measured during 1994 and was detectable on three occasions with values ranging from 9 ug/L to 19 ug/L. Iron concentrations, which have historically exceeded the objective of 0.3 mg/L, showed a continuous increase from 0.5 mg/L to 2.6 mg/L over the 1994 sampling season. The historical data reflects this increasing trend of iron concentration from spring with the levels decreasing in the fall (Gartner, 1992 -- Site S80). Zinc concentrations at this site were typically within water quality objectives with few exceptions. The levels of TSS measured during 1994 ranged from 4 to 10 mg/L. Oil and grease was 1 mg/L during one sampling event and non-detectable during the other.

Golf Club Tributary Site #8

Located north of Golf Club Road, this site was sampled seven times over the spring and summer season. Alkalinity ranged from 28 to 40 mg/L and gradually increased from 28 mg/L during the spring to levels of 34 to 40 mg/L during summer. The pH was relatively constant (7.1-7.7). Chloride levels in this area ranged from 26 to 56 mg/L and copper levels were typically at the PWQO of 5 ug/L (hardness >20mg/L). Hardness levels ranged from 42 mg/L to 60 mg/L. Lead levels fluctuated from undetectable to 20 ug/L. The higher levels of lead coincided with elevated levels of alkalinity (37 - 40 mg/L). Iron levels exceeded the PWQO of 0.3 mg/L and ranged in concentration from 1.0 to 3.4 mg/L. Zinc concentrations at this site ranged near 30 ug/L with a maximum level of 109 ug/L. TSS were less than 15 mg/L. Oil and grease levels were non-detectable during the sampling season.

Mid-Escarpment Site #7

Located north of Golf Club Road, this area was first sampled during 1994. The site was sampled seven times over the spring and summer season. Alkalinity was low (< 20 mg/L) and the pH was ranged consistently between (6.7-7.4). Chloride levels in this area ranged from 6 to 15 mg/L. Copper levels consistently exceeded the PWQO of 5 ug/L (hardness >20mg/L) and hardness levels ranged from 14 mg/L to 25 mg/L. Lead was only detectable during the early season (11 - 15 ug/L). Iron concentrations exceeded the PWQO of 0.3 mg/L and were typically around 2.0 mg/L. Zinc concentrations varied from 15 to 45 ug/L. The levels of TSS were at or exceeded 15 mg/L with the maximum level measured at 84 mg/L. Oil and grease was 3 mg/L during one sampling event and non-detectable during the other.

Bottom of Escarpment Site #6

Located at the intersection of O'Brien and Golf Club, this site was sampled seven times during 1994. Historically the pH of the site ranged from 7.0-7.9 and the 1994 pH data were consistent with these levels. Un-ionized ammonia levels exceeded 0.02 mg/L during spring months. Historically, chloride levels in this area ranged between 9-28 mg/L and the 1994 levels of chloride were consistent with this data. Historically, copper concentrations were typically not detectable, excepting an occasional measurement around 3 ug/L. During 1994, levels of copper ranged from 4 to 8 ug/L. Hardness levels ranged from 22 mg/L to 32 mg/L. Historically, lead levels were typically undetectable, and the 1994 monitoring program reflected this with the exception of two occasions when lead levels were 17 ug/L and 19 ug/L. Iron levels historically exceeded the PWQO of 0.3 mg/L with levels of 1 mg/L. Iron data for 1994 varied from 0.5 mg/L to 2.3 mg/L. Zinc concentrations at this site were typically within PWQO with few exceptions. Levels of TSS measured during 1994 ranged from 5 to 85 mg/L and oil and grease was 7 mg/L during one sampling event and non-detectable during the other.

Dudley Avenue Site #5

Located just south of Highway 17 and 11 on the main channel of Chippewa Creek, this site was sampled seven times over the spring and summer season. Alkalinity ranged from 15 to 30 mg/L and the pH was relatively constant (6.9 -7.4). Chloride levels ranged from 16 to 47 mg/L. Copper levels exceeded the PWQO of 5 ug/L (hardness >20mg/L). Hardness levels ranged from 26 mg/L to 32 mg/L. Lead levels fluctuated from undetectable to 24 ug/L. Iron levels exceeded the objective of 0.3 mg/L and ranged in concentration from 1.6 to 2.4 mg/L. Zinc concentrations measured near 30 ug/L with a maximum level of 47 ug/L. Levels of TSS exceeded 15 mg/L on several occasions and oil and grease was non-detectable during one sampling event.

Johnston Creek Tributary Site #4

The Johnston Creek Tributary, which flows into Chippewa Creek at Fisher Street, was sampled seven times over the spring and summer season. Alkalinity ranged from 35 to 40 mg/L and the pH was relatively constant (6.9 -7.1). Chloride levels ranged from 66 to 159 mg/L. Copper levels exceeded the PWQO of 5 ug/L (hardness >20mg/L). Hardness levels ranged from 44 mg/L to 53 mg/L and Lead levels fluctuated from undetectable to 37 ug/L. Iron concentrations exceeded the PWQO of 0.3 mg/L and ranged in concentration from 1.4 to 1.8 mg/L. Zinc concentrations at this site measured near 30 ug/L with a maximum level of 40 ug/L. Levels of TSS never exceeded 15 mg/L and oil and grease was detectable (7 mg/L) during one sampling event.

Thompson Park Site #3

The Thompson Park sampling site, located just upstream from the inflow of Johnston Creek, was sampled seven times over the spring and summer season. Alkalinity ranged from 18 to 31 mg/L and the pH fluctuated (6.4 -7.3) during the dry flow season. Chloride levels ranged from 21 to 39 mg/L and copper levels exceeded the PWQO of 5 ug/L (hardness >20mg/L). Hardness levels ranged from 29 mg/L to 35 mg/L and lead levels fluctuated from undetectable to 22 ug/L. Iron levels exceeded the PWQO of 0.3 mg/L and ranged in concentrations from 1.7 to 2.6 mg/L. Zinc concentrations at this site typically exceeded 30 ug/L with a maximum level of 43 ug/L. Levels of TSS exceeded 15 mg/L on two occasions with a maximum level of 108 mg/L. Oil and grease was detectable (7 mg/L) during one sampling event.

Laurier Woods Tributary Site #2

The Laurier Woods Tributary, which flows into Chippewa Creek at Second Avenue, was sampled seven times over the spring and summer season. Alkalinity ranged from 35 to 40 mg/L and the pH was relatively constant (7.0 -7.1). Chloride levels ranged from 289 to 676 mg/L and copper levels measured near the PWQO of 5 ug/L (hardness >20mg/L). Hardness levels were greater than 100 mg/L and lead levels fluctuated from undetectable to 32 ug/L. Iron levels exceeded the objective of 0.3 mg/L and ranged in concentrations from 1.8 to 12.9 mg/L. The maximum zinc concentrations measured at this site was 21 ug/L. Levels of TSS fluctuated near the 15 mg/L with a maximum of 31 mg/L. Oil and grease were detectable at 6 mg/L during one sampling event.

Mouth Site #1

Located upstream from the Lake Nipissing inflow, this site was sampled seven times over the 1994 spring and summer season. Historically the pH of the site ranged from 7.1 -7.9 and the 1994 pH data ranged from 6.4 - 7.4. Un-ionized ammonia levels have not exceeded 0.02 mg/L during recent years. Chloride levels in this area typically ranged between 50-70 mg/L with seasonal fluctuations and 1994 levels were consistent with historical data. Historically, copper concentrations were near the PWQO of 5 ug/L with a reduction of levels evident during recent years. During 1994, copper levels ranged from 5 to 12 ug/L. Hardness levels ranged from 35 mg/L to 42 mg/L. Historically, lead levels were typically undetectable and the 1994 monitoring program reflects this with the exception of two occasions when lead levels ranged from 20 - 31 ug/L. Iron levels historically exceeded the PWQO of 0.3 mg/L and showed a typical level of 0.7 mg/L. The 1994 data indicated a range of iron from 1.7 - 3.2 mg/L. Zinc concentrations at this site typically exceeded the water quality objectives of 20 ug/L with a maximum level of 45 ug/L. Historical levels of TSS occasionally exceeded 15 mg/L and levels measured during 1994 ranged from 5 to 123 mg/L. Oil and grease was 12 mg/L during one sampling event and non-detectable during the other.

2.4.9 Storm Outfalls Dry Weather Flows

During 1994 sixteen urban outfalls and the mouth of Chippewa Creek at Lake Nipissing were sampled for Escherichia coli (E.coli) bacteria levels. Samples were taken during dry flow conditions which reflects the level of an outfall's continuous contribution to Chippewa Creek's water quality. The levels measured at the Mouth Site #1 reflect Chippewa Creek's contribution of E. coli bacteria to Lake Nipissing. E. coli bacteria were detectable in all samples collected from the outfalls (Table 2.4.3). This reflects typical mature urban sources, such as storm water which collects fecal contribution from animals and organic sources. Areas which indicated significant bacteria contributions (>1800 CFU/100 mL) during 1994 were Cassells, Duke, Haig, and Hammond streets. Levels measured at Oak Street were less than 1000 CFU/100 mL. It is important to note the E. coli levels at the mouth of the creek were not significant during 1994 (ranging from 230 - 800 CFU/100 mL).

2.4.10 Contributions of Tributaries During Dry Weather Flows

Figures 2.4.2 to Figure 2.4.5 provide a comparison of the 1994 loading into Chippewa Creek from each tributary. The following percentages are based on a single tributary's contribution divided by the total load of all tributaries. Please note, the flow rate variable for each tributary is not figured into this calculation. According to this calculation, Laurier Woods Tributary contributes the most significant levels of chlorides to Chippewa Creek (79%). Johnston Tributary contributes the most significant levels of lead (48%) and copper (27%). The Landfill Tributary contributes the most significant levels of suspended solids (61%).

2.4.11 Wet Weather Water Quality Assessment

In the following descriptions, water quality data related to rain events is discussed per individual sampling site. The discussions incorporate historical data to allow for a general assessment and they are not an assessment that is specific to a particular rain event. Historical data for rain events were available for the following sites: Pre-Landfill Tributary, Landfill Tributary, Upper Escarpment, Bottom Escarpment and the Mouth. Graphs comparing historical trends in these areas are presented in E-5. The remainder of the sampling sites are not included because there is insufficient historical data for a general assessment.

Table 2.4.3

Chippewa Water Quality Tests (E. Coli) From July 05-20, 1994. Compiled: 11/07/94 by Near North Laboratories Inc., North Bay, Ontario

Site	Storm Outfall	Date	Count (CFU/100 ml)
A	Mouth (Nip.)	07/14/94 07/20/94	800 230
B	Queen St.	07/05/94 07/20/94	750 100
C	Memorial Dr.	07/05/94 07/14/94	460 300
D	Oak St.	07/05/94 07/20/94	490 900
E	Worthington St.	07/05/94	110
F	First Ave	07/05/94 07/14/94	120 180
G	Second Ave	07/05/94 07/20/94	100 100
H	Hammond St.	07/20/94	1800
I	Haig St.	07/20/94	>2000
J	Princess St.	07/20/94	120
K	Duke St.	07/05/94 07/14/94 07/20/94	100 110 2400
L	Fisher St.	07/14/94	100
M	Olive at Fraser	07/05/94	190
N	Cassells St.	07/04/94 07/20/94	150 >2000
O	Lansdowne St.	07/20/94	200
P	McKenzie St.	07/20/94	500
Q	Ramsey off O'Brien	07/05/94	170

Pre-Landfill Tributary Site #11

The measured pH values during rain events have shown gradual decrease since 1990. Iron values were relatively constant until 1992. Since then, iron levels have increased from <1 mg/L to a level of 12 mg/L measured in 1994. Chloride values have been low from 1985 to present (<8 mg/L).

Landfill Tributary Site #10

Since 1991, pH values measured during rain events have shown a gradual decrease. Measured iron values have indicated an increase since 1992 to a level of 4 mg/L. Since 1991, chloride values have steadily been decreasing.

Upper Escarpment Site #9

The upper escarpment historical rain related data provides an indication of the watershed contribution prior to the landfill tributary. Since 1990 there has been a gradual decrease of the pH levels during rain events. Iron values measured were relatively constant until 1992 when average values increased from <1 mg/L to >5 mg/L. Chloride values have remained constant between 20 to 25 mg/L.

Bottom of Escarpment Site #6

Reflective of the upper escarpment contribution, there has been a gradual decrease in pH since 1988. This decrease coincides with the decrease of alkalinity from 44 mg/L (1988) to a level of less than 15 mg/L (1994). Chloride values measured during rain events have been relatively constant since 1985. Suspended solids levels gradually decreased until 1989. Since 1989, suspended solids levels have increased to present levels of 40 mg/L. Iron levels have remained relatively constant over the years.

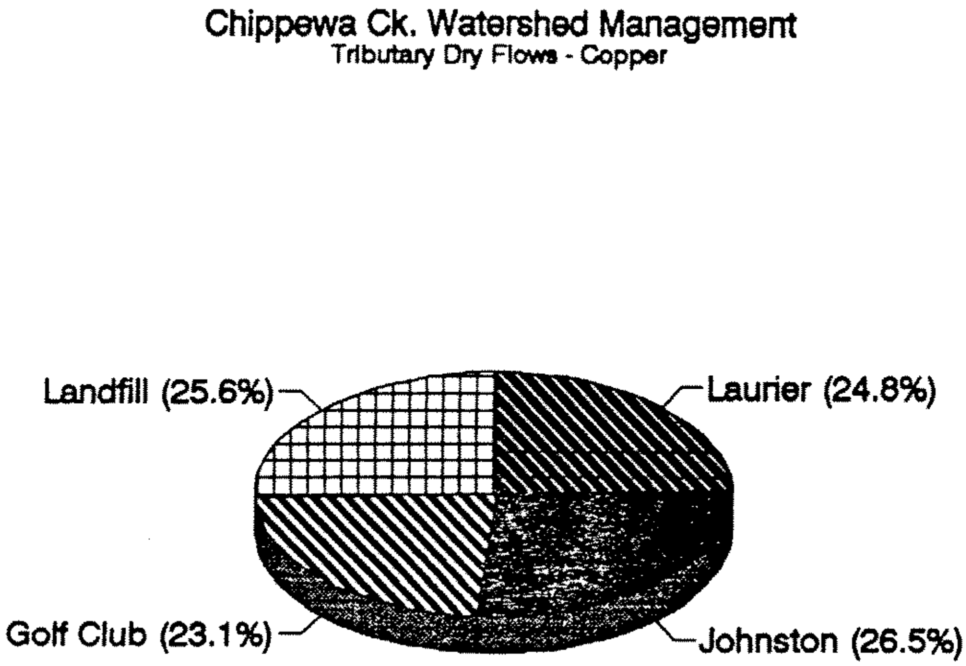


Figure 2.4.2

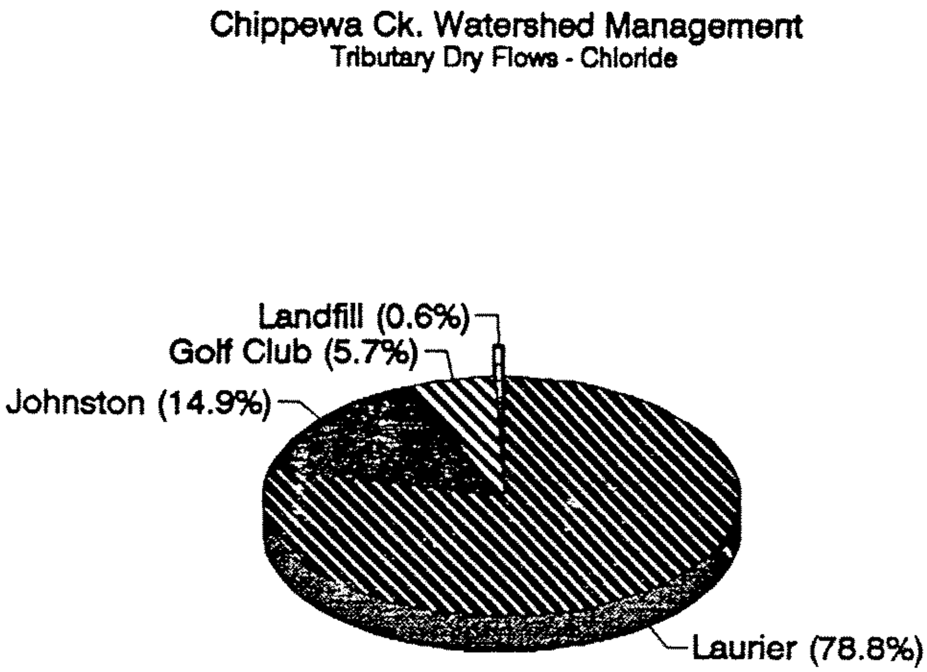


Figure 2.4.3

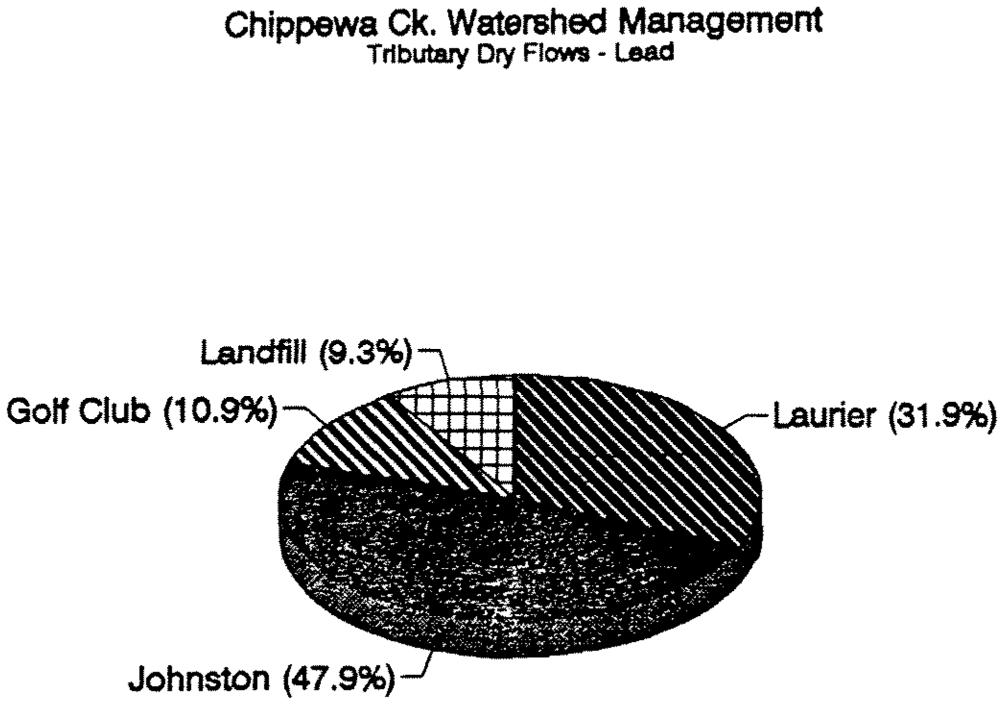


Figure 2.4.4

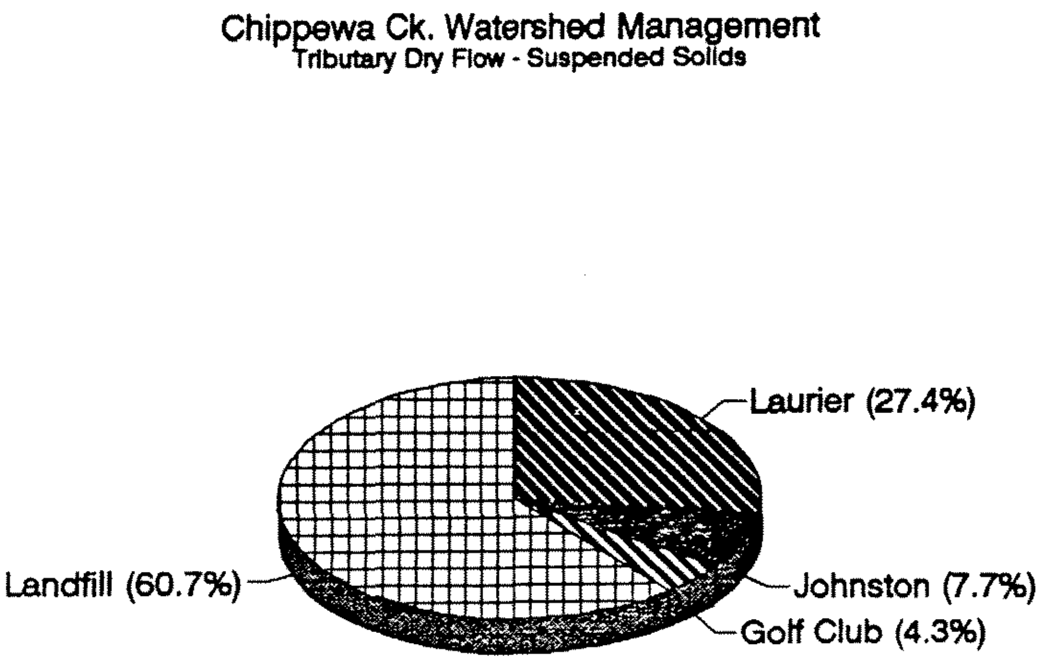


Figure 2.4.5

Mouth Site #1

There has been a gradual decrease in the pH value of water being contributed to Lake Nipissing from Chippewa Creek. This decrease coincides with the decrease of alkalinity from 40 mg/L (1988) to a level of 22 mg/L (1994). Chloride values measured during rain events have been decreasing with a slight increase in 1994. Suspended solids levels have been gradually decreasing since 1985 with the exception of 1991. Iron levels have remained relatively constant over the years.

2.4.12 Contributions of Tributaries During Rain Events

Figures 2.4.6 to 2.4.10 provide a comparison of the 1994 loading into Chippewa Creek from each tributary during rain events. The following percentages are based on a single tributary's contribution divided by the total load of all tributaries. Please note, the flow rate variable for each tributary is not figured into this calculation. Laurier Woods tributary contributes the most significant levels of chlorides to Chippewa Creek (79%). Johnston Tributary contributes the most significant levels of lead (71%) and copper (60%). The Landfill Tributary contributes the most significant levels of suspended solids (72%).

2.4.13 Long Term Trends

Two water quality parameters were examined for extended long term trends. Data were obtained for fecal coliform levels from 1964 until 1989 (Table 2.4.4) and suspended solids from 1970 to 1994 (Table 2.4.5). At the mouth site, fecal coliform levels historically (Figure 2.4.11) were measured at levels excessive of 20,000 CFU/100ml. Since 1986, the coliform levels have dropped to levels of <8000 CFU/100ml at the mouth. This drop coincides with the implementation of the Chippewa Creek trunk sewer project (discussion with Proctor and Redfern, North Bay). Five year means of suspended solids (Figure 2.4.12) indicate a rapid decrease in concentration levels in the late seventies. The reason for this rapid decrease has not

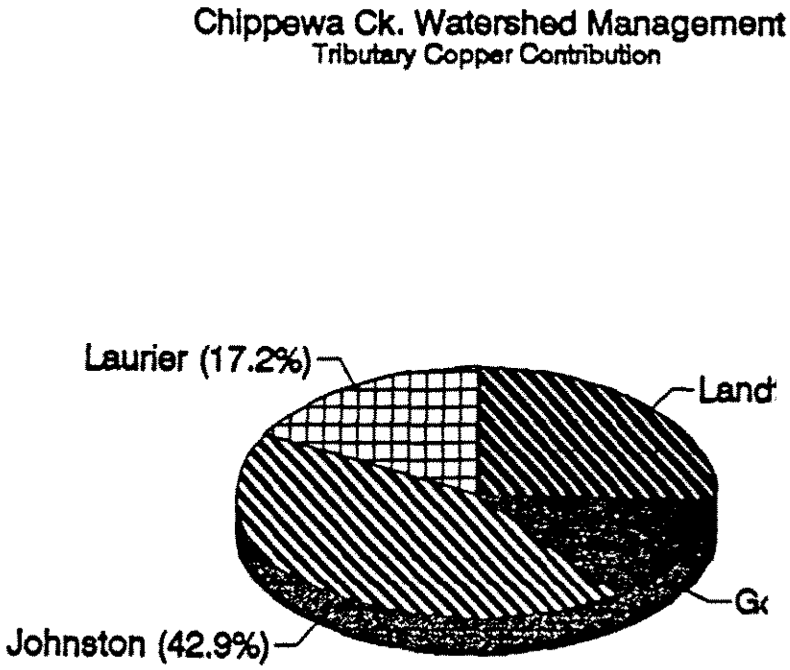
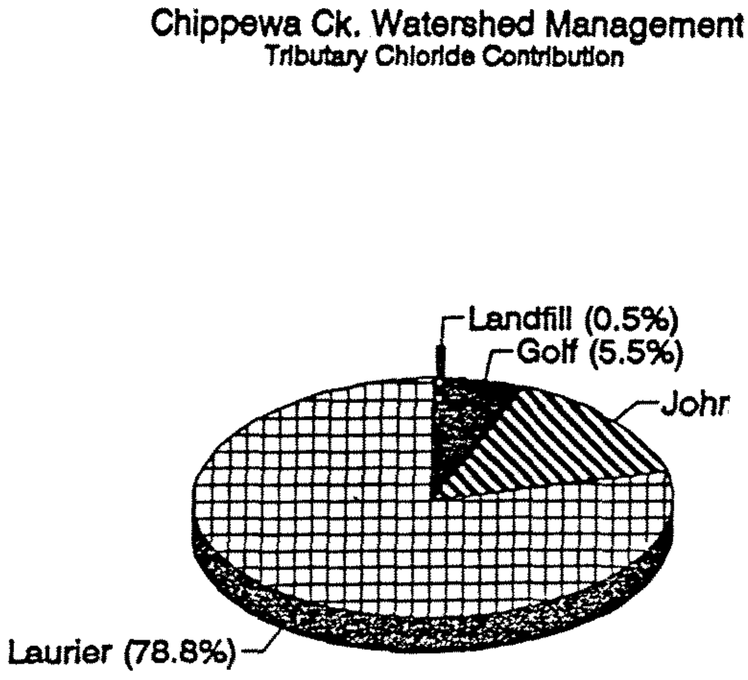


Figure 2.4.6



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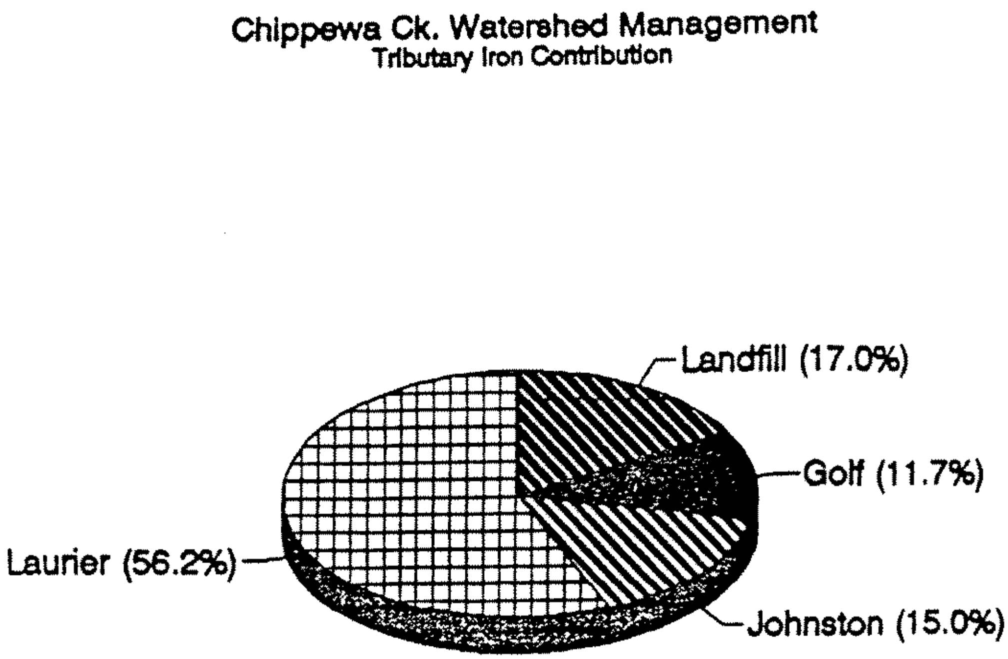

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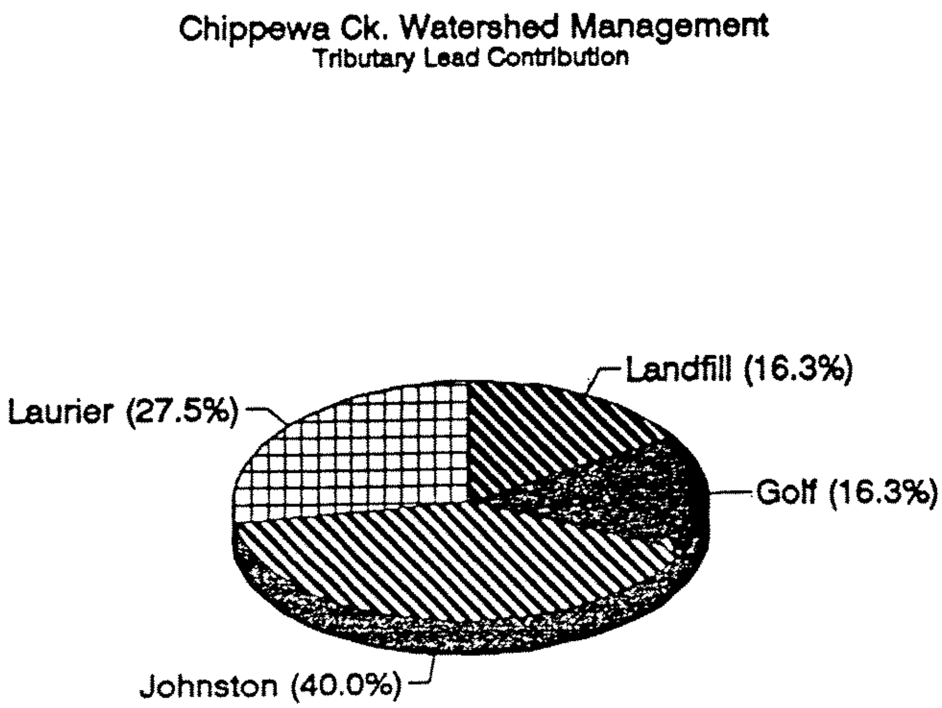


Figure 2.4.9

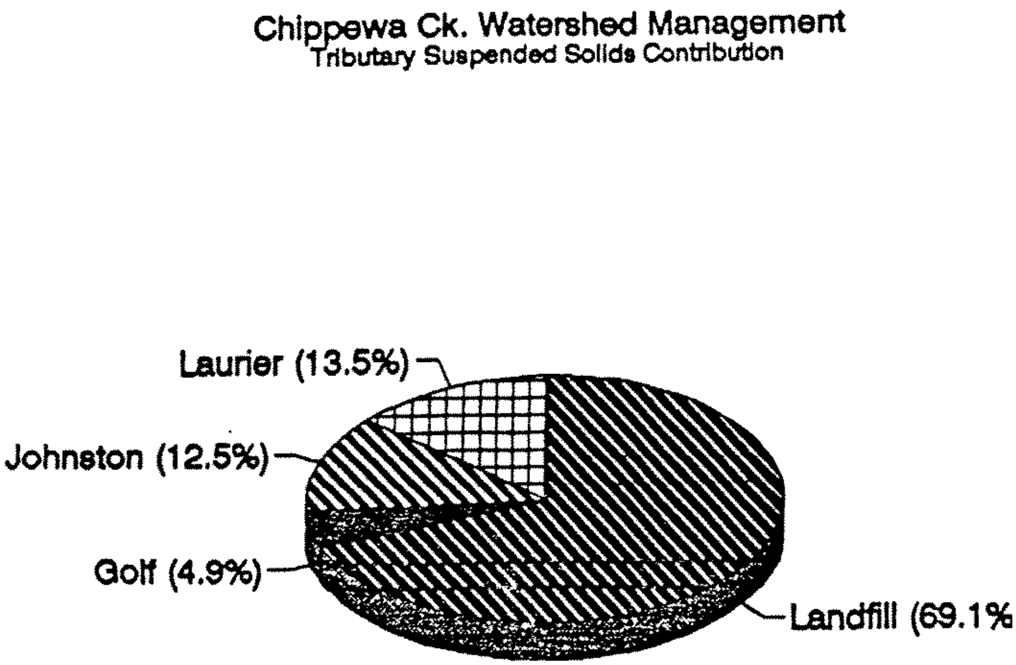
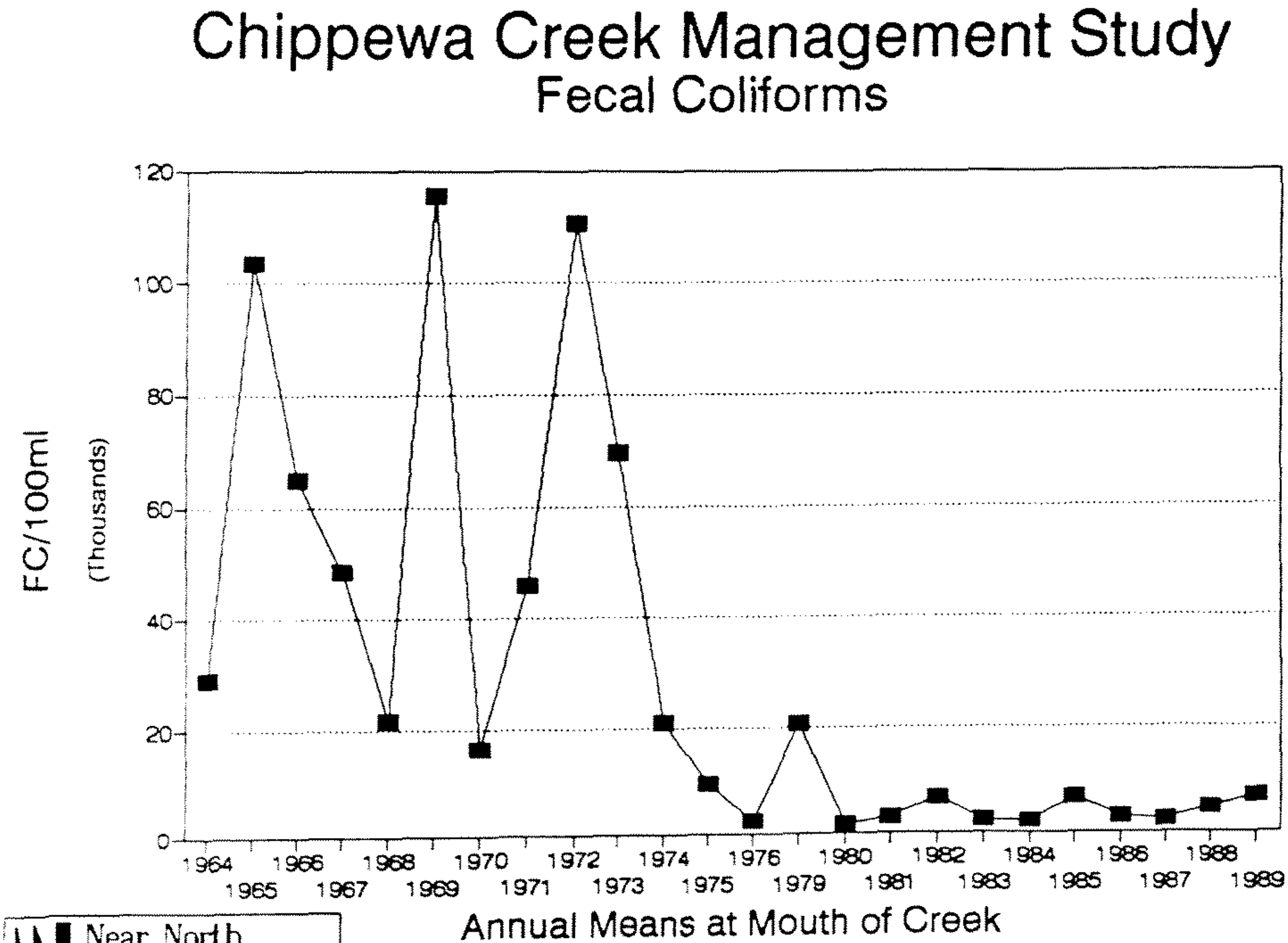

Chippewa Ck. Watershed Management
Tributary Suspended Solids Contribution
Laurier (13.5%)
Johnston (12.5%)
Golf (4.9%)
Landfill (69.1%

Figure 2.4.10

Table 2.4.4

Chippewa Creek Management Study
Fecal Coliform Annual Means at Mouth of Creek
Conducted By: North Bay District Health Unit
Compiled By: Near North Laboratories, 1995

Year	FC/100ml	Year	FC/100ml
1964	29118	1976	2718
1965	103523	1979	20868
1966	64682	1980	1899
1967	48666	1981	3158
1968	21894	1982	6869
1969	115485	1983	2767
1970	16434	1984	2044
1971	46056	1985	6992
1972	110512	1986	3111
1973	69450	1987	2752
1974	21022	1988	4853
1975	9812	1989	7166



Near North Laboratories Inc.

Figure 2.4.11

Table 2.4.5

Chippewa Creek Management Study
Suspended Solids Annual Means at Mouth of Creek
Compiled By: Near North Laboratories, 1995

Year	Mean mg/L	No. of Samples	Maximum Level	Minimum Level
1970-74	38	28	500	5
1975-79	22	43	145	2
1980-84	23	51	276	2
1985-89	11	41	69	1
1990-94	20	18	123	0

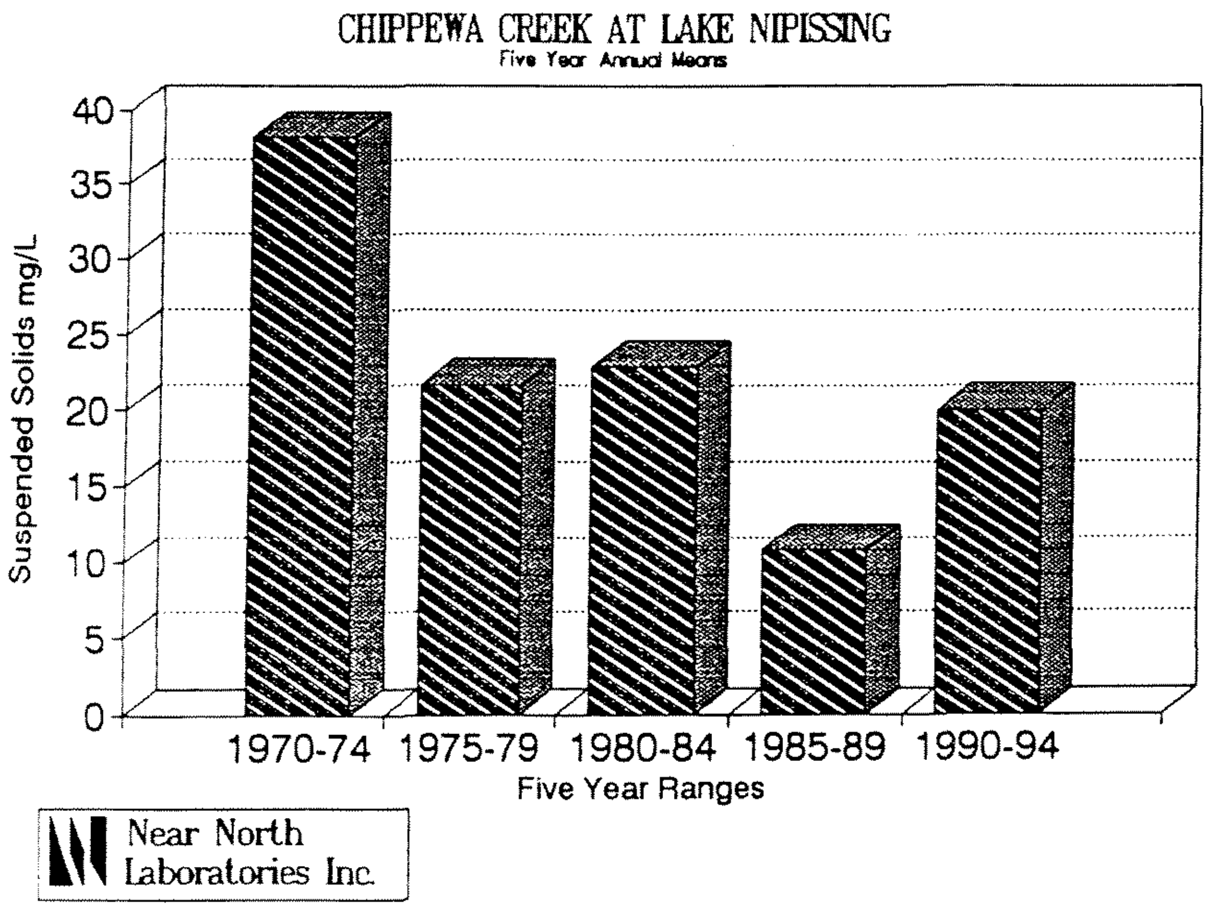


Figure 2.4.12

been determined. Since the seventies, levels have continued to decrease slowly (with exception of the late 1980s). Appendix E provides detailed water quality information on sampling sites, historical data, dry flow and rain event graphs and responses to Steering/Public Committee questions.

2.4.14 Opportunities and Constraints

Upper Watershed

The upper portion of the Chippewa Creek Watershed is mainly undeveloped. This provides the opportunity to protect the water quality and in turn the ecological resources associated with good water quality.

The landfill tributary water quality data indicates high suspended solids levels during rain events. This is mainly due to erosion occurring along the banks of this tributary. Through projects such as bank stabilization, the level of suspended solids can be reduced.

An evident restraint in the upper watershed is the low buffering capacity against heavy metals. As heavy metals are typically associated with urban run-off, the upper portion of the watershed will be very sensitive to future urban development. The historical water quality data indicate an increasing trend of heavy metal concentrations from the edge of the escarpment. A probable source of these metals is the Airport Hill subdivision area. Future subdivisions around Airport Road, without some means of alleviating urban run-off impacts, will further compromise the water quality on the lower portion of the watershed.

Lower Watershed

A significant impact on the lower watershed is the Eastview/Johnston Tributary. Levels of heavy metals are relatively higher from this tributary than the levels measured in other areas of the watershed.

Many areas along the lower portion of the creek are designated flood plains. In reference to the bacteria loadings, these flood plain areas can support additional vegetation whereby maintaining greater uptake of run-off and cooler water temperatures. The cooler temperatures will facilitate a greater die-off rate of the bacteria present.

2.5 Ecological Resources

The Chippewa Creek watershed contains a variety of ecological resources including a coldwater brook trout fishery, five evaluated wetlands (one Provincially Significant), a warmwater fish community and relatively extensive forest cover with representative tree associations from two Forest Sections. Furthermore, although not entirely within the study area, the local area supports a diverse wildlife community of herpetofaunal, mammals and birds many of which live or migrate through the Chippewa Creek Watershed.

The following sections present an overview of the ecological resources within the Chippewa Creek Watershed and the accompanying appendices provide further details and supporting studies related to those resources.

2.5.1 Fisheries and Aquatic Habitats

The North Bay District Fisheries Management Plan (OMNR, 1988) describes Chippewa Creek as a coldwater stream. Recent studies indicate that Chippewa Creek contains a healthy and diverse fish community, supporting coldwater brook trout in the upperwatershed and a warmwater fishery below the escarpment. These designations are further substantiated by the recent fish community surveys summarized below.

2.5.1.1 Upper Watershed

In the summer of 1991, Stephen Belfry (OMNR) electroshocked seven stations between Chippewa Creek's headwaters and O'Brien Road crossing. A total of 19 brook trout (*Salvelinus fontinalis*), some measuring up to 26 cm in length, were recovered from three of his upstream stations and suitable spawning beds were observed south of the highway 11 bridge (Figure 2.5-1; see Appendix F-4). Furthermore, Belfry's findings indicated a host of cyprinids and other small fish at all sample locations.

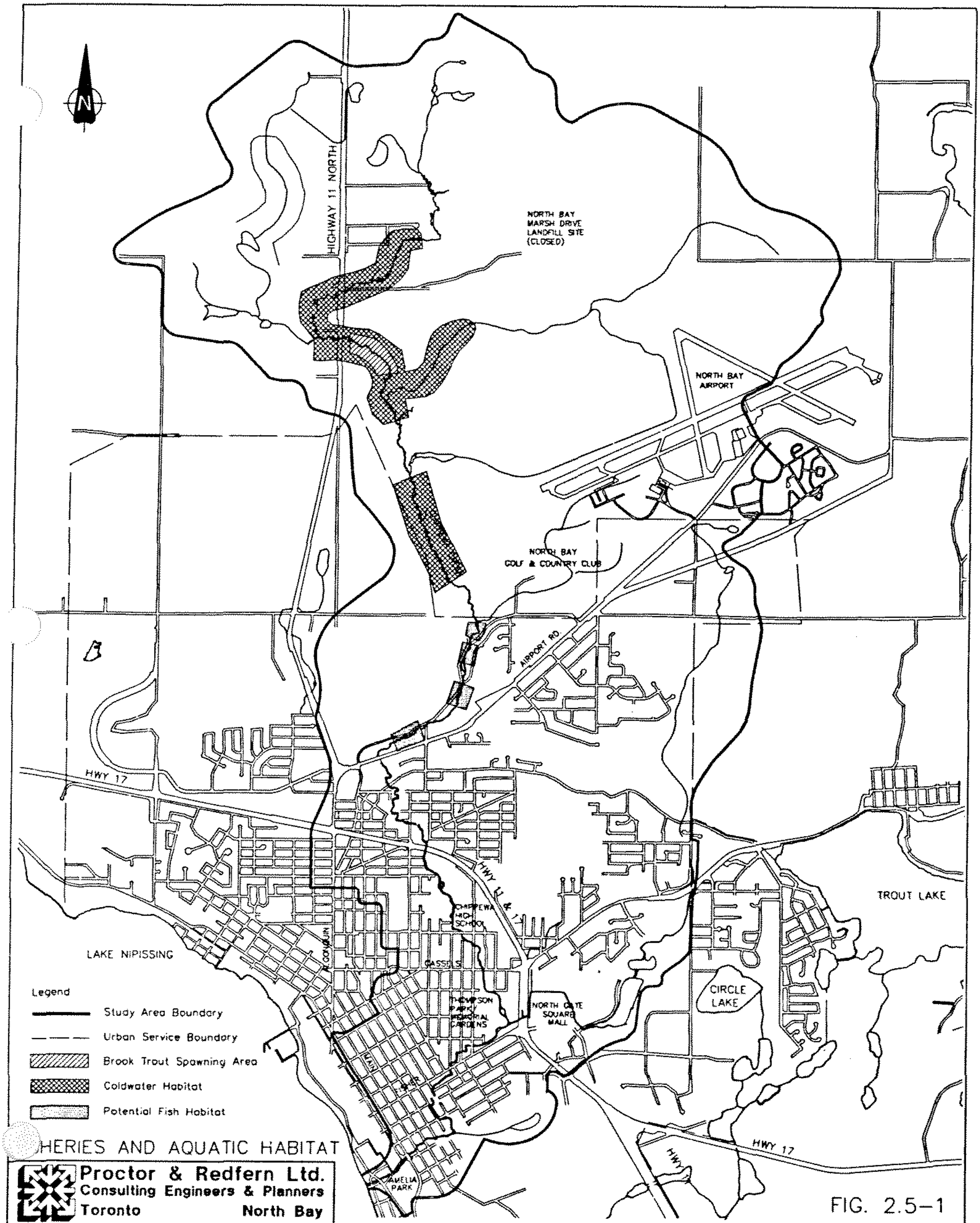
TransCanada Pipelines hired Beak Consultants Limited (BEAK) in November 1991 and 1993 to conduct a fish survey along the headwater tributaries of Chippewa Creek. The fisheries habitat in the extreme headwater channels along the western tributary was considered to be poor to non-existent due to anthropogenic activities and negligible stream flow.

South of these channels the western tributary flows through a series of beaver ponds and resultant wetland habitat. Although some fish were observed, along this reach the fisheries habitat is rated as low due to low base flow and beaver activity.

The eastern tributary, which traverses the North Bay Marsh Drive Landfill upstream of Highway No. 11, is described as a narrow relatively shallow channel and is reported to contain fair fish habitat. However, in 1993 Beak recovered brook trout from three stations in the vicinity of the TransCanada Pipeline (see Appendix F-4), along this eastern tributary which suggests that this channel provides good coldwater fish habitat.

During the summer of 1994, the North Bay-Mattawa Conservation Authority (NBMCA) undertook an aquatic habitat inventory of Chippewa Creek. Working along much of the main channel including the lower watershed, the study involved aquatic habitat mapping and max/min water temperature investigations. The report is included in Appendix F-1.

Among the study findings are the identification and location of erosion prone areas, reaches of high quality fish habitat (Figure 2.5-1) and inlets such as storm sewer outfalls, small tributaries and bank seepage/spring areas. Much of the information is presented on a series of maps which provide information for establishing state of the watershed/baseline data against which future changes can be assessed.



…HERIES AND AQUATIC HABITAT

FIG. 2.5–1

Similar to other studies, the Conservation Authority's findings indicate that the areas upstream of O'Brien Street contain the most potential for cold water fish habitat. Although fall spawning surveys were not conducted, suitable gravel areas and groundwater sources such as springs were found with increasing frequency on the main channel upstream of airport road. This suggests that brook trout spawning areas may exist in these reaches in addition to the areas south of the Highway 11 bridge.

Despite these encouraging results, the water temperatures in the upper reaches of the main channel immediately, east of the Highway 11 crossing indicate that the critical summer maximum for coldwater fish species is exceeded. This is probably due to thermal heating in the beaver ponds located immediately upstream of this station on the western tributaries.

Finally, during the same period of time as the Conservation Authority study (summer, 1994) the OMNR undertook an intensive electrofishing survey along the escarpment influenced reaches of Chippewa Creek. Brook trout were recovered at two of Belfry's 1991 stations and along the northern most tributary draining the airport lands (see Appendix F-4).

Along with brook trout, the surveys have recovered the following 15 species of fish in the upper watershed of Chippewa Creek: Brook stickleback (*Culaea inconstans*), creek chub (*Semotilus atromaculatus*), fathead minnow (*Pimephales promelas*), redbelly dace (*Phoxinus eos*), white sucker (*Catostomus commersoni*), central mud minnow (*Umbra limi*), blacknose dace (*Rhinichthys atratulus*), long nosedace (*R. cataractae*), logperch (*Percina caprodes*), pearl dace (*Margariscus margarita*), mottled sculpin (*Cottus bairdi*), emerald shiner (*Notropis atherinoides*), sand shiner (*Notropis stramineus*), Iowa darter (*Etheostoma exile*) and redside dace (*Clinostomus elongatus*).

These findings are not surprising since nearly fifty fish species including about six important types of sport fish inhabit local waters in the NBMCA area.

Some of the fish species recovered are representative of cool, clear running streams and their presence therefore indicates the presence of suitable good quality coldwater fish habitat.

One species in particular, the redside dace reportedly captured by Belfry (1991), is a significant species. According to a recent (1991) Royal Ontario Museum publication, redside dace (*Clinostomus elongatus*) is listed as vulnerable being limited in Canada to a more southern range along the western portion of Lake Ontario's watersheds and that of northern Lake Erie.

2.5.1.2 Lower Watershed

The area of Chippewa Creek below the escarpment is known to support a warmwater fish community. This habitat differs from the upper watershed and the escarpment area of Chippewa Creek by possessing reduced gradients/velocities, reduced riparian cover, a higher width to depth ratio (which all increase the potential for solar heating) and increased temperatures from imperious surface run-off.

As most of the recent electrofishing surveys have concentrated in the more pristine habitat areas above the escarpment, little information exists about the fish community south of O'Brien Road on Chippewa Creek. None-the-less, the two electrofishing investigations conducted in the lower watershed indicate that a variety of fish species inhabitat these waters.

The 1993 study conducted by Beak Consultants Limited on behalf of TransCanada Pipelines sampled Chippewa Creek near Lake Nipissing, upstream of Memorial Drive. Although only 26 fish were captured, six species were identified, including white suckers, emerald shiner, sand shiner, blacknose dace, creek chub and mettled sculpin. The second investigation conducted along the lower watershed was undertaken by the OMNR over the past two years. The inventories, part of the NBMCA's Chippewa Creek Flood and Erosion Control Project, were conducted at Chippewa Creek Secondary School and at the Hammond Street Bridge. This study revealed encouraging results with respect to rehabilitation efforts. The June 1994 collection at the Secondary School recovered only five species and had a community estimate of 612 while the August 1995 collection at the same site recovered 14 species resulting in a community estimate of 1014.

Although the majority of fish were captured in August 1995, the 19 fish species recovered indicate that a diverse warmwater community exists in the Lower Chippewa Creek Watershed.

In summary, the findings reveal that the habitat in the upper portion of Chippewa Creek supports a diverse coldwater fish community which includes brook trout, an important sport fish and the relatively wider and shallower reaches in the lower watershed supports a warmwater fish community including a host of minnows and other forage fish.

2.5.2 Aquatic Benthic Invertebrate Community

In order to provide supplemental information and data regarding the quality of aquatic habitats in Chippewa Creek, a survey of aquatic benthic invertebrates was conducted at seven (7) locations along the creek (Appendix F-2). The rationale for sampling aquatic invertebrates is that the species composition and the presence, or absence of specific organisms can provide an indication of long-term surface water quality, and, consequently, habitat quality.

Aquatic benthic invertebrates are defined here as those invertebrates (organisms without a backbone) that are found to inhabit the bottom substrate, and, or are living on plants attached to the bottom substrate within a watercourse or waterbody. Typical aquatic benthic invertebrates include worms, molluscs, insect larvae, crayfish, etc.

Appendix F-2 describes the methodology and results of the aquatic benthic invertebrate survey. Aquatic invertebrate community metrics calculated from results of the survey were compared for differences between sampling locations. Table 2.5-1 provides a summary of the aquatic benthic invertebrate community metrics for each of the sampling locations.

Table 2.5-1
Chippewa Creek
Aquatic Benthic Invertebrate Community Metrics

Parameter*	BS-1	BS-3	BS-4	BS-5	BS-6	BS-7
Total Invertebrates	20	32	14	126	14	29
Species Richness	7	9	3	17	8	12
EPT value	1	8	0	3	1	4
Hilsenhoff Biotic Index	4.5	4.0	7.9	8.0	7.1	6.5
Water Quality	very good	very good	poor	poor	fairly poor	fair

* Data from each of the stations was assessed based on the total number of invertebrates found, the total number of species (species richness), the presence of "clean-water" invertebrates (EPT value), and the Hilsenhoff Biotic Index. The Hilsenhoff Biotic Index (HBI) provides a measure of the presence of pollution-tolerant species present at a location.

The Total Number of Invertebrates per sample replicate indicate that most locations in the watershed have a relatively low density of aquatic invertebrates. The highest density of invertebrates can be found in the lower portion of the watershed, in the Johnston's Creek tributary. The data for species richness also indicates that the greatest number of species may be found in Johnston's Creek. Those species found at the Johnston's Creek tributary are, however, primarily indicators of degraded water quality. The higher total invertebrates and species richness is likely due to poor water quality and absence of competition from less tolerant invertebrate species.

Generally, Hilsenhoff Biotic Index values indicate "very good" water quality in the upper-watershed, and "poor" to "fairly poor" water quality in the lower watershed. While the water quality in the upper watershed appears to be very good, based on indicator species presence, the low numbers of organisms indicate that other habitat characteristics may be limiting the invertebrate communities in Chippewa Creek. Specific habitat features that may be restricting invertebrate communities in the creek may include substrate quality, and food supply (phtyoplankton, micro-organisms, etc.).

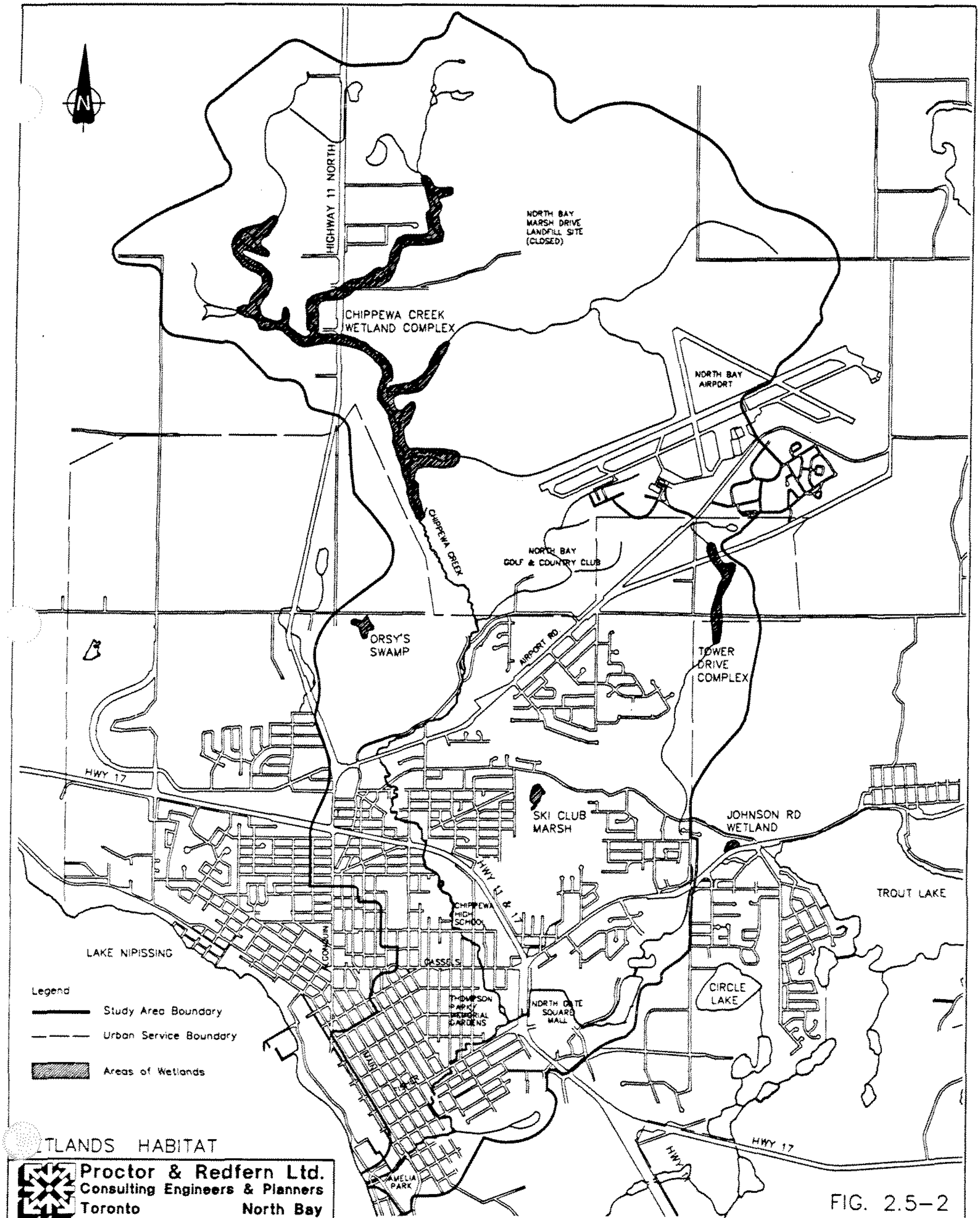
The results found in this study are consistent with those of studies conducted at the Marsh Drive Landfill site (Gartner Lee, 1993). Invertebrate surveys conducted along the Marsh Drive tributary of Chippewa Creek also revealed low benthic invertebrate numbers. The low densities were attributed to the sandy substrates in that portion of Chippewa Creek. Furthermore, despite the proximity of the Marsh Drive Landfill site, surveys found indication of very good to excellent water quality along the tributary.

2.5.3 Wetlands

In 1993, the Ministry of Natural Resources, in conjunction with the North Bay-Mattawa Conservation Authority, completed wetland evaluations on a significant portion of the City of North Bay. All identified wetlands were evaluated according to the Ontario Wetlands Evaluation System-Northern Manual, March 1993.

A total of five (5) identified wetlands are located within the Chippewa Creek watershed. These wetlands are within the Great Lakes-St.. Lawrence region. Figure 2.5-2 shows the locations of each of the wetlands identified and evaluated for the Chippewa Creek watershed.

The evaluated wetlands areas within the Chippewa Creek watershed are further described in the Table 2.5-2. Summary Scoring Sheets for the wetlands evaluated in the Chippewa Creek Watershed are presented in Appendix F-3.



…TLANDS HABITAT

FIG. 2.5–2

Table 2.5-2
Chippewa Creek Watershed Wetlands

Wetland	Provincially Significant	Size	Description
Upper Chippewa Creek Wetland Complex	Yes	156 hectares	13 individual wetlands; bog, fen swamp and marsh wetlands present. Majority of area of wetland is swamps and marshes. Dominant vegetation; narrow leaved emergents, tall shrubs and coniferous trees
Orsy's Swamp	No	4.1 hectares	Swamp wetland with dominant vegetation species; dead deciduous trees and tall shrubs. Land recently acquired by local developer.
Tower Drive Wetland Complex	No	10.98 hectares	Wetland 100% permanent or intermittent flow. Dominant vegetation species; coniferous trees and narrow leaved emergent.
Ski Club Marsh	No	13.3 hectares	Swamp and marsh wetland within built-up area of city. Dominant vegetation; emergents, free floating plants, dead conifers, tall shrubs, and mosses. Wetland is under development, ditching, vegetation removed, filling and the breaking of beaver dams.
Johnston Road Wetland	No	5.9 hectares	Swamp and marsh wetland. Majority of vegetation is tall shrubs and robust emergents.

The Ministry of Natural Resources has evaluated the Upper Chippewa Creek Wetland complex as as a provincially significant wetland. The City of North Bay has undertaken a review of this evaluation.

2.5.4 Terrestrial Wildlife

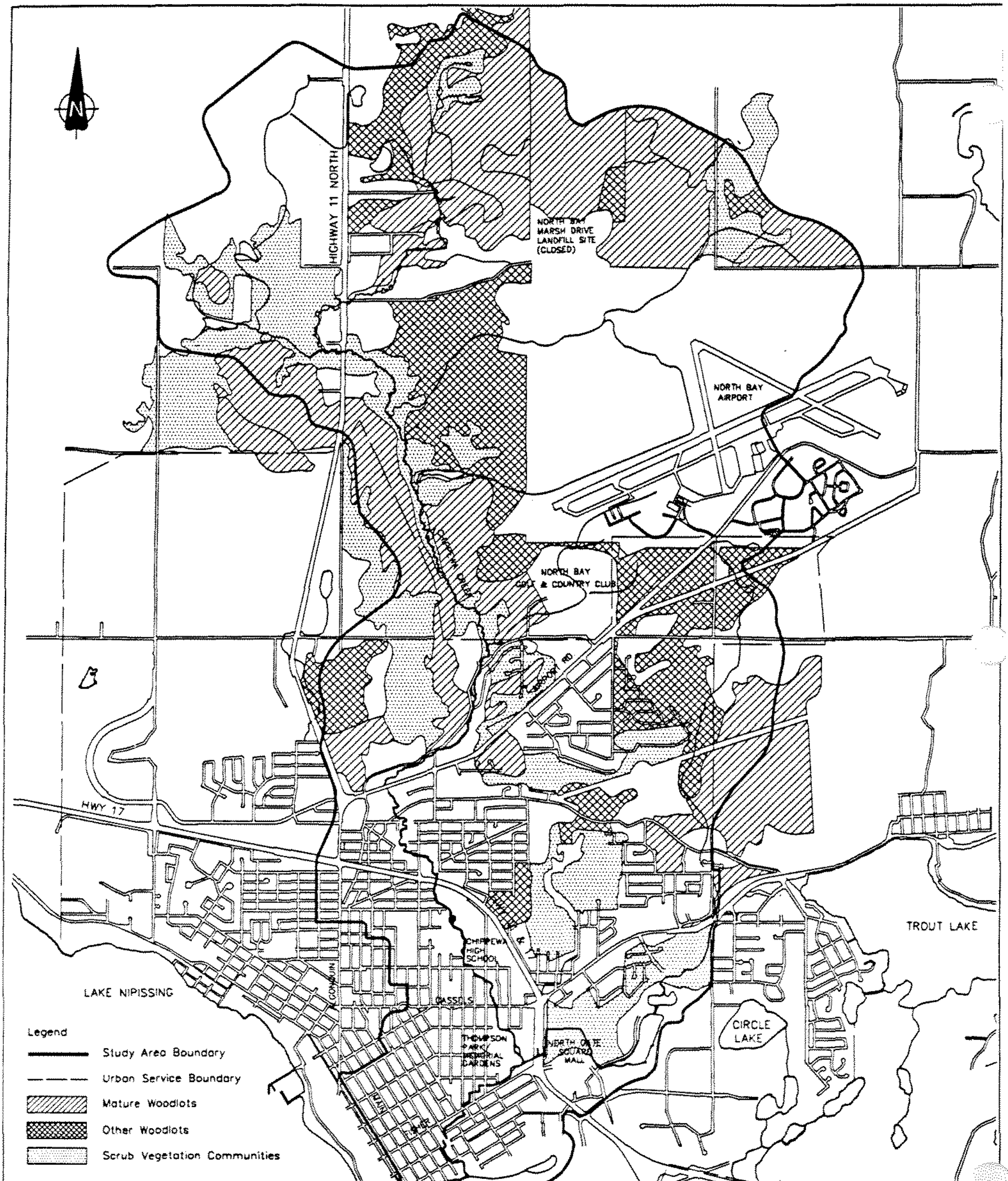
The North Bay-Mattawa Area supports a diverse wildlife community including about 28 reptile species, 209 avian (bird) species and 41 mammals which live within or migrate through the local area. Given the variety of different habitats within the Conservation Authority's jurisdiction, it is likely that many of the above species could be found in the Chippewa Creek Watershed. Due to the concentration of urbanization below the escarpment, the majority of wildlife species are likely to be found in the upper watershed areas. However the occasional deer, moose or black bear has been reported to have wandered into the city by accident.

There are no known vulnerable, threatened or endangered species of wildlife within the Chippewa Creek watershed nor has the MNR identified any specific sensitive nesting areas for birds. However, the watershed provides habitat for important game birds such as the black duck, wood duck, ring-necked duck, mallards, ruffed grouse and woodcock although hunting is not permitted due to the close proximity of the city.

Similarly, trapping activity is low and restricted mainly to removing beavers along the upper reaches of the creek to protect against flooding.

2.5.5 Woodlots/Forested Areas

The Chippewa Creek Watershed falls within the northern part of the Great Lakes\St. Lawrence Forest Region in a transitional zone south of the Boreal Forest Region. This zone typically produces a mix of coniferous and deciduous trees (Figure 2.5-3). The dominant tree species below the escarpment are the White Pine and the Manitoba Maple. Other trees species found in the lowland include the Red Maple, White Spruce, White Cedar, Yellow Birch and White Birch. The Eastern Cottonwood, Butternut and Crab Apple have been introduced through landscaping. Though many varieties of trees exist below the escarpment, the area is for the most part grass covered.



FOREST RESOURCES

FIG. 2.5-3

Wooded areas dominate above the escarpment, although there is an increasing amount of urban influence. A mix of coniferous and deciduous trees exist, including the Mountain Maple, White Birch, Black Ash, Choke Cherry, Pin Cherry, Speckled Alder, Trembling Aspen, White Cedar, White Elm, Yellow Birch, Black Willow, Pussy Willow, White Spruce, Balsam Hemlock, Larch, Jack Pine and White Pine (Rees, 1981). Forested areas combine with tall grasses, sedges, ferns and small shrubs. Wetland areas exist as well, with various grasses, reeds, cattails and pondweeds present. In addition to the vegetation found, there are many barren areas within the watershed. These are caused by either bedrock outcrops, erosion or form the existence of aggregate pits. The landfill site occupies a large, formerly forested region. Because the area is rich in aggregate deposits, many extraction pits have been created. Other human influences have been the pipeline, the North Bay Golf and Country Club and the airport.

The Canada land Inventory map rates the land capability for forestry in the watershed as a combination of Class 3, Class 4 and Class 5. Subclasses of low fertility, moisture deficiency, shallowness of soil to bedrock and excess water are also identified. Major tree types are defined as Eastern White Pine, White Spruce, Red Pine and Hard Maple.

2.6 Archaeology

2.6.1 Introduction

The Chippewa Creek watershed lies within the CbGu Borden Block. Although the archaeological data base search revealed that there had been no sites previously recorded within the Chippewa Creek study area, a total of eleven sites have been recorded in the Provincial Sites Database in the general vicinity of the Chippewa Creek Watershed (see Table 2.6-1).

Except for the previous Parks Creek Study (Settlement Surveys: 1992), and work by Tyyska and Burns (1973) plus a brief survey by Phil Wright in 1980 (Wright and Saunders, 1980) no previous archaeological work has been undertaken in the North Bay City area and none specifically in the Chippewa Creek basin.

Table 2.6-1

Distribution and Description of Known Archaeological Sites in the Study Area

Site Borden #	Site Name	Type & Description
CbGu-1	La Vase North Bank Site, at Champlain Park, La Vase River Mouth	Find spot recorded by J.V. Wright, 1961
CbGu-2	Palferman Site, Dugas Bay, Trout Lake	Rock structure, recorded by Allan Tyyska, 1972
CbGu-3	Palferman 2 sites	Stone construction, recorded by Allan Tyyska, 1972
CbGu-4	La Vase Park Site	Historic building complex with prehistoric component may be early settler's (pre-1880) or perhaps Fort Laronde, recorded by J. Pollock and Peter Bullock 1991.
CbGu-5	La Vase Island Site	Historic and prehistoric site near what is now an island at the mouth of the La Vase River. Site underwater during most of year. Could represent the original Ft. Laronde Site recorded by J. Pollock and Peter Bullock 1992.
CbGu-6	Parks Creek Site 1	Prehistoric site on Parks Creek
CbGu-7	Parks Creek Site 2	Prehistoric site on Parks Creek
CbGu-8	Parks Creek Site 3	Prehistoric site on Parks Creek
CbGu-9	Parks Creek Site 4	Prehistoric site on Parks Creek
CbGu-10	La Vase River Portage	Historic portage landing south end
CbGu-11	La Vase River Portage	Fur trade dam site, north end of portage

2.6.2 Prehistoric Site Distribution and Settlement Patterns

There has not been enough archaeological work undertaken on Lake Nipissing and the North Bay area to comment on any distinctive settlement patterns. However, it does appear that there was significant use and occupation of the area (i.e. City of North Bay Municipal Area) including the islands and shoreline of Lake Nipissing and the mouths and shorelines of tributary creeks and Rivers such as Parks Creek and Duchesnay Creek. Sites vary in age from prehistoric to historic with the possibility of locating very early prehistoric sites along the old former Glacial Lake Nipissing shorelines (Nipissing Phase of the Glacial Great Lakes). These uplifted shoreline features are present throughout the North Bay area and especially in the general vicinity of Highway 11 where the shoreline of Lake Nipissing used to be some five thousand years ago. Work by Peter Bullock (personal communication) has indicated that a major glacial lake outlet/spillway once drained east through Trout Lake from Lake Nipissing. Lake Nipissing at 5,000 years ago had an elevation of 212 metres dropping to 202 metres at 4,200 years ago and then to the present elevation of 185 m. The shoreline would have had lots of rocky bays and islands. It stretched roughly parallel to Highway 11. Several inland raised sandy beaches from the ancient lake are present in the Chippewa Creek basin. These ancient beaches are of archaeological site potential.

2.6.3 Research Plan and Methodology

At the initiation of the study it was not known what management alternatives such as stormwater control, creek corridor restoration or other opportunities would be forthcoming.

Due to the large size of the Chippewa Creek watershed basin a brief overview archaeological survey (not an intensive or comprehensive study such as that required for environmental impact assessment purposes) was undertaken in the fall of 1994 in order to identify areas of high site potential and to locate as many sites as possible within the project constraints.

The fall 1994 preliminary archaeological site assessment revealed that the entire lower reaches of Chippewa Creek had been completely disturbed by Urban development. However, it also demonstrated that there are undisturbed areas along Chippewa Creek and elsewhere in the watershed that either contain archaeological values or have potential to contain sites.

The 1994 Chippewa Creek field work located three cultural heritage sites within the study area boundary consisting of one prehistoric archaeological site on Delaney (Mud) Lake, an old sawmill site, and a prehistoric/historic winter portage/trail. Just outside of the study area another prehistoric site and an old cabin foundation site were located for a total of five sites. Although all the sites are described below, only the two prehistoric sites within the Chippewa Creek project study area have been completed documented in this report. All of the sites, however, have been registered in the Ministry of Culture Tourism and Recreations' Provincial Archaeological sites Data Base (as required by Heritage Act Regulations). Detailed site forms for all five sites can also be found in Appendix G, along with an artifact catalogue.

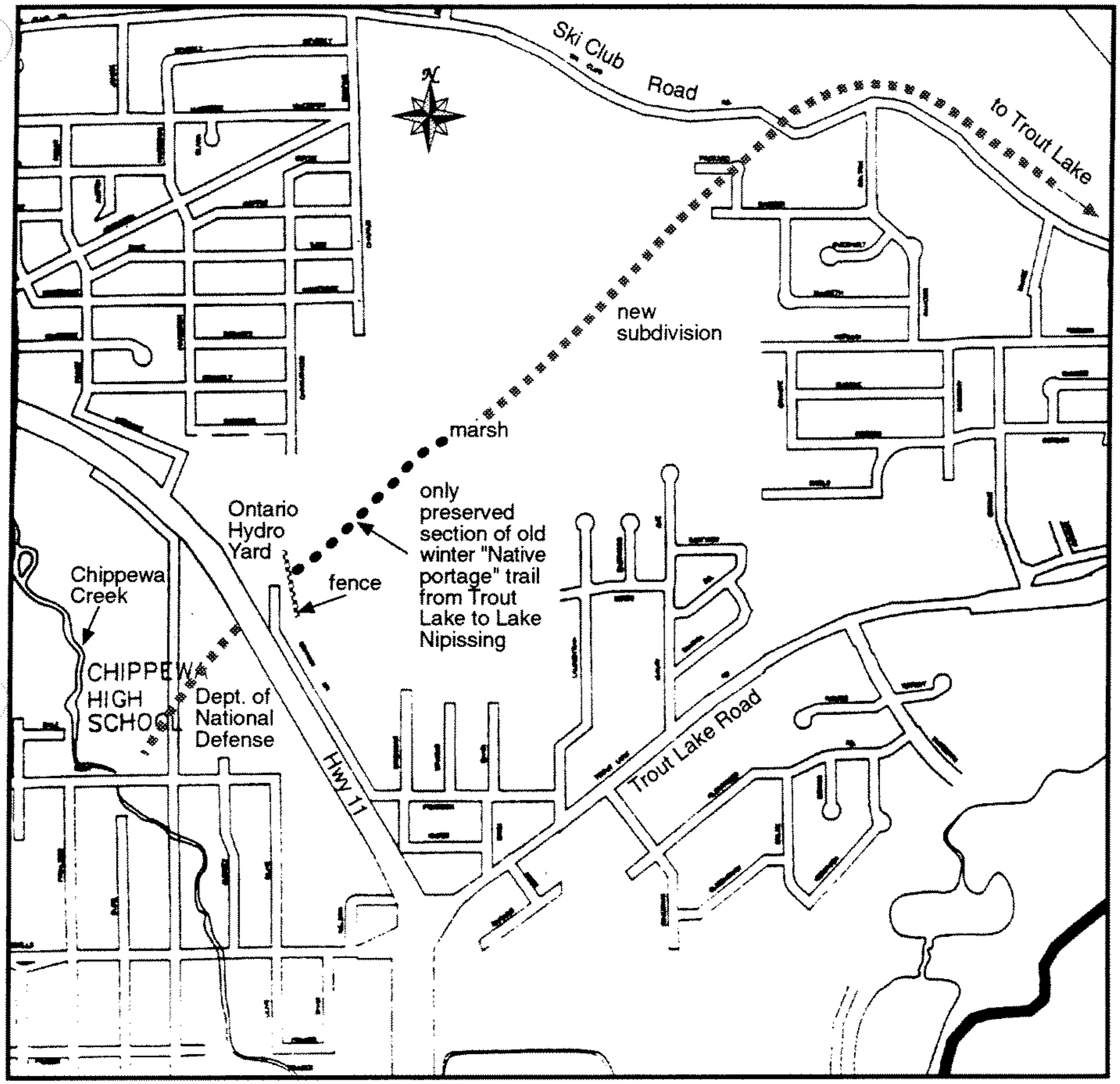
2.6.4 Study Results

Site One: Prehistoric/Historic Winter Portage/Trail

An area north (Figure 1) of the Trout Lake Road and East of the Ontario Hydro Yards contains the remnants of an ancient trail which may have served as a winter portage or overland walking trail (Figure 2) from Trout Lake to Chippewa Creek and Lake Nipissing. Anishnabek Peoples (Nipissings/Algokins) called these trails "bon-ka-nahing" (at the place of the winter trail).

Only a short remnant of about 250 metres remains of this trail which once ran all the way to Trout Lake. Fortunately part of the ancient "treadway" or path worn into the ground is preserved in this small section.

Artifacts recovered from test pits included: five pieces of densely burnt and melted rock, rusted bottle cap, and two pieces of white soft rock.



LEGEND

● ● ● ● ● Preserved winter trail / portage

⁂ ⁂ ⁂ ⁂ ⁂ Areas where trail has been destroyed by development

250m

Settlement Surveys Ltd.
P.O. Box 2529 • 17 Wellington St., North
New Liskeard, Ontario P0J 1P0
Tel: (705) 647-8833 • Fax: (705) 647-7026

Figure 1. Old Portage / Winter Trail

Figure 2.6-2

Photograph of Old Portage or Winter Trail Remnant from Trout Lake to Chippewa Creek

Site Two: Prehistoric Archaeological Site on Delaney (Mud) Lake

This site (Figure 3) is located at the extreme west end of Delaney Lake. It is situated on a flat rock outcrop that forms a small point. This location (Figure 4) would be ideal for landing birchbark canoes at a portage trail that went west along the creek which connected to Chippewa Creek in what is now Thompson Park.

Artifacts recovered from test pits included: two pieces of fire cracked rock, 2 chert flakes, a piece of white and a piece of lilac coloured glass, a large corroded and rust nail, a piece of carbonized wood and two pieces of white quartz.

Site Three: Prehistoric Site and Portage on McLean Lake

This site is located on the northwest end of McLean Lake at a portage landing area. The site is located in a low area next to a new subdivision. Numerous chert flakes were recovered from several test pits at a depth of 10 to 15 cm in a sandy subsoil. Total site area is unknown. The site warrants further testing.

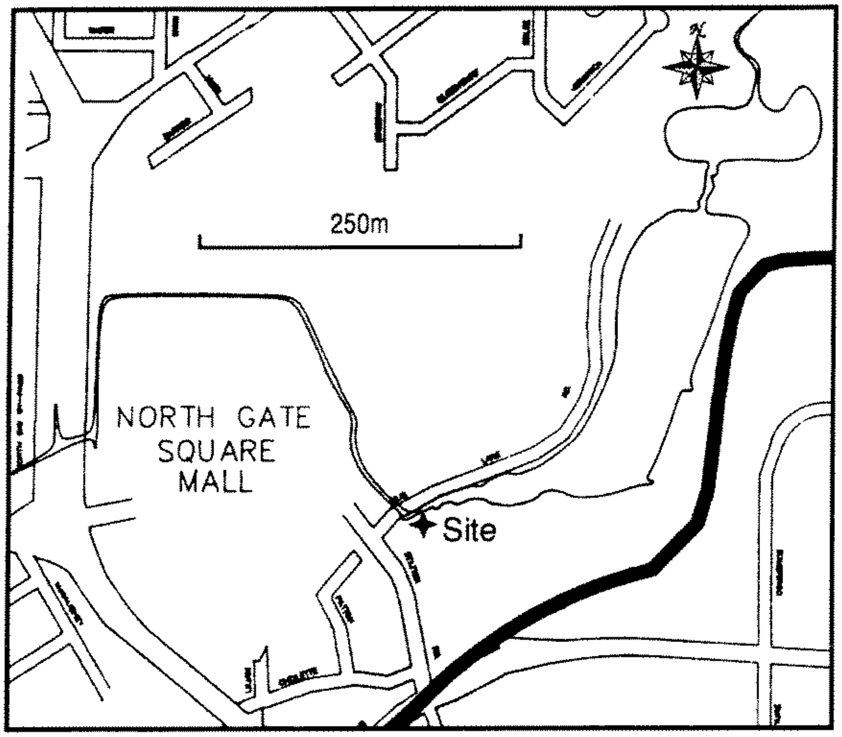
From the site area a portage trail which aboriginal people called "o-nig-um-ing" (summer canoe portage) travels north to Camelot Lake and then to Trout Lake.

Site Four: Sawmill Foundation on Delaney (Mud) Lake

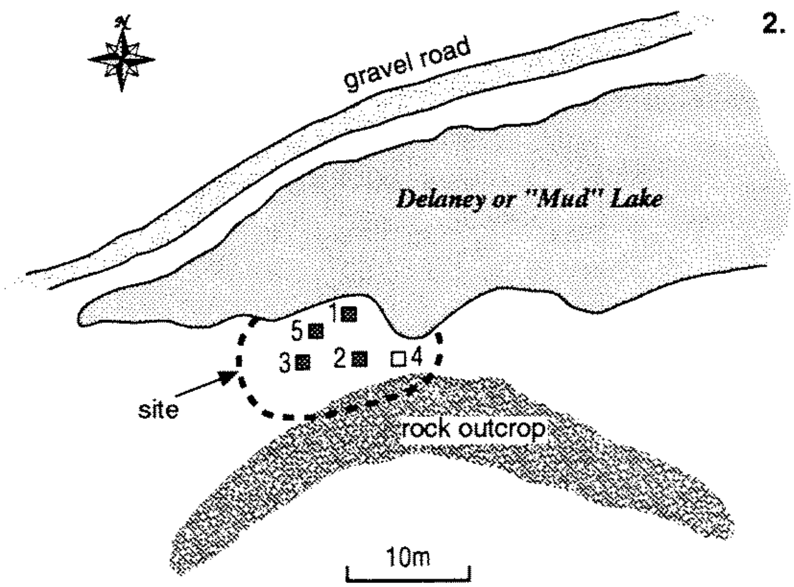
On the northwest shore of Delaney Lake there are remnants of an old sawmill including the foundations for a jackladder used to retrieve logs that were dumped in the lake. The ruins do not appear to be old, but further "local history" research would have to be undertaken to date and describe the site.

Prehistoric Archaeological Site

1. Site Location Map



2. Detailed Site Map



LEGEND

- Site datum point
- Positive test pit
- Negative test pit

Settlement Surveys Ltd.
P.O. Box 2529 • 17 Wellington St., North
New Liskeard, Ontario P0J 1P0
Tel: (705) 647-8833 • Fax: (705) 647-7026

Figure 3. Sketch map of Prehistoric Archaeological Site, Delaney Lake

Figure 2.6-4

Prehistoric Archaeological Site (Portage Landing) West End of Delaney (Mud) Lake

Site Five: Historic Cabin or Cache Site

On the lower east side of the narrows between the Twin Lakes is a low earthen mound representing the remains of a very small (1.5 to 2.0 m square) former log cabin or cache for storing food and/or supplies. Some limited subsurface testing did not produce any cultural material and further work would have to be done to date the site and define its location.

2.6.5 Conclusion

The limited 1994 Archaeological field work indicated that most of the high potential areas for archaeological sites within the Chippewa Creek Basin have already been severely distributed by urban development. This however, increases the importance of any sites that do remain such as the Delaney Lake prehistoric site, located close to the ONR Bus/Train Station, just east of Northgate Square.

The research strongly suggests that in prehistoric times there were a number of shorter portages and trails between Trout Lake and Lake Nipissing. Some of these were as follows:

1. An overland trail and winter route along or near Ski Club Road turning southwest at Packard Crescent towards Chippewa Creek (a small portion survives - see Site One of this study).

2. A water based route utilizing land portages through Delaney (Mud) Lake and Chippewa Creek (see Site Two of this study).

3. A water based route through Camelot - McLean - Twin Lakes - Passmore Lake - Parks Creek to Lake Nipissing. This was likely the major route in prehistoric times before the La Vase route was used by fur traders.

4. The Dugas Bay/La Vase River Route. This is the best known route which was used by the explorers and fur traders probably due to the fact they used larger canoes and portaged greater quantities of goods. This meant that the La Vase Route although longer was generally much flatter with slopes and rocky outcrops to traverse. Also the North West Company built at least three dams on the La Vase, one of which was maintained by an aboriginal caretaker as noted in Gordon Davidson's 1918 book on The North West Company:

> .... The North West Company kept up a dam near the level of the river (La Vase) which emptied into Lake Nipissing. An Indian was caretaker. This dam would help the canoes (Gordon 1918:211, footnote #52).

These dams were possibly the first ever built in Ontario and could date as early as 1784 when the North West Company first began trading via the Ottawa River route (Davidson 1918:210).

In summary then it seems that the Chippewa Creek watershed was primarily used in prehistoric times as a secondary travel route between Trout Lake and Lake Nipissing. No doubt there were many campsites and other sites within the watershed but these appear to have been largely destroyed by urban development.

2.7 Watershed Linkages and Interrelationships

The watershed ecosystem is a relatively discrete complex of physical, chemical, biological and cultural components all functionally linked. It is, therefore, important for management and planning purposes, that the creek valley, its channel, the water they convey, their associated floodplain, aquatic life, riparian vegetation, and humans not be viewed in isolation from one another.

The following section identifies the linkages and interactions between the various watershed components discussed in previous sections.

Chippewa Creek flows in a southerly direction, originating in the northern most area on a glacial outwash plain covered by sand and gravel. For the most part, the Chippewa Creek watershed and its topography, are strongly influenced by underlying bedrock. The most prevalent geological feature affecting the creek ecosystem is the escarpment ridge which bisects the watershed at an elevation over 70 meters above the more level urbanized portion of the City of North Bay. The physical division of the watershed, by the escarpment, into upper and lower sections has influenced drainage, local vegetation, aquatic life, water quality, etc. One of the most critical consequences of local geology is that the creek channel has remained relatively stable. Channel stability is further enhanced and maintained in the upper-watershed by riparian (stream-edge) vegetation.

The highest level of recharge and baseflow generation is in the headwater area where sand and gravel overburden provide high permeability to precipitation. Groundwater discharges to the creek channel appear to be localized within each of the tributary channels in the upper-watershed. The input of groundwater to the creek in the upper-watershed provides areas for cold water fish habitat. In fact, the greatest potential for cold water species, such as brook trout, is found in areas upstream of O'Brien Street, in the upper-watershed.

The local recharge and bedrock topography within the upper-watershed have provided conditions suitable to the growth of wetland vegetation along the channel. The result is a Provincially Significant Wetland Complex, the Upper Chippewa Creek Wetland, that is largely confined to a narrow riparian zone along the main channel and several tributaries in the upper-watershed. This complex of swamp, marsh, and bog vegetation provides excellent habitat for both game and non-game wildlife (black duck, wood duck, ruffed grouse, wood cock etc.). The corridor afforded by the wetland complex combined with adjacent wooded areas provides excellent potential for a diverse natural ecosystem in this area.

As with other resources, water quality within Chippewa Creek is affected by the bedrock geology and overburden soils. The upper-watershed is characterized as having low alkalinity, elevated iron levels, relatively low total suspended solids, and low heavy metal concentrations. The impact on aquatic life is reflected by the presence of bottom-dwelling organisms (benthic-invertebrates) that are typical of "clean" water environments. The overall composition of aquatic invertebrates in Chippewa Creek, however, is limited. This may, in part, be due to the lack of food supply organisms and instream vegetation.

Significant differences exist between the upper and lower sections of the watershed particularly with regard to erosion, sedimentation, flooding, ecological features and urbanization.

As the creek's water slows in the lower-watershed, suspended solids become deposited in the channel. This has, in some cases, lead to sedimentation problems in this portion of the watershed. In these lower sections, potential for flooding occurs in areas where urbanization has encroached on the floodplain.

As a result of the urbanization in the lower-watershed, the ecological resources in this area are very limited. Riparian vegetation in the lower reaches is mostly comprised of manicured lawns, Manitoba Maples and scrub vegetation in scattered clumps. While little information exists on the lower-watershed fish community, physical attributes and water quality conditions indicate limited potential for warm water fish.

Water quality within the lower-watershed show typical urban land use impacts. For example, heavy metals concentrations and bacteriological counts are significantly greater in the lower-watershed. The impact of elevated suspended solids and heavy metals from Johnston's Creek is noticeable by the presence of an invertebrate community dominated by species characteristic of "degraded-waters".

By the time the creek's waters reach the mouth at Lake Nipissing the creek will have drained 40 km^2. Approximately 25% of this area is presently urbanized and will increase to greater than 35% in the future.

3.0 OPPORTUNITIES AND CONSTRAINTS

The following sections identify the opportunities for, and constraints to development within the Chippewa Creek watershed with regards to a number of the watershed components.

3.1 Hydrogeology

In terms of the overall water balance and maintaining the Chippewa Creek baseflow runoff, the most sensitive area in the watershed is Area 1, within the headwater sands and gravels. This area has been fairly intensively developed in the past for gravel extraction; however, urbanization may result in lower levels of deep aquifer recharge and higher overland runoff, which will act to lower the available baseflow appearing in the creek. Area 3 is the least sensitive area in terms of affecting baseflow by development, since overland flow in this area is interpreted to be dominant. Area 4, while contributing 11% to 18% of baseflow, is already largely urbanized at this time, and may not likely be more intensely developed. Area 2 is partly developed and contributes a significant portion of water surplus recharge to baseflow. Development in this area should, therefore, consider the reduction in aquifer recharge (baseflow).

Once the overall planning constraints have been further established, the developed water balance model can be used to assess the effect of development and zoning proposals on the water budget, through a sensitivity analysis.

3.2 Fluvial Geomorphology

There are only a few limited opportunities and constraints with respect to the geomorphology of Chippewa Creek. This is due primarily to the many interrelationships between other study disciplines and fluvial geomorphology. As well there are no policies or legislation which specifically deals with fluvial geomorphology.

Limited opportunities consist of reducing stress and impacts to the lower portion of the watershed, through ensuring the hydrologic regime is not altered by new developments. This is an hydrotechnical issue but has ramifications to the shape of the channel and formation of riffle and pools. As well, creek corridors through new developments should be left intact, with abundant riparian vegetation to act as buffer strips, which will aid channel stability. This is an ecological and planning opportunity but will maintain existing creek conditions and eliminate traditional sediment loading from new developments.

A constraint to the protection and enhancement of the creek in new development areas is the necessity for crossings of the creek. These structures, whether for pedestrian or motorized use, lead to local entrenchment and altered channel form. The crossings should be kept to a minimum with the largest practical clearance and with as little disturbance to the creek as possible.

3.3 Hydrology

The hydrologic opportunities and constraints are limited primarily to flooding and erosion.

In recent years, the NBMCA has expended much time and money in identifying flood damage areas, constructing remedial works and acquiring property to mitigate flood damages. To this end, much of the flood damage potential on the Eastview Creek and Johnston Creek tributaries have been rectified through in stream works. On the main branch of Chippewa Creek, a number of homes had been acquired that were within the 1:25 year floodplain, that had been exposed to the highest potential for flood damages.

There remain, however, some floodplain areas that could potentially suffer flood damages on Chippewa Creek during severe, very infrequent rainstorms. These areas are generally located downstream of the Chippewa High School to Lake Nipissing. The area of highest priority, in this regard, is the main branch downstream of Thompson Park to the lake.

The NBMCA has also corrected many of the erosion prone sites on Chippewa Creek using channelization and armouring techniques. Most of the more severe sites were on the main branch of the creek, downstream of Airport Road to the Chippewa High School. Some isolated incidences of erosion remain to be rectified downstream of here, but are less critical. These remaining sites have been identified by the conservation authority and will be addressed, as is necessary.

Section 2.3, of this report, identifies the relative magnitude of increase to flow rates that might occur as a result of controlled runoff from developing areas of the watershed. See Figure 2.3.5. The flows that most likely affect the morphology of the creek channels are those having frequencies up to approximately 1:20 years. These are the most frequent runoff events that shape the creek channels, with time, and potentially cause the greatest erosion when the frequency and magnitude of theses flows change and the channels attempt to adjust to these changes.

From Figure 2.3.5., one can see that uncontrolled runoff would increase the 1:5 year storm flow rates approximately 20% to 60% along the main branch of Chippewa Creek, downstream of Thompson Park, where recent erosion control work has been done. The 1:5 year storm flow rates would increase by as much as 1200%, on Chippewa Creek near Airport Road, where the recent erosion control work has been completed. The potential for accelerated erosion rates, and/or damage to erosion control works, in these areas are extremely significant should runoff from developing areas not be controlled.

Similarly, 1:5 year storm flow rate increases would be approximately 75% to 150% along the lower portions of Eastview and Johnston Creek tributaries. Although there are some erosion control works in place here, and erosion is considered to be under control, flow increases of this magnitude could certainly erode the creek channels here. Furthermore, very significant increases in 1:5 year flow rates are expected through the headwaters of Johnston Creek. As with the developing areas along the main branch of Chippewa Creek, soils with low runoff potential are being replaced with pavement and storm sewers, thereby causing particularly high increases to the more frequent flows. The potential for erosion is, therefore, very high through the upper reaches of Johnston Creek.

The area having the highest flooding potential is the lower reach of Chippewa Creek, along the main branch. The 1:100 year storm flow increases here are expected to be approximately 30% to 50%. Downstream of the Chippewa High School, these flows could increase 50% with no runoff controls. Increase in flow rates of this magnitude would be significant and could translate to increased flood damages, and potential loss of life, during severe rainfalls. These damages could also include washed out roadways that may be critically needed during such storms.

The flood damage areas on the Eastview and Johnston Creek tributaries have been rectified, however, these works have finite capacities that may be exceeded should the 1:100 year storm flows increase by 75% to 120% over existing rates. The capacity of the conveying channel or enclosure in each case is as follows:

	Design	Return Period	
Location	Capacity	Existing	Future (uncont.)
1. Eastview Trib. d/s of Laurentian Ave.	6.1 m^3/sec	>100 yr.	± 25 yr.
2. Johnston Creek u/s of Trout Lake Rd.	6.8 m^3/sec	>100 yr.	<100 yr.

In summary, the incidences of flooding and erosion, including the works carried out to address these, constrain the watershed's development and the manner by which its runoff is controlled. Uncontrolled runoff from future, development will create the need for significant in, or near, stream works to be constructed (or reconstructed) and increases the potential for loss of life. Consequently, runoff rates should be controlled in developing areas to limit the increases in flow rates to a manageable range. A preliminary list of watershed runoff control criteria that potentially addresses these constraints are as follows:

Constraint	Criteria
1. Homes remain between 1:25 yr. and 1:100 yr. floodplains along main branch.	Control runoff rates from large rain events to minimize flooding potential.
2. Erosion has yet to be rectified on main branch and recent works may be jeopardized by increased flow rates.	Control all frequent runoff rates to reduce erosion potential.

3.4 Water Quality

Upper Watershed

The upper portion of the Chippewa Creek Watershed is mainly undeveloped. This provides the opportunity to protect the water quality and in turn the ecological resources associated with good water quality.

The landfill tributary water quality data indicates high suspended solids levels during rain events. This is mainly due to erosion occurring along the banks of this tributary. Through projects such as bank stabilization, the level of suspended solids can be reduced.

An evident restraint in the upper watershed is the low buffering capacity against heavy metals. As heavy metals are typically associated with urban run-off, the upper portion of the watershed will be very sensitive to future urban development. The historical water quality data indicate an increasing trend of heavy metal concentrations from the edge of the escarpment. A probable source of these metals is the Airport Hill subdivision area. Future subdivisions around Airport Road, without some means of alleviating urban run-off impacts, will further compromise the water quality on the lower portion of the watershed.

Lower Watershed

A significant impact on the lower watershed is the Eastview/Johnston Tributary. Levels of heavy metals are relatively higher from this tributary than the levels measured in other areas of the watershed.

Many areas along the lower portion of the creek are designated flood plains. In reference to the bacteria loadings, these flood plain areas can support additional vegetation whereby maintaining greater uptake of run-off and cooler water temperatures. The cooler temperatures will facilitate a greater die-off rate of the bacteria present.

3.5 Ecological Resources

In recent years there has been considerable effort spent on the identification and inventory of ecological resources in the Chippewa Creek watershed. This section discusses the opportunities and constraints that some of these resources present.

Perhaps, one of the most important ecological constraints for Chippewa Creek is the **cold water fish habitat located in the upper watershed** (Figure 2.5-1). This area has been demonstrated to provide suitable habitat for brook trout and other cold water fish species. The habitat in the upper watershed should, therefore, be protected and managed for the purpose of maintaining and enhancing the cold water fisheries.

In order to protect cold water fish habitat it is critical to maintain a riparian (stream-side) vegetation buffer strip. For the protection of cold water habitat along Chippewa Creek this buffer should be a minimum of 30 meters from the edge of the creek channel (OMNR 1987). The purpose of providing a vegetative buffer zone is to provide cover, maintain cooler water temperatures, reduce run-off and erosion impacts, stabilize the creek channel etc.

In regards to wetlands, **the Upper Chippewa Creek Wetland Complex is the only Provincially Significant wetland within the watershed.** Development in this wetland is prohibited under the Provincial Wetland Policy (1992). Furthermore, development within a 120 meter area around the wetland is restricted pending the outcome of an Environmental Impact Study (EIS).

The remaining identified wetlands within the Chippewa Creek watershed are considered to be locally significant. The Wetland Policy encourages protection of these wetlands, but does not prohibit development in these areas. It is, therefore, recommended that the function of locally significant wetland areas be maintained.

The extensive forest cover within the upper watershed contains a high degree of mature forest communities. The integrity of these areas and the interior habitat that they provide is important to a wide variety of wildlife. Furthermore, these areas are important corridors for wildlife migration. The maintenance of large interior forest areas is encouraged. These areas should be further identified in a Greenlands Strategy for the watershed.

3.6 Archaeology

The 1994 Chippewa Creek overview study which located five archaeological/heritage sites indicates that the watershed has potential to contain presently unknown archaeological sites and values. Thus, there is a good possibility of presently undetected archaeological remains existing within the Chippewa Creek study area.

Due to this, it is recommended that archaeological site inventory and field work be undertaken of any portions of Chippewa Creek or its watershed area prior to any management or development projects that would disturb the earth's surface.

4.0 IDENTIFIED NEEDS

4.1 Fluvial Geomorphology

The primary function of a creek system is the proper storage and conveyance of water and sediment. This function is one of the prime processes which defines the fluvial geomorphology of the creek. This function is impaired and out of balance at several locations within the lower Chippewa Creek watershed. The identified needs for restoring and enhancing the fluvial geomorphology at these locations is as follows:

1. Control erosion and improve conveyance of sediment in the lower urban reaches. With continued development, bank erosion will continue and likely accelerate. As well, continued sedimentation will add significant stress to creek banks, resulting in further erosion and eventual channel degradation.

2. Control and reduce sediment loadings to the creek. Several sources below the escarpment have been identified and efforts should be made to reduce the impact from these areas. A detailed sediment budget of the drainage basin should be completed. This will provide an indication of other sources of sediment as well as the capacity of the creek system.

3. The improvement of tributaries, especially adjacent to Johnston Road. These tributaries will be subject to increased discharges and related stresses. Given the existing shape and form, the Johnston Road tributary will become unstable. Improving creek function through a natural channel design, will improve conveyance of water and sediment, reduce maintenance costs, and reduce erosion to creek bed and banks.

4.2 Ecological Resources

The needs regarding ecological resources are primarily related to the lower watershed. In this area, ecological resources have been dramatically altered. The opportunity to restore these altered resources, however, is limited by existing development. The needs identified here are those which are considered to be feasible given the existing development constraints.

Within the lower watershed the riparian zone (area adjacent to the creek channel) is mostly exposed manicured lawn vegetation providing little or no cover to the creek channel. Furthermore many of these areas are eroded and have unstable banks. Future works in these areas should implement natural channel design and biotechnical slope stabilization principles in an effort to naturalize and stabilize the creek channel.

Detailed information regarding the lower watershed fisheries is absent. For this reason, it is recommended that a study regarding fisheries in the lower Chippewa Creek watershed be conducted prior to any major creek restoration.

4.3 Linear Parkway

The Near North Trail Partnership identified the need for a pathway along the Chippewa Creek corridor in a report titled "Discovery Routes of the Near North". The report makes mention of the Chippewa Creek Parkway system. A significant portion of this parkway has been completed.

At this point in time, bike and walk pathways have been completed between Fisher Street and Airport Road. Almost all the land required for the portion between Fisher and the waterfront have been acquired, and funding initiatives are underway.

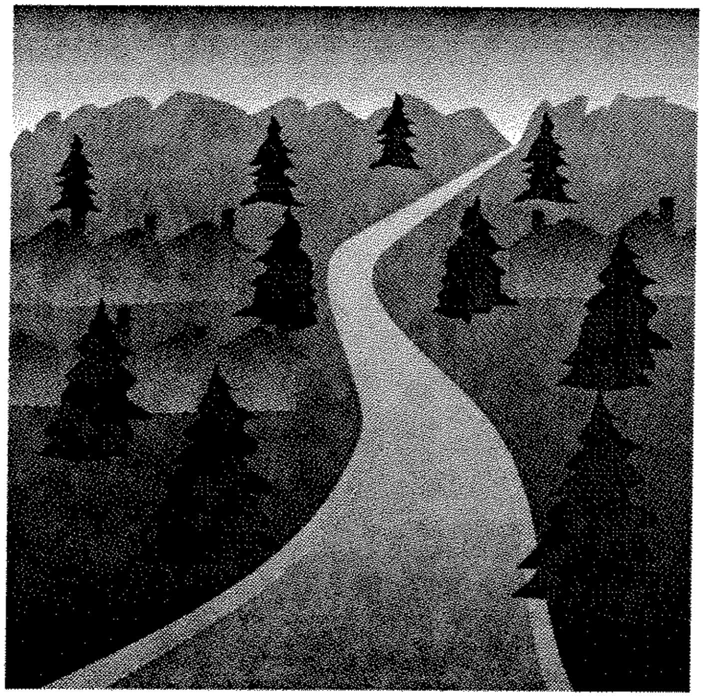
The report "Discovery Routes of the Near North" makes reference for the need to have this parkway extend to the top of the escarpment and linking into the Ferguson Colonization Road trail that serves a regional context.

The Corporation of the
City of North Bay

NORTH BAY-MATTAWA
CONSERVATION AUTHORITY

Chippewa Creek

Watershed Management Study



Phase 2
Watershed Management Strategy

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For this to be realized, private property owners who abut Chippewa Creek in the upper reaches, will be contacted during Phase II to explore methods of using portions of these lands for parkway development.

5.0 WATERSHED MANAGEMENT

5.1 Approach

Watershed planning and management requires the development of clear goals and objectives that are attainable through a number of concrete mechanisms. The success of a watershed management plan, in turn, is measured by the degree to which the watershed goals and objectives have been implemented. The development of goals and objectives is, therefore, a critical link in the watershed management and planning process.

The Chippewa Creek watershed goals and objectives were developed through a series of discussions and correspondence between the Watershed Study Steering Committee, the Public Liaison Committee, the public and the Study Team. Draft Goals and Objectives were presented and discussed during meetings held on April 18, 1995. A general consensus was reached regarding the intent and content of the goals and objectives for Chippewa Creek. Following the discussions on April 18, 1995, the goals and objectives were finalized for input to Phase 2.

Watershed management alternatives were subsequently developed with each of the goals and objectives in mind. Alternatives were selected based on how well they meet the watershed goals and objectives. In this manner, the process is objective driven. Furthermore, because all relevant alternatives are considered, many of the elements of an environmental assessment are inherently addressed.

Details regarding the alternatives and their evaluation are provided in Section 6 of this report.

5.2 Watershed Goals and Objectives

At the meetings held on April 18, 1995, the Chippewa Creek Watershed Study Steering Committee, Public Liaison Committee, Conservation Authority staff and the Study Team finalized the Chippewa Creek Watershed Goals and Objectives. For purposes of the present study a "Goal" is defined as the overall ambition or objective for the watershed, and the "Objective" is defined as a specific target required to meet the overall goal.

The following are the Chippewa Creek Goals and Objectives agreed to by the committees and Study Team:

1. **Goal:** **Enhance and protect the ecological integrity of the Chippewa Creek watershed.**

   Objectives:

   1.1 *Protect and enhance water quality in Chippewa Creek and Lake Nipissing.*

   1.2 *Protect and promote stable, natural aquatic communities and habitat within Chippewa Creek.*

   1.3 *Protect natural areas within the watershed including environmentally important forested and vegetated areas, and Provincially and Locally Significant Wetlands.*

   1.4 *Protect, enhance and rehabilitate riparian habitat along Chippewa Creek.*

   1.5 *Protect fisheries and wildlife within the upper and lower watershed.*

2. **Goal:** **Reduce or eliminate flooding damage potential within the Chippewa Creek watershed.**

   Objectives:

   2.1 *Maintain or reduce flow rates through flood vulnerable areas (identified already).*

   2.2 *Ensure flooding is not worsened through further urbanization or by instream works.*

3. Goal: **Prevent and control detrimental erosion and sedimentation.**

Objectives:

3.1 *Promote long term channel stability through design, implementation, and maintenance of natural reaches.*

3.2 *Ensure protection of structures/property*

3.3 *Achieve and maintain a low (natural levels) sediment aquatic ecosystem that permit natural bioremediation processes to occur.*

4. Goal: **Enhance the human use of Chippewa Creek and the watershed corridors.**

Objectives:

4.1 *Provide public access, opportunities and linkages between urban and natural systems.*

4.2 *Maintain, enhance and promote the aesthetic value and the educational, tourism and recreational features of the watershed.*

4.3 *Reduce health-related hazards to users of Chippewa Creek.*

5. Goal: **Encourage environmentally sensitive development within the Chippewa Creek watershed.**

Objectives:

5.1 *promote local planning policy which encourages environmentally and ecologically sensitive design principles.*

5.2 *Promote the reasonable and appropriate distribution of land uses within the watershed by way of a secondary plan.*

5.3 *Establish environmental design guidelines for developer's reference when submitting applications.*

5.4 *Maintain or improve the water quality and quantity functions of existing channels and wetlands for effective stormwater management.*

6. Goal: **Promote public awareness and implementation of the watershed plan by decision-makers, property owners and the public.**

Objectives:

6.1 *Increase knowledge of the watershed and its importance in the community.*

6.2 *Encourage responsible and wise use of the watershed.*

6.3 *Encourage public involvement in the planning, management and rehabilitation of the watershed.*

7. Goal: **Ensure that the Chippewa Creek Watershed Goals and Objectives are implemented.**

Objectives:

7.1 *Establish an Implementation Committee to track the progress of Chippewa Creek Watershed management.*

7.2 *Establish a Community Outreach Program for the purpose of increasing community involvement and public education.*

6.0 EVALUATION OF WATERSHED MANAGEMENT ALTERNATIVES

The development of a comprehensive Watershed Management Plan for Chippewa Creek was based on the evaluation of alternatives and the subsequent selection of a set of alternatives that best meet the Watershed Goals and Objectives. The set of alternatives that best meet the Goals and Objectives then forms the overall Watershed Management.

6.1 Alternatives Evaluation

The appropriateness of watershed management alternatives can be judged as a function of the degree that each meets the watershed goals and objectives. One means of making this assessment is through the use of decision matrices that rate each set of alternatives. Despite their subjectiveness, the matrices clearly illustrate how each alternative rates in comparison with other alternatives.

Of the seven goals established for Chippewa Creek, only four, Goals 1 to 4, are considered "tangible" and appropriate for evaluation through the use of a decision matrix. For example, Goal 2, "Reduce or eliminate flooding damage potential within the Chippewa Creek watershed", requires physical measures to remediate a problem. The last three goals, Goals 5 to 7, are considered to be recommendations and will be directly considered as a part of the preferred Watershed Management Strategy.

Within the decision matrix, each of the four (4) goals evaluated were considered to be equally important and were, therefore, weighted accordingly. A total weighting of 10 was given to each goal. The weighting of individual objectives was then a function of the number of objectives established to achieve a particular goal. For example, Goal 1 has five (5) objectives resulting in a weighting of two (2) for each objective.

The ability of each alternative to meet each of the objectives is assigned a value between 0 and 10. A value of 0 means that the alternative does nothing to meet the objective, while a value of

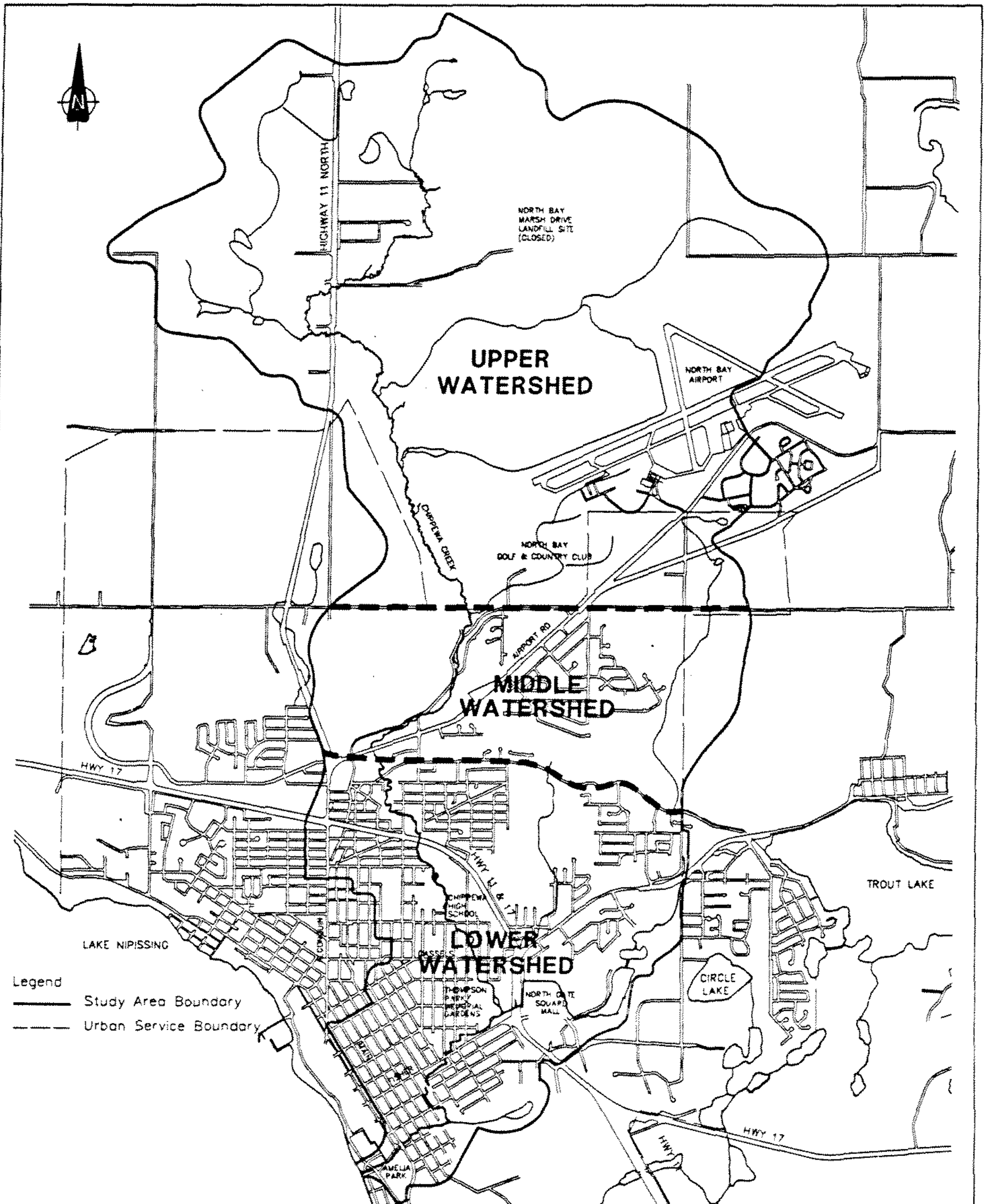
10 indicates that an alternative fully satisfies an objective. To reduce subjectiveness, only values of 0 (no effect), 2 (not very effective), 5 (moderately effective), and 8 (very effective) were used. Negative values are possible in instances where an alternative negatively effects an objective.

The Total Rating of each alternative is equal to the sum of individual alternative scores multiplied by their respective Objective Weightings. The Overall Rating is then determined by the Total Rating and the applicability of the alternative to the particular section of the watershed (i.e. upper, escarpment, or lower watershed). Applicability is assigned as either 0% (not applicable), 50% (conditionally applicable), or 100% (very applicable). The assignment of 50%, conditionally applicable, indicates that the alternative is appropriate subject to certain conditions being met. Such conditions could be related to physical constraints, property ownership along the creek corridor, availability of area for treatment pond locations, or functional importance of locally significant wetlands (to be determined through Environmental Impact Studies).

Once evaluated, those alternatives that best meet the objectives, as determined by the Overall Rating, are included on a "short list" of alternatives. The "short list" of alternatives for the three sections of the watershed represent the Chippewa Creek Watershed Strategy.

In the present study, alternatives for the decision matrices were sub-divided into the following categories: Ecological Alternatives, Hydrologic and Surface Water Quality Alternatives, Social/Recreational Alternatives, and Land Use Planning Alternatives. These sets of alternatives are described in detail in following sections (6.2 to 6.6) along with rationale for the selection of alternatives, their evaluation and applicability. Furthermore, a separate matrix is presented for the Upper Watershed, the Escarpment, and the Lower Watershed as these areas represent distinctly different environments within the Chippewa Creek Watershed. Figure 6.1-1 shows the three watershed areas.

The watershed management alternatives evaluations for the Upper Watershed, Escarpment, and Lower Watershed are presented in the matrices contained in Table 6.1-1.



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CHECKED BY	Watershed Sections	SCALE N.T.S. | DATE DEC. 1994
		DRAWING NO. Figure 6.1-1

Upper Watershed Alternatives Evaluation

Objectives	Ecology					Flooding		Erosion			Social							
	1.1 Protect and Enhance Water Quality	1.2 Protect Promote Aquatic Communities	1.3 Protect Natural Areas within Watershed	1.4 Protect Riparian Habitat	1.5 Protect Fisheries and Wildlife	2.1 Maintain or Reduce Flow Rates	2.2 Ensure Flooding is not Worsened	3.1 Promote Long Term Channel Stability	3.2 Ensure protection of structures/property	3.3 Achieve Low Sediment Aquatic Ecosystem	4.1 Provide Public Access Opportunities	4.2 Enhance Aesthetic Value, Educational	4.3 Reduce Health-Related Hazards	Total Rating at Meeting Objectives	Applicability Factor	Overall Rating	Recommended for Further Consideration	
Objective Rating (1-10)	2	2	2	2	2	5	5	3.3	3.3	3.3	3.3	3.3	3.3					Comments
Ecological Alternatives																		
protect Provincially Signif. wetlands	8	8	8	5	8	5	5	5	5	5	5	5	5	223	100%	223	✓	Chippewa Creek wetland PSW
maintain function of other wetlands	8	5	2	2	5	5	5	2	5	5	2	2	5	163	50%	82	✓	upper portion of Tower Drive
protection of significant forest areas	5	2	8	2	5	2	2	2	0	2	5	5	0	110	100%	110	✓	large areas of mature forested land
protect RTE species habitat	0	2	8	2	8	0	0	0	0	0	2	5	0	63	50%	32		potential exists
protect significant wildlife corridors	0	2	8	2	5	0	0	0	0	0	5	5	0	67	100%	67	✓	high potential with forested habitat
establish buffers along creek	8	8	5	8	8	2	2	8	2	8	8	5	2	203	50%	101	✓	limited need;no development planned
eliminate barriers to fish passage	0	5	0	0	5	0	0	2	0	5	0	2	0	50	100%	50		beaver dams & brush jams
revegetate & manage riparian areas	8	8	5	8	8	0	0	8	0	8	0	5	0	143	0%	0		no requirement
natural channel remediation	5	8	5	8	8	5	5	8	5	5	0	5	0	194	0%	0		no requirement
biostabilization of slopes	5	0	5	0	2	0	0	0	0	5	0	5	0	57	0%	0		no requirement
Hydrologic Alternatives																		
extended detention BMPs	8	5	0	2	0	0	0	5	8	8	0	2	0	106	0%	0		no development existing or planned
infiltration BMPs	8	8	0	5	2	0	0	5	2	8	0	2	0	102	0%	0		no development existing or planned
creek corridor BMPs	8	8	8	8	8	0	0	8	5	5	2	8	0	172	0%	0		no development existing or planned
oil / grit separators	5	2	0	0	0	0	0	0	0	5	0	0	0	31	0%	0		no development existing or planned
agricultural BMPs	8	8	0	0	0	0	0	5	0	2	0	0	0	55	100%	55	✓	retrofitting required
mining BMPs	8	8	0	0	2	0	0	5	0	2	0	0	0	59	100%	59	✓	retrofitting required
forestry BMPs	8	8	8	0	0	0	0	5	0	2	0	0	0	71	100%	71	✓	retrofitting required
peak flow control	0	0	0	0	0	8	8	2	2	0	0	0	0	93	0%	0		no development existing or planned
compact development forms	2	5	8	0	5	2	2	0	2	2	0	5	0	90	0%	0		no development existing or planned
disinfection	8	0	0	0	0	0	0	0	0	0	5	0	8	59	0%	0		no development existing or planned
floodproofing	0	0	0	0	0	0	8	0	0	0	0	0	0	40	0%	0		no buildings in floodplain
enlarge creek channel	0	-2	-5	-2	0	0	8	-2	0	0	0	-2	0	9	0%	0		does not meet objectives
Social/Recreation Alternatives																		
ext pathway to heritage sites											8	8	5	69	50%	35		contribution to Heritage North

NOTES:

Rating Scale

8	very effective	-8	very adverse
5	effective	-5	adverse
2	not very effective	-2	somewhat adverse
0	no effect		

Applicability

0%	not applicable
50%	marginally applicable
100%	applicable

Objective weighting

2	somewhat important
5	important
8	very important

Recommended

✓	recommended for further consideration
?	marginally meets objectives

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Table 6.6-

Escarpment Watershed Alternatives Evaluation

Objectives	Ecology					Flooding		Erosion			Social							
	1.1 Protect and Enhance Water Quality	1.2 Protect Promote Aquatic Communities	1.3 Protect Natural Areas within Watershed	1.4 Protect Riparian Habitat	1.5 Protect Fisheries and Wildlife	2.1 Maintain or Reduce Flow Rates	2.2 Ensure Flooding is not Worsened	3.1 Promote Long Term Channel Stability	3.2 Ensure protection of structures/property	3.3 Achieve Low Sediment Aquatic Ecosystem	4.1 Provide Public Access Opportunities	4.2 Enhance Aesthetic Value, Educational	4.3 Reduce Health-Related Hazards	Total Rating at Meeting Objectives	Applicability Factor	Overall Rating	Recommended for Further Consideration	
Objective Rating (1-10)	2	2	2	2	2	5	5	3.3	3.3	3.3	3.3	3.3	3.3					Comments
Ecological Alternatives																		
protect Provincially Signif. wetlands	8	8	8	5	8	5	5	5	5	5	5	5	5	223	0%	0		no existing PSWs
maintain function of other wetlands	8	5	2	2	5	5	5	2	5	5	2	2	5	163	50%	82	✓	existing Tower Drive wetland
protection of significant forest areas	5	2	8	2	5	2	2	2	0	2	5	5	0	110	100%	110	✓	mature forested areas along creek
protect RTE species habitat	0	2	8	2	8	0	0	0	0	0	2	5	0	63	50%	32		none known;potential exists
protect significant wildlife corridors	0	2	8	2	5	0	0	0	0	0	5	5	0	67	100%	67	✓	high potential for corridors
establish buffers along creek	8	8	5	8	8	2	2	8	2	8	8	5	2	203	100%	203	✓	some development considered
eliminate barriers to fish passage	0	5	0	0	5	0	0	2	0	5	0	2	0	50	0%	0		negligible effect
revegetate & manage riparian areas	8	8	5	8	8	0	0	8	0	8	0	5	0	143	0%	0		existing riparian areas natural
natural channel remediation	5	8	5	8	8	5	5	8	5	5	0	5	0	194	0%	0		not required
biostabilization of slopes	5	0	5	0	2	0	0	0	0	5	0	5	0	57	100%	57	✓	potential areas exist
Hydrologic Alternatives																		
extended detention BMPs	8	5	0	2	0	0	0	5	8	8	0	2	0	106	100%	106	✓	can accompany development
infiltration BMPs	8	8	0	5	2	0	0	5	2	8	0	2	0	102	50%	51	✓	at source estern half
creek corridor BMPs	8	8	8	8	8	0	0	8	5	5	2	8	0	172	100%	172	✓	can accompany development
oil / grit separators	5	2	0	0	0	0	0	0	0	5	0	0	0	31	100%	31	✓	can accompany development
agricultural BMPs	8	8	0	0	0	0	0	5	0	2	0	0	0	55	0%	0		no agriculture in escarpment area
mining BMPs	8	8	0	0	2	0	0	5	0	2	0	0	0	59	0%	0		no mining in escarpment area
forestry BMPs	8	8	8	0	0	0	0	5	0	2	0	0	0	71	0%	0		no forestry in escarpment area
peak flow control	0	0	0	0	0	8	8	2	2	0	0	0	0	93	100%	93	✓	can accompany development
compact development forms	2	5	8	0	5	2	2	0	2	2	0	5	0	90	100%	90	✓	requires regulatory acceptance
disinfection	8	0	0	0	0	0	0	0	0	0	5	0	8	59	0%	0		expensive
floodproofing	0	0	0	0	0	0	8	0	0	0	0	0	0	40	0%	0		no bldgs in floodplain
enlarge creek channel	0	-2	-5	-2	0	0	8	-2	0	0	0	-2	0	9	0%	0		does not meet objectives
Social/Recreation Alternatives																		
ext pathway to heritage sites											8	8	5	69	50%	35		contribution to Heritage North

NOTES:

Rating Scale

8	very effective	-8	very adverse
5	effective	-5	adverse
2	not very effective	-2	somewhat adverse
0	no effect		

Applicability

0%	not applicable
50%	marginally applicable
100%	applicable

Objective weighting

2	somewhat important
5	important
8	very important

Recommended

✓	recommended for further consideration
?	marginally meets objectives

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Table 6.6-1

Lower Watershed Alternatives Evaluation

Objectives	1.1 Protect and Enhance Water Quality	1.2 Protect Promote Aquatic Communities	1.3 Protect Natural Areas within Watershed	1.4 Protect Riparian Habitat	1.5 Protect Fisheries and Wildlife	2.1 Maintain or Reduce Flow Rates	2.2 Ensure Flooding is not Worsened	3.1 Promote Long Term Channel Stability	3.2 Ensure protection of structures/property	3.3 Achieve Low Sediment Aquatic Ecosystem	4.1 Provide Public Access Opportunities	4.2 Enhance Aesthetic Value, Educational	4.3 Reduce Health-Related Hazards	Total Rating at Meeting Objectives	Applicability Factor	Overall Rating	Recommended for Further Consideration	Comments
	Ecology					Flooding		Erosion			Social							
Objective Rating (1-10)	2	2	2	2	2	5	5	3.3	3.3	3.3	3.3	3.3	3.3					
Ecological Alternatives																		
protect Provincially Signif. wetlands	8	8	8	5	8	5	5	5	5	5	5	5	5	223	0%	0		no existing PSW
maintain function of other wetlands	8	5	2	2	5	5	5	2	5	5	2	2	5	163	100%	163	✓	several existing non-PSW
protection of significant forest areas	5	2	8	2	5	2	2	2	0	2	5	5	0	110	50%	55		relatively small areas in east portion
protect RTE species habitat	0	2	8	2	8	0	0	0	0	0	2	5	0	63	0%	0		no known RTEs
protect significant wildlife corridors	0	2	8	2	5	0	0	0	0	0	5	5	0	67	50%	34		restricted to creek corridor
establish buffers along creek	8	8	5	8	8	2	2	8	2	8	8	5	2	203	50%	101	✓	limited opportunity for buffers
eliminate barriers to fish passage	0	5	0	0	5	0	0	2	0	5	0	2	0	50	100%	50	✓	barriers exist
revegetate & manage riparian areas	8	8	5	8	8	0	0	8	0	8	0	5	0	143	100%	143	✓	numerous opportunities/needs
natural channel remediation	5	8	5	8	8	5	5	8	5	5	0	5	0	194	100%	194	✓	opportunities exist
biostabilization of slopes	5	0	5	0	2	0	0	0	0	5	0	5	0	57	0%	0		no significant slopes
Hydrologic Alternatives																		
extended detention BMPs	8	5	0	2	0	0	0	5	8	8	0	2	0	106	100%	106	✓	retrofitting required
infiltration BMPs	8	8	0	5	2	0	0	5	2	8	0	2	0	102	50%	51	✓	disconnect roof leads
creek corridor BMPs	8	8	8	8	8	0	0	8	5	5	2	8	0	172	100%	172	✓	retrofitting required
oil / grit separators	5	2	0	0	0	0	0	0	0	5	0	0	0	31	100%	31	✓	retrofitting required
agricultural BMPs	8	8	0	0	0	0	0	5	0	2	0	0	0	55	0%	0		no agriculture in lower watershed
mining BMPs	8	8	0	0	2	0	0	5	0	2	0	0	0	59	0%	0		no mining in lower watershed
forestry BMPs	8	8	8	0	0	0	0	5	0	2	0	0	0	71	0%	0		no forestry in lower watershed
peak flow control	0	0	0	0	0	8	8	2	2	0	0	0	0	93	0%	0		allow lower to flow uncontrolled
compact development forms	2	5	8	0	5	2	2	0	2	2	0	5	0	90	100%	90	✓	infilling / redevelopment
disinfection	8	0	0	0	0	0	0	0	0	0	5	0	8	59	0%	0		expensive
floodproofing	0	0	0	0	0	0	8	0	0	0	0	0	0	40	100%	40	✓	for exist bldgs in flood plain
enlarge creek channel	0	-2	-5	-2	0	0	8	-2	0	0	0	-2	0	9	0%	0		does not meet objectives
Social/Recreation Alternatives																		
ext pathway to heritage sites											8	8	5	69	50%	35		contribution to Heritage North

NOTES:

Rating Scale

8	very effective	-8	very adverse
5	effective	-5	adverse
2	not very effective	2	somewhat adverse
0	no effect		

Applicability

0%	not applicable
50%	marginally applicable
100%	applicable

Objective weighting

2	somewhat important
5	important
8	very important

Recommended

✓	recommended for further consideration
?	marginally meets objectives

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Table 6.6-'

6.2 Ecological Alternatives

The ecological alternatives for the Chippewa Creek watershed are divided into protection alternatives, and enhancement and restoration alternatives. Protection alternatives, while primarily applicable in the less developed Upper watershed, are also appropriate for the developed and developing portions of the Lower watershed and Escarpment. Conversely, enhancement or restoration alternatives are more applicable in the Lower watershed portions of Chippewa Creek.

6.2.1 Protection Alternatives

Protection of Provincially Significant Wetlands

The protection of Provincially Significant Wetlands (PSWs) is an alternative that affords many integrated benefits such as the enhancement of water quality, protection of rare species habitat, promotion of aquatic communities including fisheries, etc. Much of the importance of wetlands within a watershed is due to the fact that they represent an ecosystem that occurs at the interface of terrestrial and aquatic environments. For this reason, inherent in the protection of PSWs are other protection measures such as erosion control, water quality treatment, groundwater recharge, and protection of wildlife.

The Ontario Wetlands Policy presently protects Provincially Significant Wetlands from development, however, further protection can be established through Environmental Impact Studies (EISs) conducted on adjacent lands within 120 meters of a PSW.

The protection of Provincially Significant Wetlands is considered to be effective to very effective in meeting the goals and objectives. Within the Chippewa Creek watershed only the Upper Watershed area contains a Provincially Significant Wetland, the Upper Chippewa Creek Wetland. For this reason, applicability is 100% in the Upper Watershed and protection of PSWs is recommended for further consideration.

Maintenance of Locally Significant Wetlands' Function

Locally Significant Wetlands (LSWs), while not protected by provincial policy, play an important role in watersheds in terms of their key functions. Some of the functions of such wetlands include the enhancement of water quality, provision of habitat for wildlife, flood control, and erosion protection. If protection of a wetland is not feasible then maintenance of its functions is a reasonable alternative to consider. Maintenance of a wetlands functions may be achieved through allowing controlled development within a wetland, protection of certain features within a wetland, or by the replacement/transplant of wetland features to an alternate location.

An example of the maintenance of a wetland function might entail the construction of a surface water management pond with transplanted wetland plants for increased nutrient uptake.

Within the Chippewa Creek watershed there area several Locally Significant Wetlands occurring in all three portions of the watershed. The maintenance of wetland function is particularly applicable in the Lower Watershed because of the presence of several wetlands and the potential positive impact these areas have on water quality in the lower reaches of the creek. Maintenance of wetland function is recommended for all three portions of the Chippewa Creek watershed.

Protection of Significant Forested Areas, ESAs, and ANSIs

The protection of Significant Forested Areas, Environmentally Sensitive Areas (ESAs), and Areas of Natural and Scientific Interest (ANSIs) contribute to the environmental quality of watersheds in several ways. Significant Forested Areas, ESAs, and ANSIs often contain a high degree of biological diversity which in turn confers greater resilience and integrity on watershed ecosystems. Where these areas are associated with creek valleys and steep slopes, they reduce the intensity and volume of storm water run-off and decrease soil erosion and flooding. Water quality is improved by the removal of nutrients, sediments and toxins from storm water run-off by vegetation. Vegetation associated with forested areas, ESAs, and ANSIs assists in cooling water temperatures in creeks, thereby providing an environment suitable for cold water fisheries. Other species of wildlife and plants benefit from the habitat contained with forested areas, ESAs, and ANSIs.

Within the Chippewa Creek watershed the majority of mature forested areas are found in the Upper Watershed and the Escarpment area. While no ESAs or ANSIs are designated for the watershed, future designations may be established subject to environmental studies. Protection of mature (significant) forested areas, especially those associated with the Chippewa Creek valley corridor, is considered to be very applicable in the Upper Watershed and Escarpment areas.

Protection of "Significant Forested Areas" will require clear definition and identification of area boundaries. An interim definition to consider may be "all mature forested areas, those >4ha in area and greater than 80 years of age, associated with the creek valley corridor."

Protection of the Habitat of Rare, Threatened, and Endangered (RTE)Species

The most effective means of protecting rare, threatened, and endangered (RTE) species is to protect the environment in which they live, their habitat. While RTE species' habitat is indirectly protected by a number of other alternatives (i.e. protection of Significant Forested Areas, ESAs, and ANSIs, wetlands, BMPs, etc.), certain habitat requirements are specific to a species and are not necessarily coincident with the areas protected in other alternatives.

RTE species habitat varies considerably and requires a determination on a species-by-species basis within any given watershed or region. Any determination of such kind should be done by, or in consultation with the Ministry of Natural Resources (MNR). No RTE species are known to occur in the Chippewa Creek watershed, however, the potential for the occurrence of RTEs exists in the Upper Watershed and the Escarpment area.

Protection of Significant Wildlife Corridors

The movement of species through and within a watershed is largely facilitated by and dependent on natural corridors such as riparian zones associated with creek corridors, forested areas, and wetlands. These areas may act as either temporary cover or refuge, or they may provide vegetation that serves as a food supply to wildlife. The delineation and extent of corridors within a watershed is dependent on the wildlife that lives in the watershed. Corridors within a watershed should be identified in consultation with MNR.

Within the Chippewa Creek watershed the greatest opportunity for natural corridors exists in the Upper Watershed and the Escarpment. The Lower Watershed corridor potential is limited to the creek channel which has the potential for enhancement subject to riparian (creek bank) zone revegetation.

Establish Buffers along Creek Corridor

The establishment of buffer zones along creek corridors is generally though to provide protection for creek fisheries, surface water quality, channel stability, and riparian vegetation. The establishment of buffers also recognizes that creeks are constantly evolving systems that change in their geometry and ecology. In order to establish appropriate buffers for a creek, various factors must be considered. For example, areas with sensitive cold water fisheries or spawning beds may require buffers of up to 30 meters from the edge of the creek channel in order to maintain the sensitive feature.

While creek buffers are appropriate for the entire length of a creek system within a watershed, in the case of Chippewa Creek the greatest potential for establishment of buffers is in the Upper Watershed where existing development is scattered. The Lower Watershed, however, is severely limited in areas because of the extent of existing development. In the Lower watershed, buffers should be applied in conjunction with redevelopment and enhancement/restoration projects.

6.2.2 Enhancement and Restoration Alternatives

Elimination of Barriers to Fish Passage

Improperly installed man-made structures (i.e. culverts and bridges) as well as brush and log-jams can obstruct the passage of fish along a watercourse, hence limiting the distribution of certain fish species within a watershed. In order to allow free movement of fish through a watershed, these barriers should be modified or removed. In the case of brush, log-jams, or beaver dams, barrier removal or elimination is relatively simple and can be done by local interest groups. With more permanent structures, however, barrier elimination may require re-design and reconstruction.

Barriers to fish passage in Chippewa Creek occur within both the Upper and Lower Watershed. Barriers within the Upper Watershed occur as beaver dams and brush/log-jams. Removal of these barriers is considered to be very applicable.

Revegetation and Management of Riparian Areas

Vegetation along the riparian zone (creek bank and floodplain) is an important attribute of a natural watershed system. Riparian vegetation not only provides cover and food for fish and wildlife, but it also helps to stabilize creek banks, take-up nutrients, and filter sediments from run-off. Perhaps the most critical role of riparian vegetation is the moderating effect on a creek's water temperature. The shade from trees adjacent to a creek channel combined with sufficient water depth can significantly cool the creek's water enabling it to support cold water fish species. The maintenance of riparian vegetation in a watershed system is, therefore, a key element in achieving a healthy watershed ecosystem.

Many watercourses situated in urban areas have lost most of the natural riparian vegetation that once formed an integral part of the watershed. In these areas, water in open channels, or channel areas devoid of tree cover, becomes warmer from direct sunlight. The warmer water in turn reduces the potential for aquatic life and fisheries not only by direct temperature effects, but also due to the lower dissolved oxygen capacity of the warmer water. In areas where a watercourse lacks sufficient riparian cover, revegetation is considered to be a viable alternative. Revegetation may take the form of simple plantings of suitable trees and shrubs, or it may involve more complex restoration of riparian plant communities.

In the Chippewa Creek watershed, urbanization has left the Lower Watershed with many open channel areas. Revegetation of the riparian zone in the Lower Watershed is considered to be very applicable as a watershed management alternative. Particular areas requiring revegetation include Thompson Park and areas between Highway 17/11 and Cassells Street. While revegetation in these areas of Chippewa Creek will promote aquatic life and some fisheries, it is thought that establishment of a cold water fishery in the Lower Watershed is not feasible given other physical constraints such as water depth and creek geometry.

Biostabilization and Maintenance of Creek Valley Slopes

Oftentimes the erosion of slopes and land adjacent to a creek corridor can lead to sedimentation and water quality problems in a watershed. For this reason it is important to maintain vegetation on slopes and any exposed land associated with a creek's valley system. "Biostabilization", or the use of vegetation and other natural resources to stabilize soil on slopes or exposed land, is an alternative that provides benefits beyond just stabilization of soil. Biostabilization and the maintenance of vegetation on valley slopes reduces surface water quality impacts on a watercourse, provides cover and food for wildlife, and enhances overall biodiversity.

Biostabilization is not considered applicable in the Upper or Lower Watershed areas, however, the maintenance of vegetation associated with the creek's valley is. In these areas, buffers may sufficiently address adjacent land impacts. In the Escarpment area, biostabilization of slopes should be considered, particularly in the Golf Club - O'Brien Street area where exposed slopes may be contributing to creek sedimentation.

Natural Channel Creek Restoration

Natural Channel Creek Restoration is the re-establishment of a naturally functioning, stable, and sustainable creek channel through design, reconstruction, and revegetation. This method involves the integration of the disciplines of ecology, hydrology, and fluvial geomorphology in order to be successfully implemented. While the success of Natural Channel Creek Restoration has been mixed over the past few years, it still holds great potential for revitalizing urbanized or degraded watercourses. The success of natural channel creek restoration may be dependent on a blending of traditional engineering methods with more natural ecological restoration methods. An example might be the integration of rip-rap with soil and riparian vegetation plantings.

In the Chippewa Creek Watershed, Natural Channel Creek Restoration is most applicable in the Lower Watershed. Areas where structures and properties encroach on the creek channel may require Natural Channel Creek Restoration. Application of this method, however, will be largely dependent on property acquisition and cost feasibility.

6.3 Hydrologic Alternatives

Several opportunities are available to address stormwater quality and quantity issues within the watershed. The following is a description of the entire list, or "long list", of hydrologic options available to address watershed concerns, and their applicability within the lower escarpment and upper watershed areas.

Extended Detention BMPs

Extended detention best management practices are one of the most effective and therefore, the most common form of BMP in Ontario. Extended detention refers to capturing runoff, all but the very heavy storms then releasing the captured volume over an extended period of time, usually 12 to 48 hours. Water quality improvements are primarily driven by sedimentation within the pond. The reduction in total suspended solids results in lower concentrations of other pollutants, as these are often attached to the suspended solids. Extended detention facilities can be in the form of dry ponds, wet ponds or constructed wetlands.

These type of facilities rank quite high in the matrices and are well suited to many land uses and are, therefore, *recommended for further consideration in the watershed.* In addition to the limited development planned for the upper watershed, there are also quarries and these BMPs might also be considered for erosion and sediment control here.

Infiltration BMPs

Infiltration BMPs generally take two forms, namely, at-source infiltration and centralized infiltration. At-source infiltration refers to decreasing the amount of surface runoff leaving individual building lots by creating depressed areas, flattening lot grades, or disconnecting roof leads to promote infiltration. Centralized infiltration BMPs refer to either conveyance mechanisms such as perforated pipes or end of pipe mechanisms such as infiltration basins. Recent experience has shown that centralized infiltration mechanisms require substantial pretreatment to be effective. Both clogging of the soil with silt and infiltrating road runoff that can be contaminated are concerns and, therefore, infiltration ponds are generally unacceptable. At source infiltration of relatively clean roof runoff, however, does have significant water quality and erosion control benefits, although public acceptance of standing water in yards is still a concern.

Infiltration type BMPs ranked quite high in the matrices and require permeable soils to function best. The soils in the lower watershed contain silts and may not be very appropriate for infiltration techniques, however, directing roof leads to grassed areas will provide some filtration and infiltration. The eastern half of the escarpment area should be considered for at source infiltration techniques because the soils here are more permeable. The western half of the escarpment area, on the other hand, has very low infiltration and infiltrative BMPs are less feasible land effective here. The upper watershed has permeable soils and infiltration BMPs here are possible. Since very little development and changes to the land use is planned for the upper watershed, therefore the opportunity to employ at source infiltration BMPs is very limited.

Creek Corridor BMPs

Creek corridor BMPs refer to in stream works which would enhance or restore the creek channels. Examples of this set of BMPs include channel stabilization, revegetation or creating buffer strips along the channel. Some more specific information regarding these BMPs can be found in the Ecological Alternatives section of this report.

Creek corridor BMPs received the highest ranking in the matrices for meeting the watershed objectives. The escarpment area and particularly the lower watershed are very well suited to BMPs of this type. The upper area of the watershed is currently in a mostly natural condition and maintaining the creek corridor is important. Similarly, reestablishing a more natural creek corridor downstream has merit.

Oil / Grit Separators

Oil / grit separators are prefabricated units that intercept some of the grit through sedimentation and prevent discharge of some of the floating contaminants. These separators can be effective to treat runoff from small paved areas and are most appropriate for parking lots and industrial sites. Several variations in the design of oil/grit separators have been tested in recent years and the most recent designs appears to be manhole type separators. One of the most common name brands for this technology is Stormceptor™.

These separators scored rather low in meeting the overall watershed objectives because they have no flooding, erosion, or social benefits, however, they can be fairly easily employed in retrofit situations such as the lower watershed. Oil / grit separators are, therefore, recommended for further wide spread consideration in the lower watershed and for new parking lots elsewhere.

Agricultural BMPs

Agricultural BMPs refer to those BMPs specifically associated with farming. This set of BMPs often overlaps other types of BMPs included elsewhere in the long list of alternatives. It is, however, important to assess them separately because the implementation mechanisms are very different. Agricultural BMPs include; buffer strips adjacent to watercourses, filter strips at the edge of fields, extended detention ponds to trap sediment prior to discharge to the stream, fencing of watercourses to keep livestock out, fertilizer management and manure management.

Agricultural BMPs are recommended wherever agricultural land use may be considered. This is primarily limited to the upper watershed, where at present, no agricultural practices now take place, but may in the future.

Aggregate Extraction BMPs

Similar to agricultural BMPs, aggregate extraction BMPs also overlap many of the other methods included in the long list of alternatives and aggregate extraction BMPs also have different implementation mechanisms and warrant specific attention. Aggregate extraction BMPs include control of runoff from any disturbed lands. This can take the form of vegetated buffer strips, extended detention ponds, road maintenance practices etc.

Aggregate extraction within the watershed is limited to the upper portion where there is active sand and gravel extraction and, consequently aggregate extraction BMPs are recommended for further consideration. Erosion and sediment control plans could be developed for each sand and gravel pit to reduce the high suspended soils loads. These might include extended detention of dewatering effluent/runoff, vegetating disturbed areas, truck wash down, road cleaning, silt fences and gravel check dams in the ditches.

Peak Flow Control

Traditional peak flow control or "quantity control" ponds address the watershed's flood objectives quite well and, as such, rank high in the alternative evaluation decision matrices. This method of control typically provides reduction of the peak outflow from an area, using a stormwater detention pond, most times to pre development peak rates flow. The range of flows controlled are usually a 1:2 year storm up to a 1:100 year storm inclusive.

These flood control facilities are recommended for further consideration in the developing areas of the watershed. The approximate size and approximate location of these facilities has been described in more detail in section 6.3.1 of this report.

Compact Development Forms

Compact development forms or "cluster developments" focus and concentrate the number of units (residential and other) in a smaller overall land area and, in doing so, leave a large portion of the total development plan in a more natural state. This type of development satisfies many of the watershed objectives as shown in the matrices.

This type of development is recommended for further consideration in the middle watershed area and the lower watershed. The upper watershed does not have any significant urban development planned and, therefore, this type of approach is not as applicable.

Disinfection

High bacteria levels are common in urban and agricultural runoff. Disinfection of runoff to kill bacteria through the use of ultra violet radiation, chlorination or ozone treatment is sometimes considered where body contact is a primary concern. Disinfection is very rarely employed in Ontario because of its very high capital and maintenance costs. The primary application of this technology to date, has been UV disinfection. Other BMPs, such as wetlands, are generally considered to provide less reliable disinfection, and require very significant detention times and land requirements.

Although swimming in Lake Nipissing is an important, and current, issue within North Bay, body contact recreation use has not been identified as a specific watershed objective for Chippewa Creek. Because it provides only one function, disinfection receives a comparatively low assessment in the decision matrices. For this reason, as well as the very high cost of this technology and lack of opportunity for retrofitting in the urban areas, disinfection is not recommended as a practical alternative anywhere in the watershed

Flood Proofing

Flood proofing refers to removing or protecting structures within the creek's regulatory flood plain. Flood proofing can include measures such as berming around structures, back flow preventers, raising structures, removing structures etc.

The overall ability of flood proofing to meet the watershed objectives is comparatively low, however, it is very applicable in the lower watershed where the there are a few remaining flood prone structures within the floodplain. For this reason flood proofing is recommended primarily for further consideration in the lower watershed on a site specific basis.

Enlarge Creek Channel

Enlarging the creek channel increases the Creek's conveyance capacity through techniques which increase the flow area of the channel resulting in lower water levels during extreme storms. These techniques often include straightening and lining of the channels which in turn decrease in stream flood attenuation and can increase flows downstream.

Although channelization can decrease flooding damages, it can also have many negative ecological and social impacts, especially with respect to terrestrial and aquatic resources.

Because of these negative impacts and relatively the little extent to which channelization meets the watershed objectives it is not recommended for large scale consideration.

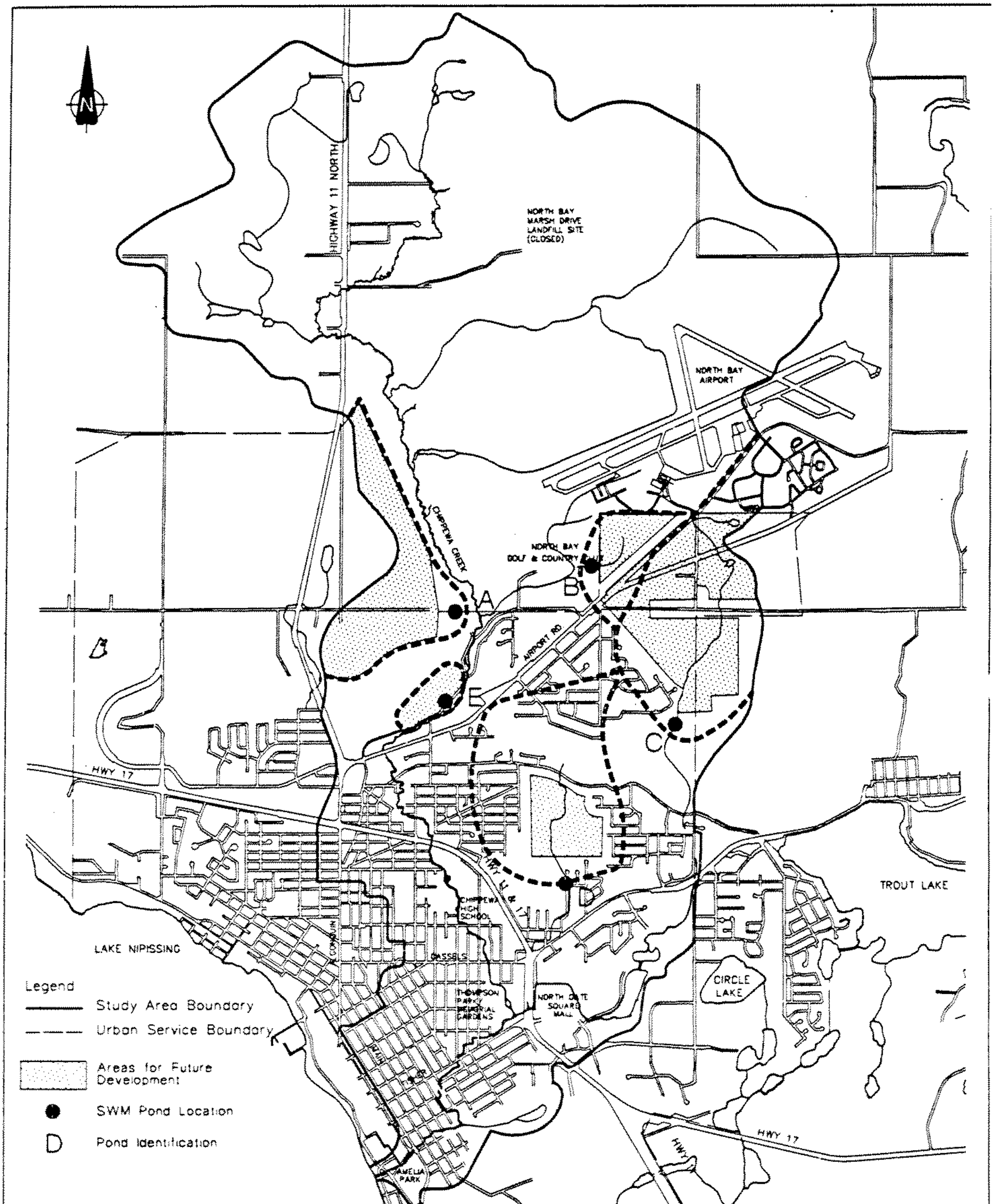
6.3.1 Further Stormwater Management Considerations

Using matrices to screen the long list of hydrologic watershed management alternatives indicates those that best meet the watershed objectives. This does not, however, quantify the degree to which they meet these objectives. The purpose of this section of the report is to quantify the magnitude of some of these alternatives.

Peak Flow (Quantity) Control

Figure 6.3-1, derived from Figure 2.3.4, shows those lands planned for development and the most logical locations for ponds to control the increase in runoff rates. The location of the proposed developments, combined with the watershed topography, necessitates the creation of at least five peak flow control ponds within the watershed. These ponds have been labeled Ponds A to E. It is important to note that for the purposes of a watershed wide study it is appropriate to assume that each of the five developing areas will be serviced by one peak flow control pond. However, detailed inspection of topography and the timing of the developments within each of the five areas may require any one of the ponds to be constructed as two or more smaller ponds having approximately the same total volume.

Assuming that runoff from only the developing areas needs to be controlled with a pond, (i.e. no external lands would be controlled) and assuming the release rates will be limited to existing rates up to the 1:100 year storm, the required active storage volumes are as listed in Table 6.3-1. It is further assumed that there will be an extended detention component for water quality control.



DRAWN BY	Chippewa Creek Watershed Management Study - Phase 2	Proctor & Redfern Limited Consulting Engineers & Planners Toronto North Bay	
CHECKED BY	Potential Stormwater Management Pond Locations	SCALE N.T.S.	DATE DEC. 1994
		DRAWING NO.	Figure 6.3–1

Table 6.3-1 Peak Flow Control Volumes (including water quality control)

Pond	Total Active Volume (m^3)	Approximate Area Required (ha)
A	24000	2.4 - 3.6
B	12100	1.2 - 1.8
C	47000	4.7 - 7.0
D	10000	1.0 - 1.5
E	2000	0.2 - 0.3

Due to its downstream location in the watershed and due to the relatively small fraction developing of land, there may not be sufficient impacts on the in stream flows to warrant peak flow control of area E. Each of the pond sizes included extended detention wet ponds incorporated into them. Pond E would still be required, however, it may not need a peak flow control component. If only the extended detention volume was required, pond E would be 600 m^3 plus any permanent pond volume.

Ponds, A, C, and E would be located and operated as off line facilities due to their large upstream external drainage areas. Pond B, however, can be located such that all lands upstream of it are planned for development and an on line pond is practical and implementable.

The developing area draining to Pond D has only a small external upstream drainage area (which is currently developed) and, therefore, a second analysis was completed to determine the required pond size to create an on-line facility controlling all of the Eastview Tributary, including the existing urban areas. This analysis indicates that pond D would only have to be marginally increased from 10 000 m^3 to 11 000 m^3 to service the entire tributary for water quality control (extended detention) and to 27 000 m^3 to retroactively control peak flow rates back to pre development condition. The hydrologic effects of this facility is shown on Table 6.3-2.

Table 6.3-2 In Stream Peak Flows (m^3/s)

	1:5 year Storm			1:100 year Storm		
Location	**Existing**	**Case 1**	**Case 2**	**Existing**	**Case 1**	**Case 2**
Confluence of Eastview and Johnston	1.8	1.9	1.3	4.6	5.8	3.0
Confluence of Eastview Johnston and Main	4.6	4.3	4.3	11.7	12.4	10.7
Outlet to Lake Nippissing	7.9	7.8	7.8	16.8	16.6	16.6

Case 1: Control developing areas to existing rates

Case 2: Retroactive control of all of Eastview Tributary

Retroactively controlling the peak flows from the existing urban areas, within the Eastview Tributary, reduces flows through the downtown area for the 1:100 year storm by as much as 8 % over existing rates. This may be significant in lowering flood damages during a 1:100 year storm. The reduction in flows due to smaller storms (1:5 year) may not be as evident through the downtown area, however, the reason for retroactive control is to limit flooding damages, and flooding during a 1:5 year storm is likely not a concern.

Other than the Eastview tributary there is little opportunity for retroactively controlling existing urban areas. The peak flows for all of Johnston Creek are already reduced substantially by Delaney Lake and the only other possibility to control the urban areas would be near the main branch. Detaining flow to the main branch may increase flows by delaying the flows here to that from its very large upstream are. The facilities would need to be off-line because an on line facility would form a significant impediment to fish movement. For these reasons, the only opportunity to retroactively control flows through the downtown area is on the Eastview Tributary.

Water Quality

Water quality is a particularly important issue for Chippewa Creek and Lake Nippissing, consequently there is a need to quantify the effectiveness of stormwater quality control measures. In order to assess the effectiveness of the best management practices in addressing the water quality of Chippewa Creek, a rudimentary water quality model was set-up for the watershed.

The model considers suspended solids loading to the creek from the direct runoff of various land uses. Other contaminants could also have been considered, however, water quality data associated with suspended solids is well documented, their interception by BMPs, such as wet ponds, is well understood, and many of the other urban stormwater contaminants physically associate themselves with the suspended solids, or are solids themselves. The degree of controlling suspended solids would, therefore, be a reasonable indicator of general stormwater quality control for the purposes of watershed planning for Chippewa Creek.

The model makes a number of assumptions:

- The suspended solids loading INPUT to the creek comes primarily from direct runoff. The groundwater component would be free of any significant suspended solids load input.
- The amount of average ANNUAL surface runoff is approximately 10% for open space areas and increases to approximately 80% for fully paved areas of the annual precipitation depth (850 mm). It is further assumed there is an exponential relationship between annual runoff depth and the square of the imperviousness of the drainage area.
- The loading to the creek is the product of the annual surface runoff volume and the average total suspended solids (TTS) concentration for each land use.
- The sediment transport of the creek system is in long term equilibrium and there are no reservoirs that store sediment, with the exception of Delaney Lake on Johnston Creek. Consequently, the average annual suspended solids loading to the creek is the same as that leaving the creek system.

- The average efficiency of trapping sediment loads in an urban wet pond facility is 75% and is assumed to be only 50% for Delaney Lake. These are conservatively low values.

Three key locations are considered for comparing TSS loading into the creek system. They are at the:

1. mouth of the creek at Lake Nippissing
2. outlet of Eastview Tributary
3. outlet of Johnston Creek

The model is run using the Excel spreadsheet program. The loading to the creek is computed as a function of the total drainage area of each land use upstream of that point and the total annual surface runoff from each land use. Three watershed conditions are considered:

- Existing land use conditions, including any subdivisions that are now Draft Plan approved but not built. This establishes baseline conditions.
- Ultimate, future urbanization conditions according to the City's Official Plan, without stormwater management.
- Future urbanized conditions with wet pond controlling the sediment loads to the creek system from those areas that develop.

The are two options considered for the Eastview Tributary, that is, controlling just the developing areas using stormwater wet ponds at each new neighbourhood, and using one large pond to control and treat the runoff from most of the lands drained by this tributary, including lands that are now urban.

The TSS loading presented in Table 6.3-3 compares future and future controlled scenarios in relation to existing conditions, hence the absolute values of average annual runoff volumes and TSS loading computed by the rudimentary model become less critical. It does, however, give a reasonable idea of the trends associated with these scenarios.

Table 6.3-3 - Total Suspended Solids Loading to Chippewa Creek

Location	Existing	Future Uncontrolled	Future Controlled
Johnston Ck. outlet	100%	113%	107%
Eastview Trib. outlet	100%	147%	53% or 109%*
Chippewa Ck outlet	100%	128%	97% or 103%*

* considers an on-line pond on Eastview Trib. or with ponds on each new development

The conclusion of this analysis is that urbanization can significantly increase the TSS loading to the creek and that constructing wet ponds, as part of the urban stormwater best management practices, reduces these loads to just greater than pre-development conditions. Constructing an online pond on Eastview Tributary that treats runoff from the existing urban areas, as well as, urbanizing areas can reduce TSS loadings here to approximately 53% of the present rate. This translates to a small net reduction at the mouth of Chippewa Creek.

In considering the three watershed scenarios, much of the urban land use is low density residential. The precise areas of commercial, institutional, parks, etc. are estimated. These estimations should not change the overall findings of this exercise, keeping in mind that are based upon a rudimentary model. The TSS loading computations are shown in Appendix D.

Hypothetically, a low density residential area generates very approximately 12 times the TSS loading as an open area, according to the spreadsheet model. Using a wet pond to treat the TSS load decreases this by a factor of four (75% efficiency), but this is still 3 times that of an open, undeveloped area. The use of wet ponds cannot, by themselves, limit pollutant loads to pre-development rates, but they can significantly reduce the loading. Implementing additional BMPs in developing and redeveloping areas and retroactively controlling runoff from existing urbanized areas (such as the on-line pond on the Eastview Tributary, disconnecting roof leads, etc.) is required to maintain or reduce pollutant loads to Chippewa Creek and Lake Nippissing.

Infiltration BMPs

At source infiltration BMPs are recommended for further consideration in the developing areas of the eastern half of the escarpment zone, more specifically, developing areas B and C as shown on Figure 6.3-1.

Both of these areas, B and C, are located within hydrogeologic zone 2 (ref. Figure 2.1-1) and have an average annual infiltration rate of 160 mm. Development of these areas without at source infiltrative techniques will decrease the total infiltration from these areas. Discharging runoff from impervious surfaces into infiltration trenches will aid in maintaining the recharge characteristics of the areas. Only the runoff from the roof areas is suitable for infiltration. The detailed calculations can be found in Appendix D which demonstrate, in general terms, that providing an infiltration volume of 6 mm from each of the roofs will maintain the existing infiltration rates within developing areas B and C. Assuming the clear stone in the infiltration trend has a void ratio of 33%, the volume of each infiltration trend would be 1.8 m^3 per 100 m^2 of roof area.

6.4 Social/Recreational Alternatives

The social/recreational alternatives for the Chippewa Creek Watershed are divided into the three sections of the Watershed: Lower Watershed, Middle and Upper Watershed.

The social/recreational alternatives to be evaluated in this Watershed Plan are the following:

1) Identify and acquire lands of recreational value and develop parks (passive, sports fields, parkettes).

2) Develop four season trails to link recreational nodes (schools, parks, archaeological sites, etc.)

3) Locate public buildings and facilities on lands abutting watercourse to optimize public use and appreciation of the watercourse's assets.

6.4.1 Lower Watershed

The Lower Watershed (Golf Course Road - Lake Nipissing) is almost entirely urbanized except for the Ski Club marsh area between Ski Club Road and Trout Lake Road. The lands directly abutting the creek are almost entirely owned by public agencies. The use of these lands is primarily institutional (schools) and recreational (parks, Chippewa Way).

In Lower Watershed all of the alternatives mentioned in Section 6.4 have been implemented to a large extent.

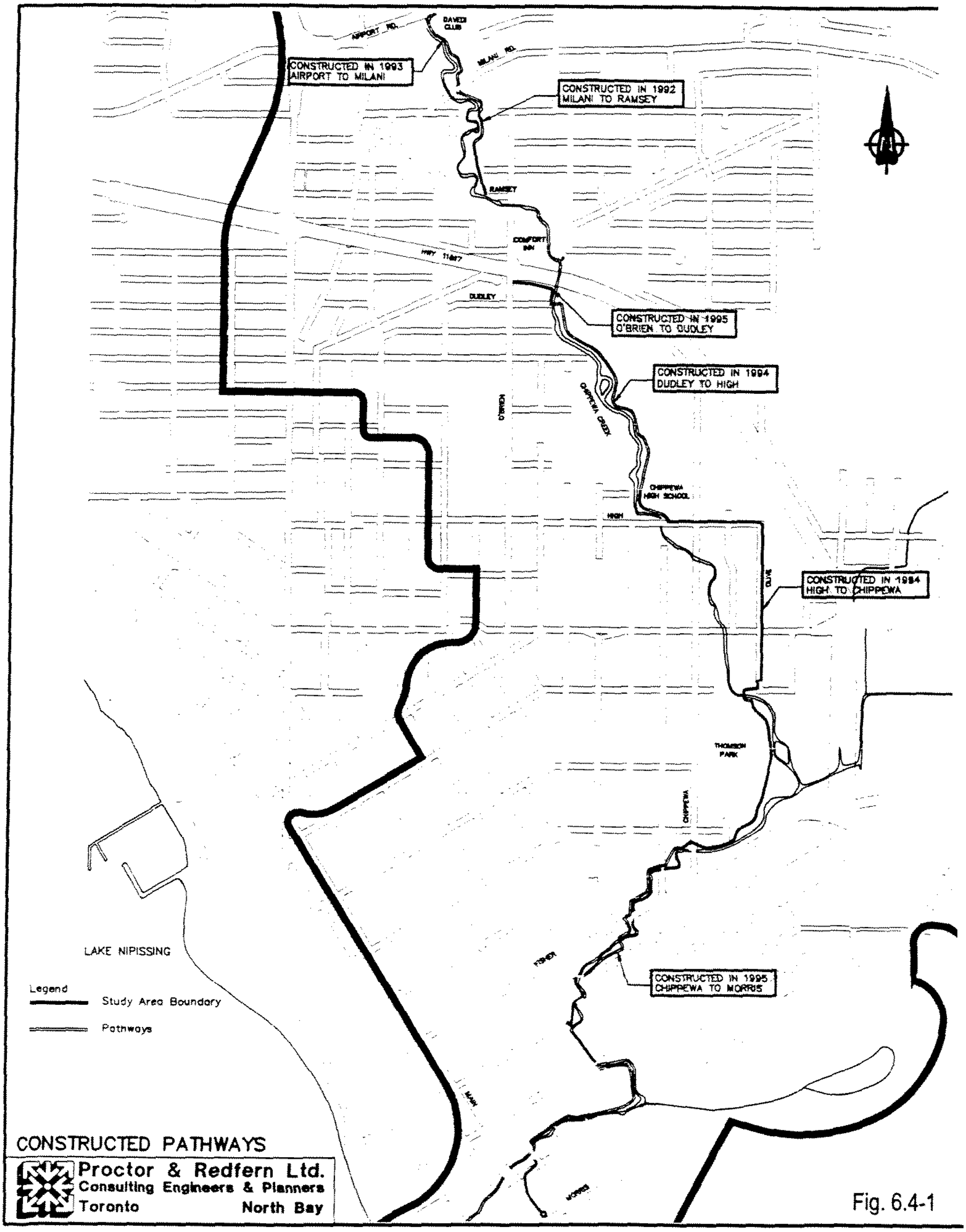
Figure 6.4-1 illustrates the completed portions of "Chippewa Way", city parks and schools. "Chippewa Way" provides a link with all of these public uses (schools, YMCA, parks, as well as some service clubs).

The Archaeologist on the study team identified four archaeological sites within the Lower Watershed. The linking of these sites with existing "Chippewa Way" is an alternative to be evaluated.

The social/recreational alternatives for the Lower Watershed of Chippewa Creek have been already substantially implemented.

6.4.2 Middle Watershed

The Middle section of the Watershed (Golf Course Road - Cedar Heights) is within the Urban Service Area of the City of North Bay's Official Plan, but is largely undeveloped at present



CONSTRUCTED PATHWAYS

Fig. 6.4-1

and primarily rural in nature. The majority of the lands are designated for Residential Use. Almost all of the land in close proximity to the creek is privately owned, except for one parcel owned by the City of North Bay for their Public Works Department.

The social/recreational alternatives identified in Section 6.4 are described below as they are applied to the Middle section of Chippewa Creek.

1) ***Identify and Acquire Lands of Recreational Value***

In contrast to the Lower Watershed, the Middle section of the Chippewa Creek is undeveloped, and the land abutting the creek is privately owned. These lands are slated for development in the short and long term. The subdivision of land must be approved by the Municipality. The Planning Act of Ontario enables municipalities to acquire parkland dedication of 5% of the total land area involved in a subdivision development application.

2) ***Develop Four Season Trails to Link Recreational Nodes***

The TransCanada Trail is a national project to link every province and territory and thousands of communities along its route. The route slated for the TransCanada Trail includes North Bay. The "Discovery Routes Partnership" is a local initiative to build the regional trail network that will hook into TransCanada Trail. At this early stage, the discussions have focused on the TransCanada Trail Route running along the Escarpment to capitalize on its vistas of Lake Nipissing. If "Chippewa Way" were to be extended up the Escarpment, it would be logical to hook into the TransCanada Trail, which would provide access to the Lower Watershed.

Another local initiative has been the concept of linking "Chippewa Way" to a Duchesnay River park/trail and then along the Lake Nipissing Shoreline to link into the "Kate Pace Way". The link between "Chippewa Way" and Duchesnay River would be the TransCanada Trail.

3) *Locate Public Buildings and Facilities on Lands Abutting a Watercourse*

Lands required for Institutional Uses (schools, etc.) are assessed during the development approval process. Because the TransCanada Trail will likely follow along the face of the Escarpment it would be appropriate to locate Institutional Uses so that they would intersect with the trail and function as nodes.

6.4.3 Upper Watershed

The Upper Watershed is mostly outside the planned Urban Service Boundary and therefore will not experience the development pressures experienced in the Lower and Escarpment sections of the Watershed.

The social/recreational alternatives identified in Section 6.4 are described below as they are applied to the Upper Watershed.

1) *Identify and Acquire Lands of Recreational Value*

At present, Besserer Road Park is the only park in the Upper Watershed. The land is owned by the City of North Bay and within the Watershed is the Marsh Drive Landfill Site (closed). This is a large parcel of public property within the Watershed and it would be worthwhile to evaluate any recreational attributes the area may have.

2) *Develop Four Season Trails to Link Recreational Nodes*

At present, the idea of trails in the Upper Watershed is at the conceptual stage. Two potential concepts have been identified.

The first concept would be to extend "Chippewa Way" north of the Escarpment to Highway 11 North where it would intersect with a local transit route. The idea being, one could ride to the top of the "Chippewa Way" trail on a City Transit and start their excursion at the headwaters of Chippewa Creek. On a single trail, the trail user would experience Chippewa Creek in its "natural" (Upper Watershed) setting and "developed" (Lower Watershed) setting.

The second concept, discussed to-date, is the linking of the "Chippewa Way" extension, described above, to a four season trail developed along the headwaters of Duchesnay Creek. This concept would provide for a second larger Upper Watershed loop to the Escarpment loop discussed in Section 6.4.2. This loop would intersect the "Ferguson Colonization Trail" that has been identified by the "Discovery Routes Partnership".

3) ***Locate Public Buildings and Facilities on Lands Abutting Watercourse***

It is assumed that because the Upper Watershed is outside the "Urban Service Boundary" that the land uses in the Upper Watershed will be of a low density form and rural in nature. No institutional uses (i.e., schools, hospitals, etc.) exist or are proposed in the Upper Watershed. This scenario is likely to remain the same for the foreseeable future. Therefore the opportunity to locate institutional uses on lands with proximity to Chippewa Creek are limited.

6.5 Land Use Planning Alternatives

Traditionally, planning for developing areas within a municipality was based on the formation of an Official Plan and Secondary Plans for various planning districts within the municipality. These planning districts were not based on Watershed boundaries, therefore, resource management opportunities to help protect the ecological integrity of the Watershed were not capitalized on.

In June 1993 the Ministries of Environmental Energy and Natural Resources released guidelines on Watershed Planning. The key theme to these guidelines was the integration of Land Use

Planning and Watershed Planning. In short, the guidelines encourage municipalities to undertake Watershed Planning and integrate it into their Land Use Planning decision making process.

The purpose of this phase of the study (Phase 2), is to develop and evaluate Watershed alternatives. Within the broad Land Use Planning context there are only two alternatives:

1) Keep the status quo/do nothing, or;
2) Implement integrated Watershed and Land Use Planning.

1. ***Keep the Status Quo/Do Nothing***

At present, land use approvals and environmental approvals are processed separately by separate agencies. This leads to a disjointed approval process with lengthy delays. It is the opinion of the study team that this alternative is unsatisfactory because of the costs associated with a lengthy approval process and the resulting unknown cumulative impacts on the ecological integrity of the Watershed.

2. ***Implement Integrated Watershed and Land Use Planning***

There are broad environmental and economic benefits to be had by integrating Watershed and Land Use Planning. It considers watershed management and land use planning in terms of the whole ecosystem. It sets water related objectives and targets to be considered prior to land use decisions being made. These targets can be formally incorporated into the Official Plan. Development proposals that conform with the Official Plan lead to streamline approvals because the interests of many agencies will have already been incorporated into the plan.

A Watershed Plan and the resulting Land Use Planning Policy assist in evaluating a development proposal by considering the whole ecosystem, so the scope of what is taken into consideration provides a better "vision" for the local ecosystem so that environmental problems can be prevented. In most cases, it should be possible to accommodate both development and ecosystem needs (MOEE, MNR, 1993).

In the context of the Chippewa Creek Watershed Master Plan, specific land use alternatives for managing the watershed are presented below and can be applied to the various sections of the watershed (lower, escarpment, upper as required).

The planning and watershed management alternatives to be evaluated are:

- implement best management practices when existing developed areas are redeveloped (i.e. utilize vegetated filter strip and/or Stormceptor™ devices) in new commercial on medium to high density residential developments. The tool to implement the BMP's is the development approval process (i.e. rezoning, condominium application, site plan control).
- Implement BMP's on in Lower Watershed by requesting BMP's as a condition of approval.
- Implement BMP's on remaining vacant land in lower watershed by requesting BMP's as a condition of approval.
- Change "Industrial Land Use" designations along Chippewa Creek and its tributaries in Official Plan to a land use (i.e. residential) that doesn't pose the threat of spills and exposure to toxic chemicals. This would not make the existing industrial uses illegal, but over time the intent would be that these uses would not be able to expand and cease to exist. The alternatives listed above can be applied to the various sections of the Watershed (Lower, Escarpment, Upper) as required.

6.6 Preferred Watershed Management Strategy

The Preferred Watershed Management Strategy for the Chippewa Creek Watershed is the combination of ecological, hydrological, social/recreation, and land use alternatives that best meet the goals and objectives of the Watershed Management Plan. The following section summarizes the Preferred Watershed Management Strategy based on the evaluation of a range of watershed management and planning alternatives.

Upper Chippewa Creek Watershed

Preferred Ecological Alternatives

The preferred ecological alternatives for the upper watershed are:

- *Protection of the Upper Chippewa Creek Wetland as a Provincially Significant Wetland.*
- *Maintain the Function of other Wetlands. (i.e. Tower Drive Wetland)*
- *Protection of Significant Forest Areas (i.e. mature forests).*
- *Protection of Significant Wildlife Corridors.*
- *Establish Buffers along the Creek Corridor.*
- *Eliminate Barriers to Fish Passage (i.e. beaver dams west of Hwy 11)*

These alternatives are indicated on Figure 6.6-1.

Preferred Hydrologic Alternatives

The following hydrologic alternatives are recommended for the Upper Watershed:

- *Stormwater management pond B, with the following configuration:*

    Permanent pool volume: *2800 m^3*
    Extended detention volume *1600 m^3*
    Flood control volume *10500 m^3*

- *Sediment and erosion control plans for all of the gravel pits*

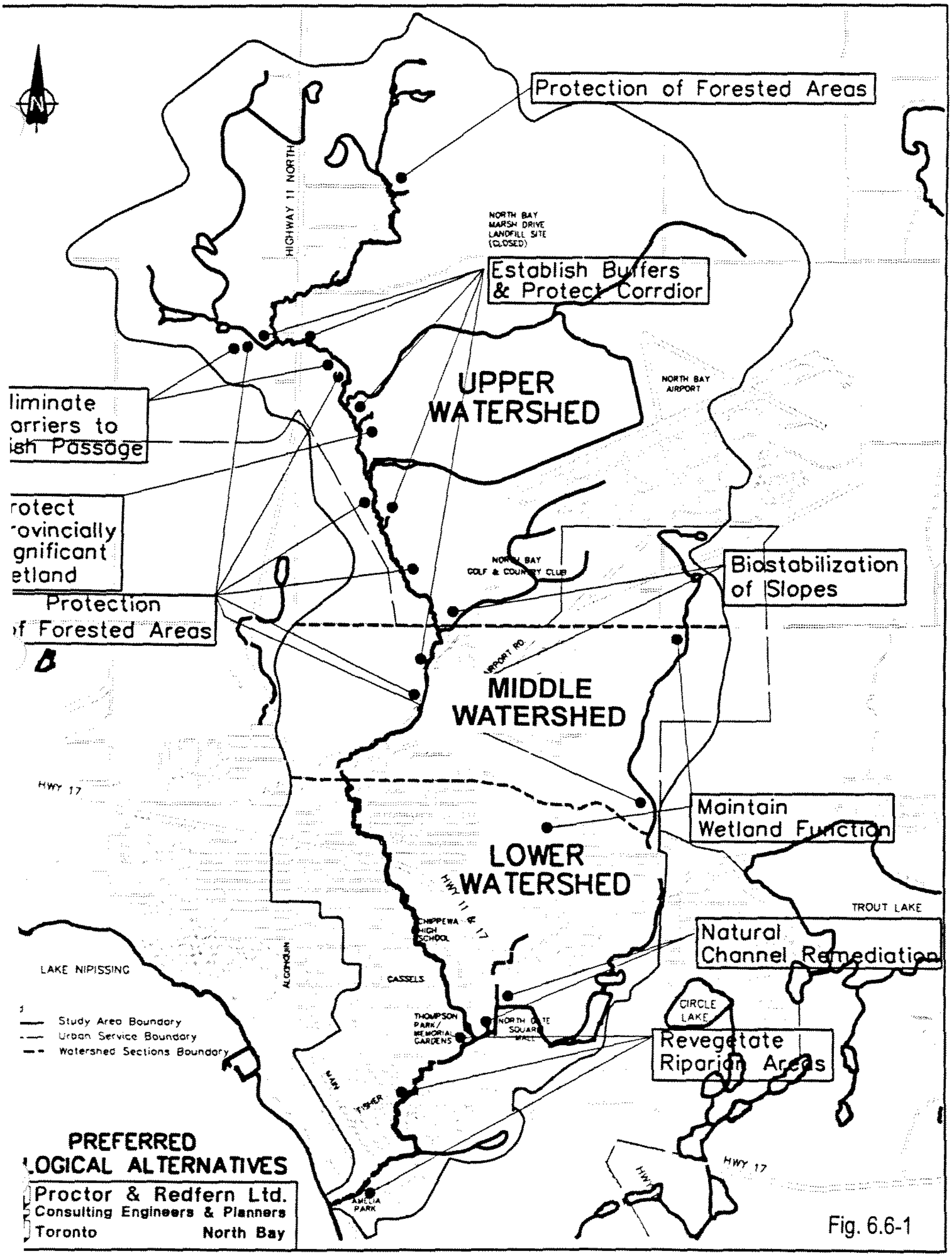

Protection of Forested Areas
HIGHWAY 11 NORTH
NORTH BAY MARSH DRIVE LANDFILL SITE (CLOSED)
Establish Buffers & Protect Corrdior
liminate arriers to ish Passage
UPPER WATERSHED
NORTH BAY AIRPORT
rotect rovincially gnificant etland
Protection of Forested Areas
NORTH BAY GOLF & COUNTRY CLUB
Biostabilization of Slopes
AIRPORT RD.
MIDDLE WATERSHED
HWY 17
Maintain Wetland Function
LOWER WATERSHED
HWY 11 & 17
TROUT LAKE
CHIPPEWA HIGH SCHOOL
Natural Channel Remediation
LAKE NIPISSING
ALGONQUIN
CASSELS
CIRCLE LAKE
Study Area Boundary
Urban Service Boundary
Watershed Sections Boundary
THOMPSON PARK/ MEMORIAL GARDENS
NORTH GATE SQUARE MALL
Revegetate Riparian Areas
MAIN
FISHER
HWY 17
PREFERRED
LOGICAL ALTERNATIVES
AMELIA PARK
Proctor & Redfern Ltd.
Consulting Engineers & Planners
Toronto North Bay

Fig. 6.6-1

- *Agricultural BMPs as required*

These alternatives are indicated on Figure 6.6-2.

Preferred Social/Recreational Alternatives

The following is recommended for the Upper Watershed:

- *The upper watershed is outside the "Urban Service Boundary" and, therefore, will not experience intense development pressure. A recreational opportunity that could be realized would be the extension of the "Chippewa Way" along the creek to its intersection with Highway 11 and a City transit route.*

Chippewa Creek - Middle

Preferred Ecological Alternatives

The preferred ecological alternatives for the escarpment are:

- *Maintain the Function of other Wetlands. (i.e. Tower Drive Wetland)*
- *Protection of Significant Forest Areas (i.e. mature forests).*
- *Protection of Significant Wildlife Corridors.*
- *Establish Buffers along the Creek Corridor.*
- *Biostabilization of slopes (i.e. southeast of Golf Club Road)*

These alternatives are indicated on Figure 6.6-1.

Preferred Hydrologic Alternatives

The following hydrologic alternatives are recommended for the escarpment area:

- *Stormwater management pond A, with the following configuration:*

Permanent pool volume:	*7100 m^3*
Extended detention volume	*4000 m^3*

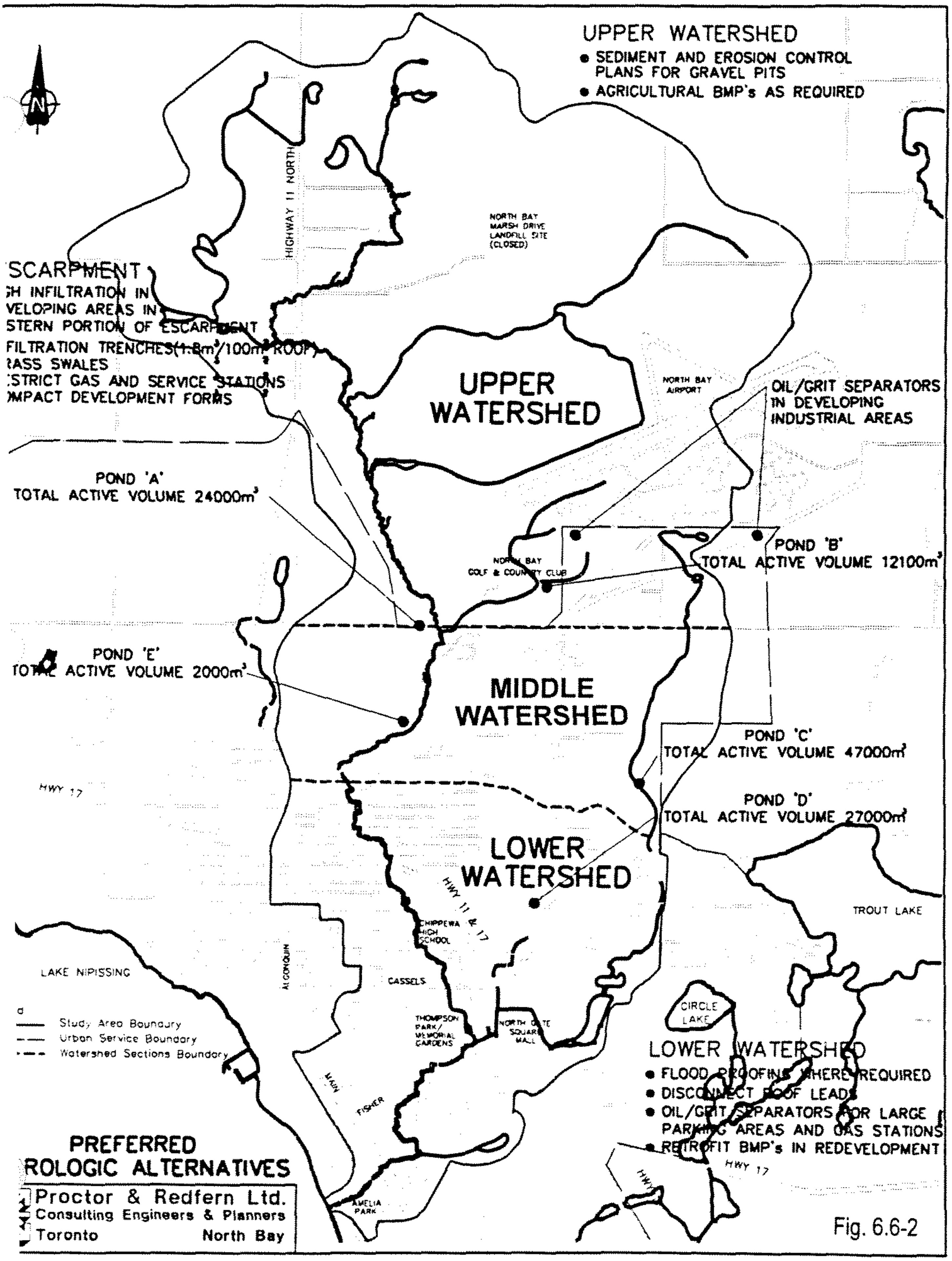

UPPER WATERSHED
• SEDIMENT AND EROSION CONTROL PLANS FOR GRAVEL PITS
• AGRICULTURAL BMP's AS REQUIRED
HIGHWAY 11 NORTH
NORTH BAY MARSH DRIVE LANDFILL SITE (CLOSED)
SCARPMENT
GH INFILTRATION IN
VELOPING AREAS IN
STERN PORTION OF ESCARPMENT
FILTRATION TRENCHES(1.8m³/100m² ROOF)
RASS SWALES
STRICT GAS AND SERVICE STATIONS
MPACT DEVELOPMENT FORMS
UPPER WATERSHED
NORTH BAY AIRPORT
OIL/GRIT SEPARATORS IN DEVELOPING INDUSTRIAL AREAS
POND 'A' TOTAL ACTIVE VOLUME 24000m³
NORTH BAY GOLF & COUNTRY CLUB
POND 'B' TOTAL ACTIVE VOLUME 12100m³
POND 'E' TOTAL ACTIVE VOLUME 2000m³
MIDDLE WATERSHED
POND 'C' TOTAL ACTIVE VOLUME 47000m³
HWY 17
POND 'D' TOTAL ACTIVE VOLUME 27000m³
LOWER WATERSHED
HWY 11 & 17
TROUT LAKE
CHIPPEWA HIGH SCHOOL
LAKE NIPISSING
ALGONQUIN
CASSELS
THOMPSON PARK/ MEMORIAL GARDENS
NORTH GATE SQUARE MALL
CIRCLE LAKE
Study Area Boundary
Urban Service Boundary
Watershed Sections Boundary
MAIN
FISHER
LOWER WATERSHED
• FLOOD PROOFING WHERE REQUIRED
• DISCONNECT ROOF LEADS
• OIL/GRIT SEPARATORS FOR LARGE PARKING AREAS AND GAS STATIONS
• RETROFIT BMP's IN REDEVELOPMENT
HWY 17
AMELIA PARK
PREFERRED
ROLOGIC ALTERNATIVES
Proctor & Redfern Ltd.
Consulting Engineers & Planners
Toronto North Bay

Fig. 6.6-2

Flood control volume *20000 m^3*

- *Stormwater management pond C, with the following configuration:*

  Permanent pool volume: *13200 m^3*

  Extended detention volume *7500 m^3*

  Flood control volume *39500 m^3*

- *Stormwater management pond E, with the following configuration:*

  Permanent pool volume: *1000 m^3*

  Extended detention volume *600 m^3*

  Flood control volume *1400 m^3*

- *Infiltration trenches and grass swales in developing areas of the eastern portion (high infiltration) of the escarpment*
- *Oil grit separators in the developing industrial areas*
- *Restrict the development of service and gas stations in the eastern portion (high infiltration) of the escarpment*
- *Compact development forms in the eastern portion (high infiltration) of the escarpment*

Preferred Social/Recreational Alternatives

- *The lands directly abutting the creek in the escarpment section of the watershed are largely undeveloped, but they are experiencing development pressure (i.e. development applications). Lands of recreational value should be acquired during the development approval process.*

Lower Chippewa Creek Watershed

Preferred Ecological Alternatives

The preferred ecological alternatives for the lower watershed are:

- *Maintain the Function of other Wetlands. (i.e. Ski Club Road Wetland)*
- *Establish Buffers along the Creek Corridor.*
- *Eliminate Barriers to Fish Passage (i.e. removal of debris and sediment)*
- *Revegetate and Manage Riparian Areas (i.e. revegetation along creek in Thompson Park and other open space in the urban area)*
- *Natural Channel Remediation (i.e. Johnston's Creek; redevelopment of sites adjacent to the creek should include creek remediation)*

These alternatives are indicated on Figure 6.6-1.

Preferred Hydrologic Alternatives

The following hydrologic alternatives are recommended for the lower watershed:

- *Stormwater management pond D, with the following configuration:*

Permanent pool volume:	*13000 m^3*
Extended detention volume	*7400 m^3*
Flood control volume	*19600 m^3*

- *Flood proofing where required*
- *Disconnect roof leads*
- *Oil/grit separators in all large parking areas as well as service and gas stations*
- *retrofit BMPs as redevelopment occurs*

Preferred Social/Recreational Alternatives

- *The lands directly abutting the creek in the lower watershed are almost owned entirely by public agencies. Social/recreational alternatives have already been substantially implemented.*

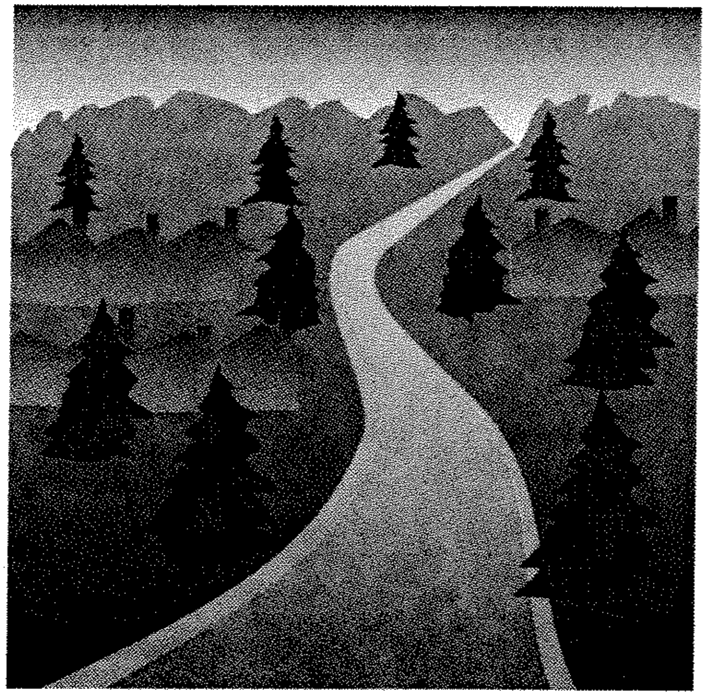
The above preferred alternatives and the recommendations contained in Goals 5, 6, and 7 will for the basis for the Implementation Plan to be developed in Phase 3.

The Corporation of the City of North Bay

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

Chippewa Creek

Watershed Management Study



Phase 3
Watershed Implementation Plan

PROCTOR & REDFERN LIMITED

7.0 WATERSHED MANAGEMENT PLAN

In general, watershed and subwatershed management plans are intended to provide an overall direction to the City, and its partners, by identifying:

1) those lands which should be protected or conserved;
2) any extraordinary design criteria which should be used in the execution of future urban development to address specific watershed objectives;
3) conservation and management practices which address the effects of existing and past land use activities; and
4) a series of practices and programs that seek to remedy specific watershed problems and increase public awareness of the needs of the environment.

Watershed Plans typically identify any developing subwatersheds within the watershed and describe their characteristics (base flows, soils, development pressure, etc.), at a primary level, for any future investigation at the subwatershed level. This report has identified these issues and has proposed a series of recommendations for each subwatershed.

A key component of the implementation of a Watershed Management Plan is the identification of specific items and actions to be investigated, including recommendations on the urgency of the initialization of these actions. There are three general levels of detail associated with watershed planning and these are typically driven by the corresponding level of development planning as follows:

1. Official Plan (or Amendment)	Watershed Plan
2. Secondary Plan	Subwatershed Plan
3. Draft Plan of Subdivision	Stormwater Management Plan

The Official Plan for the City of North Bay has been prepared and adopted prior to the preparation of this watershed study. The Municipality's Secondary Plans do not include policy with regard to watershed planning. It is intended that the findings and recommendations of this study will be implemented through secondary plans.

7.1 Watershed Management Implementation

It is intended that the Chippewa Creek Watershed Management Plan go beyond the extent of typical watershed planning strategies. This management plan has made specific watershed and subwatershed recommendations, that might otherwise be found in many subwatershed planning studies, however, it does not provide all the subwatershed planning details (such as initial design). For these reasons, the implementation of the Watershed Management Plan is being recommended on a ***two phase*** basis, instead of the three phases outlined above. This two phased approach is, as follows:

Chippewa Creek Watershed Planning Implementation

1.Watershed Plan	Official Plan & Preliminary Secondary Planning
2.Stormwater Management Plans	Secondary Plans & Draft Plans of Subdivision

Secondary planning can take place, or be completed, on a ***subwatershed basis***. This will be more consistent with the provincial guidelines and will eliminate the need to carry out formal subwatershed planning, since much of this is covered by this document. The Watershed Management Plan implementation is, therefore, recommended to be carried out for each subwatershed through secondary plans.

For the purposes of implementation, as outlined above, the Chippewa Creek watershed has been divided into four (4) subwatersheds: the Upper Chippewa Creek, the Lower Chippewa Creek (main branch), Johnston Creek, and Eastview Tributary. It must be noted that the geographical areas referred to in Phases 1 and 2 of this report are different than the subwatershed areas. At the outset of this study, the Chippewa Creek watershed was described in geographical terms (upper, middle and lower).

Specifically, these secondary plans will identify;

- infrastructure works, such as siting and refining the sizing of the stormwater management basins, including initial designs.
- identifying the major (overland flow) and minor (trunk sewer) system routes and preliminary design flows, sizing, etc.
- details of remediation programs to enhance the health of each subwatershed, including initial designs
- urban development criteria that meet the environmental targets set out by the watershed goals and objectives, established herein.
- requirements for the subsequent stormwater management plans needed to support Draft Plans of subdivision.

The above is in addition to the current secondary planning requirements for the City.

The following sections provide recommendations for Chippewa Creek and its subwatersheds and identifies requirements for future Secondary Planning.

7.2 Recommendations for Implementation - Chippewa Creek Watershed

The following recommendations are provided according to the Goals and Objectives for the Chippewa Creek Watershed and the preferred Watershed Management Strategy. In some cases these recommendations apply to specific sections or subwatersheds of the creek. These recommendations are further presented on Figure 7.2-1 (Watershed Implementation Plan).

A. Fisheries and Riparian Zone Areas

The fish communities within Chippewa Creek can be generally divided into coldwater fisheries, in the headwaters and middle portions of the creek, and warmwater fisheries, in the lower sections, and in Eastview and Johnston Creeks (Fig. 2.5-1). Within these areas the riparian zone (the floodplain and embankment areas along the creek) plays an important role in creating and maintaining the aquatic environment and the aquatic-terrestrial interface. It is for this reason that management of the fisheries and riparian zone of a creek are inseparable.

Based on the existing fish communities and the physiological attributes of Chippewa Creek it is reasonable to set the following targets for fisheries within portions of the creek:

> ***Upper & Middle Chippewa Creek*** *(Headwaters to Airport Road) - Maintenance and protection of the existing Coldwater fish community / Brook Trout population.* The existing brook trout population and spawning area in the Upper Chippewa Creek and the potential fish habitat in the Middle Chippewa Creek area represent opportunities for future management and protection. The best option for these areas is to maintain and protect the existing coldwater fish community and its environment.
>
> ***Lower Chippewa Creek*** *(Airport Road to Lake Nipissing including Eastview & Johnston Creeks) - Maintenance and enhancement of the Warmwater fish community.* The Lower Chippewa Creek area, while having an existing warmwater fish community, is limited in its potential for a coldwater fishery by virtue of its relatively flat gradient and shallow depth. Riparian vegetation is severely limited in urbanized portions of the creek resulting in a lack of cover along the creek and a increase in water temperatures. This lack of vegetation limits the potential for a fisheries in the lower creek. The most reasonable option for this portion of the creek is to maintain the existing warmwater fish community and attempt to enhance it by riparian zone revegetation an natural channel restoration.

The following recommendations are designed to achieve the above targets through management of the riparian zone and creek channel environment. Many of the recommendations provided below also are designed to protect surface water quality:

Chippewa Creek (General-entire watershed)

Recommendation A.1: ***A Fisheries Monitoring Program should be established for the purposes of tracking changes in the fish communities of Chippewa Creek with regards to the recommended implementation measures of this plan. The monitoring program should be conducted bi-yearly, and should include fish surveys, general habitat monitoring, brook trout spawning surveys, and benthic invertebrate monitoring. This monitoring program should be coordinated with any existing surveys or programs presently being conducted by the Ministry of Natural Resources, the North Bay Mattawa Conservation Authority or the City of North Bay. (See Section G for implementation of this program)***

Upper & Middle Chippewa Creek (Headwaters to Airport Road)

Recommendation A.2: ***For the purposes of protecting the existing fish community and surface water quality, a vegetated buffer of 30 meters (from the creek bank or the 25 year floodplain whichever is greater) should be maintained for the main branch and tributaries of the Upper Chippewa Creek and Middle Chippewa Creek areas from the headwaters south to Airport Road. The buffer area will be generally regarded as a "no development" or environmental protection area, with the exception of utility corridors, roadways, and recreational trails.***

Recommendation A.3: ***Proposed developments for areas within 50 meters of the creek bank, from the headwaters to Airport Road, should be required to demonstrate no impact, or minimal impact on surface water quality and the resident fish community. Site-specific environmental impact reports regarding impact should also address the appropriateness of the buffer referred to in Recommendation A2 in the area of the proposed development.***

<u>*Lower Chippewa Creek (Airport Road to Lake Nipissing including Eastview & Johnston Creeks)*</u>

Recommendation A.4: *For the purposes of protecting the existing fish community and surface water quality, a buffer of 7.6 meters from the creek bank or the 25 year floodplain whichever is greater is to be established in the Lower Chippewa Creek area. It is recognized that existing development presently encroaches on this buffer. For this reason, the buffer applies primarily to proposed redevelopment of land adjacent to the creek corridor. The buffer area should be generally regarded as a "no development" or environmental protection area, with the exception of utility corridors and roadways and recreational trails.*

Recommendation A.5: *For those areas, in the Lower Chippewa Creek south of Airport Road, where <u>redevelopment</u> is proposed within 30 meters of the creek bank or the 25 year floodplain, a site-specific environmental impact report of the needs for, and feasibility of natural channel remediation should be undertaken.*

Recommendation A.6: *A Revegetation and Creek Naturalization Plan should be developed for the area between Airport Road and Memorial Drive, particularly Thompson Park, and any other open space areas along the creek corridor. This plan should compliment the recent erosion control program carried out by the NBMCA and could include the identification of:*

- *appropriate native plant species,*
- *approximate limits of plantings,*
- *property ownership,*
- *phasing options for plantings,*
- *specific bioremediation techniques for the riparian zone,*
- *opportunities for integration with Chippewa Way infrastructure, and*
- *opportunities for public involvement in planting programs.*

Recommendation A.7: ***For the purposes of enhancing the riparian zone and fish habitat in the Lower Chippewa Creek area, it is recommended that revegetation or tree planting be conducted on publicly owned lands, within 7.6 meters of the creek bank, that are unvegetated or poorly vegetated (areas lacking shrub or tree cover). Revegetation or tree planting should be encouraged for similar areas on privately owned lands through a public education program.***

B. Wetlands

The majority of wetland area within the Chippewa Creek Watershed is located on the Upper Chippewa Creek area, with smaller wetland pockets being located between Tower Drive and Highway 11N (Fig. 2.5-2). The Upper Chippewa Creek Wetland Complex dominates the Chippewa Creek headwaters channel. Coincident with the wetland are the areas of coldwater fish habitat and brook trout spawning sites mentioned above. This wetland also functions as a wildlife corridor, protects surface water quality, prevents erosion of the creek's banks and provides hydrologic benefits which moderate downstream rates of runoff. The protection the Upper Chippewa Creek wetland complex is, therefore, important to the fulfillment of a number of watershed management objectives.

The wetland areas located in areas south of Airport Road (Ski Club Marsh and Tower Drive Wetland Complex), while limited in their habitat functions, do provide surface water quality protection and sediment trapping functions as well as hydrologic benefits. The maintenance of these functions are considered to be important to the fulfillment of the watershed management objectives and the preferred strategy.

The following recommendations are designed to meet the objectives regarding wetlands within the Chippewa Creek Watershed:

Upper Chippewa Creek

Recommendation B.1: ***The Upper Chippewa Creek Wetland should be protected as a Significant Wetland where possible, and should be managed by locally devised protection policies consistent with the 1996 Ontario Provincial Planning Policy Statement. It will be the responsibility of the City of North Bay to develop appropriate guidelines and assessment requirements for Provincially Significant Wetlands and their adjacent lands by way of Official Plan policy.***

Eastview and Johnston Creek Subwatersheds

Recommendation B.2: ***The protection of wetland area in the Ski Club Road Marsh and Tower Drive Complex wetlands is encouraged. However, development may be permitted in these areas if it is demonstrated that the key functions of surface water quality protection and sediment trapping are maintained. Consideration should be given to alternatives that address the preservation of the wetland versus the replication of the wetland's functions elsewhere within the subwatershed. Habitat functions should be maintained where possible.***

C. Forested Areas and Trees

The majority of mature forested areas (contiguous stands >75 years old) in the Chippewa Creek watershed are limited to the Upper Chippewa Creek area north of Airport Road (Fig. 2.5-3). These large forested areas provide cover and habitat for wildlife while also preventing loss of soils, and maintaining areas of groundwater recharge. The mature forest cover in the Upper Chippewa Creek area also represents the greatest area of un-urbanized lands within the watershed. These areas provide habitat, cover and natural corridor areas for wildlife and provide hydrological benefits by intercepting flow and controlling run-off. The maintenance of tree cover and proper management of forest resources is, therefore, important to the watershed as a whole.

Tree cover in the Lower Chippewa Creek, Eastview Creek, and Johnston Creek subwatersheds is very limited. Much of the tree cover in these areas are remnant individual trees and scrubby vegetation. In these areas, tree planting should be encouraged.

The following recommendations are provided regarding forested areas and tree cover:

***Chippewa Creek** (General-entire watershed)*

Recommendation C.1: ***Tree cutting should be prohibited for lands within buffer corridors.***

***Upper and Middle Chippewa Creek** (from headwaters to Airport Road)*

Recommendation C.2: ***Mature forest areas (Fig. 2.5-3 & Fig. 7.2-1) should be managed in such a way as to maintain the aesthetic characteristics of these areas and preserve hydrologic benefits.***

Recommendation C.3: ***Development should be prohibited in areas where the average slope over 100 metres is greater than 15%. Furthermore, removal or destruction of natural vegetation (excluding vegetation control program required along utility corridors) in these areas should be permitted only with authorization from the City.***

D. Stormwater Management and Surface Water Quality

Significant rises in flow rates are anticipated in response to future development, particularly on the main branch above Airport Road, the upper portion of Johnston Creek, and the entire portion of the Eastview Tributary. Similar increases are expected with the suspended solids loadings, and other associated stormwater contaminants, in these locations. Without implementing stormwater management facilities and programs, increased flooding, streambank erosion and degradation of water quality can be expected with continued development. This not only affects the Chippewa Creek watershed, but Lake Nipissing, as well.

The following are the stormwater management recommendations:

Chippewa Creek (General - entire watershed)

Recommendation D.1: ***For the purposes of water quality control and maintaining the existing peak flows require in the creek, five (5) stormwater management facilities are recommended (see Fig. 7.2-1). Each of these facilities will have a permanent pool, an extended detention component and a quantity control component. The locations and volumes for these facilities are outlined in section 6.6 of this report. It is important to note that the permanent pool volumes quoted in section 6.6 assume a Level 2 habitat in the stream. As the design and implementation of these facilities progress, consideration should be given to increasing the permanent pool volumes to meet the Level 1 criteria, wherever possible.***

Recommendation D.2: ***Stormwater Management Plans should be developed for each of the three (3) Subwatershed areas (Upper Chippewa, Johnston Creek and Eastview tributary). These SWM Plans should refine the hydrologic analyses carried out as part of this study and prepare initial designs of the stormwater management facilities and should set objectives for dissolved oxygen, temperature and suspended solids.***

Upper and Middle Chippewa Creek

Recommendation D.3: ***For the purposes of minimizing the suspended sediment loadings in the creek from the upper watershed area, sediment and erosion control plans are recommended for all of the gravel pits.***

Recommendation D.4: ***For the purposes of preserving the infiltration in the eastern portion of the escarpment and the Johnston Creek subwatershed, compact development forms, which***

concentrate development in clusters and leave large areas of open space, incorporating infiltration trenches and grass swales are recommended. More detail regarding the infiltration trenches can be found in section 6.3 of this report. Furthermore, the construction of service and gas stations in this area should continue to be restricted.

Recommendation D.5: *For the purposes of maintaining and enhancing water quality, oil grit separators are recommended in the developing industrial areas, as well as, retrofitting these into large parking areas and any gas/service stations or larger parking lot area.*

Lower Chippewa Creek

Recommendation D.6: *For the purposes of improving water quality and quantity generated from within the existing urban area, a roof leader disconnection program should be implemented and the City's program which searches for sanitary sewer cross-connections should be continued.. Infrastructure rehabilitation studies should be carried out in some of the older watersheds including First Avenue and the Chippewa Street outfall near Fisher Street along with a water sampling program and the smoke testing/dye testing program. As redevelopment occurs, BMPs should be integrated into the existing storm drainage systems. For example, oil and grit separators and grassed filter strips can be introduced into the existing large parking areas and gas/service stations while grass swales might replace curb and gutters.*

Some municipalities in Ontario are undertaking infilling studies that identify means to implement stormwater BMPs in established urban areas where redevelopment occurs by means of infilling. An infilling study should be considered for the older watersheds in the lower Chippewa creek basin.

E. Flooding and Erosion Protection

The Conservation Authority has done much to reduce flooding and erosion potential along Chippewa Creek in recent years. Some erosion protection and flood control has yet to be completed.

Chippewa Creek

Recommendation E.1: ***For the purposes of addressing erosion concerns, it is recommended that the location and types of creek stabilization and bioremediation required along sections of the landfill tributary and adjacent erosions sites should be identified. Furthermore, it is recommended that the initial design attributes of natural channel remediation along lower sections of Johnston Creek and the lower sections of Eastview Creek be determined in the SWM Plans for these subwatersheds.***

Lower Chippewa Creek

Recommendation E.2: ***For the purposes of reducing flooding in the lower watershed area, it is recommended that the Conservation Authority finalize acquiring the few remaining properties within flood risk areas.***

F. Social/Recreational

The two most important Social/ Recreational aspects of Chippewa Creek are the public's direct contact with water at the Lake Nipissing beaches adjacent to the mouth of Chippewa Creek (i.e. Amelia Beach and Golden Mile Beach) and indirect contact opportunities that the entire watershed provides (i.e. parks, pathways and schools adjacent to the creek). The recreational opportunities available along the creek and at its mouth have largely already been capitalized on, but the following recommendations when implemented could build on those already implemented.

Upper and Middle Chippewa Creek (from headwaters to Airport Road)

Recommendation F1: *That an extension to Chippewa Way Pathway should be planned and formally recognized in Secondary Plans. In planning the Chippewa Way, an emphasis should be made to investigate and capitalize on the proposed Trans Canada Trail (Discovery Routes Partnership) which is to pass through the City. Chippewa Way, if connected to the Trans Canada Trail would provide an efficient and attractive entrance into the various commercial areas for trail users and could provide a pedestrian/bicycle link to other trail systems.*

Recommendation F2: *That the Chippewa Way Pathway be extended to connect to the proposed Ferguson Colonization Road Trail (Discovery Routes Partnership), at a location where Chippewa Creek crosses Highway No. 11N. This initiative should be recognized in the City of North Bay's Official Plan to inform landowners and enable the city to protect a corridor along Chippewa Creek to implement this initiative.*

Recommendation F3: *That any extension to Chippewa Way also consider linkages to Duchesnay/Kate Pace Way pathway loop be realized in the future and also linkage at the east end of the City to possibly connect with the LaVase River portage. The existing Chippewa Way Pathway and Kate Pace Way (waterfront) will be linked in 1996 by a bridge over the overpass connecting Lakeshore Drive and Main Street. This will be the first link to a pathway loop.*

Recommendation F4: *That the route of Chippewa Way north of Airport Road capitalize on natural heritage features (post glacial shorelines and deposits) and that interpretive kiosks be located to describe how landscape features were created and what their importance is today (i.e. aggregate resource, water recharge).*

Recommendation F5: *That mature forest areas and natural feature should be managed in such a way that the aesthetic value of the Upper Chippewa Valley (Golf Course Road, Airport Road) are maintained.*

Lower Chippewa Creek

The existing Chippewa Way pathway system provides an excellent opportunity for public interaction with the lower creek corridor and for social linkages throughout the lower watershed.

Recommendation F6: ***That the Chippewa Creek Pathway within the lower watershed be expanded to link Trout lake (Armstrong Park) and to include heritage sites (ancient Lake Nipissing Shoreline, Portage Trail near old Ontario Hydro Regional Office, and Delaney Lake archeological site) where ever feasible.***

Recommendation F7: ***That water quality targets for the lower watershed be primarily aimed at improving recreational contact for swimmers to capitalize on the location of Amelia Beach as a recreational swimming beach. The water quality at the Lake Nipissing beaches adjacent to the mouth of Chippewa Creek, is dependent on the continued reduction of E.coli bacteria levels in stormwater sewer system. This involves the continuation of the Find and Fix program undertaken by the City to identify and undertake infrastructure needs assessment and to repair deficient storm and sanitary sewer system deficiencies and rectify cross connections (sanitary sewer to storm sewer) and Poop and Scoop Bylaw to limit domestic pet feces from entering storm sewers during a rainfall event and ultimately Lake Nipissing.***

G. Implementation, Monitoring, and Community Involvement

The implementation of this watershed plan is dependent on a coordinated strategy of City and Conservation Authority programs in conjunction with a community environmental advisory committee. The role of the City will be to amend the City's Official Plan and Secondary Plans to include watershed management policy (see Section 7.3) and to undertake infrastructure rehabilitation needs studies in the older parts of the City. The Conservation Authority's role will be to continue to implement flood and erosion control as well as their ongoing role in trail development.

The community environmental advisory groups will have three key roles:

- monitor the implementation of the alternatives recommended in the watershed study; and to encourage community based initiatives to continue to identify resource features and monitor environmental considerations.

- advise decision makers of priorities in waterhsed and success of implementation; and to encourage the development of subwatershed management policies.

- educate the general public on the importance of a healthy watershed and its benefits and to encourage public participation in watershed activities.

The "buy-in" from, and involvement of the public, landowners, and developers will be key to the successful implementation of this plan. It is, therefore, important that the community living in, or owning land around Chippewa Creek become a part of the implementation process. The following are recommendations for community involvement in the Implementation Plan:

Recommendation G.1: ***That a community environmental advisory committee reporting to the City Council be established for the purposes of monitoring watershed management implementation, advise decision makers coordinate public education and community involvement. The membership of the community environmental advisory committee should include representatives from the City of North Bay, the North Bay Mattawa Conservation Authority, and a cross-section of members of the public and property owners.***

Recommendation G.2: ***That the community environmental advisory committee initiate, organize and obtain where possible corporate sponsorship of watershed management operations. For example a local company may wish to sponsor the monitoring of water quality in the creek. Another company may wish to donate native plant species for***

rehabilitating school, parkland and institutional properties adjacent to the water course. Sponsorship of trail development should also be sought.

Recommendation G.3: *That an "Adopt a Creek" Program be established for public education programs.*

Recommendation G.4: *That the remaining property acquisition along the creek corridor be finalized to complete the implementation of creek restoration objectives, where warranted. These may be for reasons associated with, flooding, erosion, parkland, public access, riparian zone restoration, natural channel restoration, etc.*

Recommendation G.5: *That a "one window" approach be implemented for development applications within the watershed and that the City of North Bay Planning and Engineering and Environmental departments and the Conservation Authority perform this role. In performing this role, the City would:*

- *review development proposals submitted, to ensure they are in accord with watershed and subwatershed objectives and the criteria governing development.*
- *maintain and continuously dialogue with the appropriate provincial ministries and the Conservation Authority that they have reviewed the proposal and that it meets the requirements of the watershed plan and subwatershed objectives.*

7.3 Supporting Environmental Policies

Watershed and Subwatershed planning provides supporting input to municipal planning. At the watershed planning level the characteristics of the watershed are identified (subwatersheds, hydrology, hydrogeology, recreational aspects etc.). Subwatershed planning provides direction in protecting and enhancing the ecosystem components of Chippewa Creek and its tributaries.

Although this study is a Watershed Planning Study, there is sufficient information about each subwatershed to make recommendations at the subwatershed/secondary plan level of detail. Therefore, the planning policy recommended in this section is at the Official Plan and Secondary Plan level.

In 1993, the City of North Bay initiated a statutory review of the City of North Bay's Official Plan. This review resulted in the preparation of Official Plan Amendment No. 68. The amendment was adopted by Council but has not yet been approved by the Minister of Municipal Affairs.

Official Plan Amendment No. 68 contained policy aimed at coordinating local planning and development within a watershed context. Stated below are these specific policy sections of OPA No. 68 that address watershed planning and stormwater issues.

1. OPA No. 68 recommended Part 7 - Municipal Services of the City's Official Plan be amended by the inclusion of the Following paragraph.

   "10.6.3 In the preparation of secondary plans, ecosystem approaches to land use planning shall be encouraged. In particular, watershed and subwatershed planning shall be used to show how water resources and related resource features will be protected and enhanced to coincide with existing and changing land uses. Specifically these types of Secondary Plans will:

   i) identify location, areal extent, present status, significance and sensitivity of the existing natural environment within the watershed;
   ii) establish goals and objectives for management of the subwatershed;
   iii) address cumulative impacts of changes to subwatersheds on the natural environment;
   iv) integrate disciplines, policies, mandates and requirements of relevant agencies and interests in a subwatershed;
   v) provide technical information that will assist in the preparation of development proposals within the subwatershed.

Recommendation: *New planning policy for watershed management of Chippewa Creek should consider the following recommendations*

- *That Official Plan policies indicate that subwatershed planning is a requirement when considering land use change within the City of North Bay.*
- *That the Official Plan establish a Natural/Cultural Heritage strategy based on findings of further sub-watershed studies.*
- *That the Official Plan define a stewardship strategy for the management of natural features, floodplains and corridors and significant heritage areas.*
- *That the Official Plan establish Performance Criteria on Environmental Targets that apply to each subwatershed.*
- *That The O1 (Floodway) Zone continue to prohibit development and that the O2 (Flood Fringe) include a minimum setback requirement of 30 metres from top of bank of Chippewa Creek in the upper and middle watershed and 7.5 metre in the lower watershed.*
- *That site plan control by-law(s) be considered to assist in achieving watershed management targets.*
- *That one of Environmental Protection Land Use Schedules in the Official Plan show locally significant wetlands and heritage areas(trails).*
- *The Official Plan require Stormwater Management Plans (submitted for approval of a specific development) to meet objectives of targets set out in subwatershed plans.*
- *That the Official Plan clearly state that when land use changes are proposed, no alteration or degradation of streams with an aquatic resource will be approved unless an EMP is undertaken which shows that impacts can be mitigated to ensure conservation of the resource.,*
- *It should be the objective of the Official Plan to achieve district stormwater management control areas in district parks and show pond locations on Secondary Plans to avoid managing stormwater in an ad hoc manner.*

- ***That the OP indicate that stormwater management and erosion/sedimentation management is a requirement for developing areas.***

7.4 The Environmental Assessment Process

The Chippewa Creek Watershed Management Study and Implementation Plan has followed a process which meet requirements of a Master Plan under the Environmental Assessment process (more specifically the Municipal Class EA for Water and Sewer Projects). This study has addressed the requirements of the EA process by:

- describing the environment and outlining the problems within the Chippewa Creek Watershed,
- providing alternative solutions to remediate problems within the watershed,
- evaluating alternatives and through selection of a preferred management strategy, and
- providing opportunities for public input through the participation of a Public Liaison Committee, public notification, and through public open houses.
- providing a 30 day Public Review period from November 1 to December 1, 1996 to allow the public an opportunity to comment on the final "draft" report.

Following the thirty (30) day Public Review period comments were received from the public. These comments and responses to the comments are provided in Appendix H.

Section 2.3.3 of the Municipal Class EA for Municipal Water and Sewer Projects states that for Schedule "B" projects, Phase 1 and Phase 2 will have been satisfied by the Watershed Management Plan. Projects which fall under Schedule "C" need to fulfill the additional requirements of Phases 3, 4 and 5. Such requirements are anticipated to be addressed during site-specific Stormwater Management Plans and Secondary Plans.

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GLOSSARY OF TERMS

ABUNDANCE	the number of individuals of a given species.
ANTHROPOGENIC	of human origin; human induced.
AQUATIC COMMUNITY	an association of interacting populations of aquatic organisms in a given waterbody or habitat.
BENTHOS	the biota living on or in the surface sediment of a waterbody (i.e. stream, lake, or wetland)
BIOLOGICAL ASSESSMENT	an evaluation of the biological condition of a waterbody using biological surveys and other direct measurements of resident biota in surface waters.
BIOLOGICAL MONITORING	is the use of a biological entity as a detector and its response as a measure to determine environmental conditions. Toxicity tests and biological surveys and are common biomonitoring methods.
BIOLOGICAL SURVEY	(or biosurvey) consists of collecting, processing and analyzing representative portions of a resident aquatic community to determine the community structure and function.
BIOTIC INDEX	an numerical index that synthesizes known tolerance data for organisms with a quantitative measure of their abundance. The Hilsenhoff Biotic Index is calculated by multiplying the number of individuals of each species by its tolerance value, summing these products and dividing by the total number of individuals.

CAROLINIAN FOREST
a historic deciduous forest community type that once covered a majority of Southen Ontario. Also referred to as the Deciduous Forest Region. Carolinian forests provide habitat for a number of rare species of flora and fauna.

COLD WATER FISHERY
a community of fish species adapted to cold water environments (water temperatures less than 21 Degrees Celcius). Cold water environments typically have a high riffle to pool area ratio, predominantly coarse substrate, and a high degree of shade or canopy cover.

COMMUNITY
the group of populations of interacting plants/animals in a given area.

COMMUNITY COMPONENT
is any portion of a biological community. The community component may pertain to the taxonomic group (fish, invertebrates, algae), the taxonomic category (phylum, order, family, genus, species), or the feeding strategy.

CRITERIA
the numerical limits of contaminants which are established to protect the environment and specific uses of the environment.

DIVERSITY
a numerical index that incorporates both the number of species(richness) in a given area and their relative abundances. The Shannon-Weiner index is calculated as H = pilogpi, where pi is the relative proportion of individuals of each species.

ECOLOGY
the branch of science concerned with the relationships between organisms and their environment.

EPT RICHNESS
the number of species present of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera). These three groups (orders) are generally associated with good water quality.

EVENNESS	a measure of the homogeneity of species diversity. Calculated as a ratio of the observed diversity to the maximum possible diversity, i.e. $J = {}^{H}/_{Hmax}$.
GRAMINOID	a grass, or grass-like plant species.
HABITAT	the range of environments in which a species lives; the biotic and abiotic requirements of a species or individual.
HERBACEOUS	non-woody, non-graminoid vegetation
IMPACT	a change in the chemical, physical or biological quality or condition of a waterbody caused by external sources.
IMPAIRMENT	is a detrimental effect on the biological integrity of a waterbody caused by an impact that prevents attainment of the designated use.
INDICATOR SPECIES	a species specific to a particular set of environmental factors such that by its presence or absence it indicates a degree of environmental quality.
INVERTEBRATE	any animal species that does not possess a back-bone.
MIXING ZONE	an area of water contiguous to a point source of pollution where exceptions to water quality objectives and conditions may be granted.
PHENOLOGY	study of the periodic (seasonal) phenomena of animal and plant life and their relations to the weather and climate.
POPULATION	a group of interbreeding individuals of the same species occurring in a given area.
QUALITATIVE	distinctions that are not based on a measured scale.

QUANTITATIVE	distinctions that are based on a measured scale and that can be given a numerical value.
REACH	a comparatively short length of a stream, channel or shore.
REMNANT	a small remaining quantity or part; a surviving trace of something (i.e. a portion of a woodlot).
RICHNESS	the simplest measure of species diversity, expressed as the number of species (taxa).
RIPARIAN VEGETATION	plant growth associated with, and growing adjacent to a watercourse.
SEDIMENT	the soils/substrate at the bottom of a waterbody i.e. stream, lake or wetland.
SPECIES	the populations of organisms that actually or potentially interbreed and produce fertile offspring.
SPECIES RICHNESS	the number of different species that occur in a given defined area.
SUBSTRATE	the material that organisms live on or in (for example, sand, mud, rock).
TAXA COMPOSITION	the relative abundances of many species in a community; may be shown as total numbers of different taxonomic groups of organisms.
TAXON	a group of related organisms; a category of classification. (i.e., species)
UNDERSTOREY	the area / habitat found under the forest tree canopy.

WARM WATER FISHERY	a community of fish species adapted to a warm water (water temperatures greater than 21 Degrees Celcius) environment. Warm water habitat\environment also has high width to depth ratios, high pool area to riffle area ratio, small substrate type, and an abundance of aquatic vegetation.

APPENDIX A

BACKGROUND

APPENDIX A-1

STEERING COMMITTEE MEETING MINUTES

CHIPPEWA CREEK WATERSHED MANAGEMENT STUDY

<u>Steering Committee</u>

<u>MINUTES</u>

THIRD meeting of the Chippewa Creek Watershed Management Study Steering Committee, held on Thursday, August 25, 1994, at 2:00 p.m. in the Authority Boardroom, 233 Birchs Road, North Bay, Ontario.

MEMBERS PRESENT:	Jamie Houston - City of North Bay Jeff Celentano - City of North Bay Peter Bullock - City of North Bay Dave Maraldo - MNR Lorne Merritt - MNR (Kemptville) William P. Beckett - NBMCA Paula Scott - NBMCA Eva Wardlaw - City of North Bay/NBMCA Mike Morrison - North Bay & District Health Unit Peter Brown - Canadore College Gord Miller - MOEE
MEMBERS ABSENT:	Steve Sajatovic - City of North Bay Dave Robinson - City of North Bay David King - Municipal Affairs Dave Rees - NBMCA John McNutt - NBMCA/City Bob Gray - NBMCA/City Frank Driscoll - MOEE Morley Dalter - City of North Bay
ALSO PRESENT:	Sally Campbell, Janet Ross, Chippewa Creek Public Liaison Gerry Strachan, David Bannister, Michael Puccini, Ian Kilgour, Gary Epp - Proctor & Redfern

ADOPTION OF PREVIOUS MINUTES:

Mr. Jeff Celentano, Chair, called the meeting to order and made note that Dave Rees, Dave King and Bob Gray were unable to attend due to a previous commitment. Dave Robinson is unable to attend this meeting, but will attend the Public Liaison Committee meeting at 7:00 p.m.

<u>Resolution No. 4-94, Beckett/Houston</u>

That the minutes of the meeting held January 25, 1994 be adopted as written.

CARRIED UNANIMOUSLY

SCHEDULE & WORKPLAN:

Gerry Strachan, Project Manager from the firm of Proctor & Redfern, explained that the project was "officially" awarded to Proctor & Redfern in July of 1994, however, inventory work had begun prior to this in order to gather important data at peak seasons. He also gave a description of the watershed and the path of the creek.

Mr. Strachan explained that the study is expected to take approximately one year to complete, and that the expected date of completion is July, 1995.

The study is broken down into 3 phases. At this time, we are still at Stage 1, which involves collecting existing information, conducting inventory work and analysis of the results in a comprehensive manner. As a result of the findings, opportunities and constraints can be identified. All information will be arranged into a "Background Review and Assessment Report" to be presented at the next Steering Committee meeting.

PROGRESS REPORT:

Each member of the study team gave a progress report for the various resources of the watershed.

Extensive existing background information has been collected, in addition to field surveys for both water quality and ecological resources. The data that has been gathered must be analyzed so as to come to some conclusions about the watershed.

Other topic areas such as geomorphology, hydrology and environmental planning are still in the initial stages of being studied.

The consultants distributed a hand-out which summarizes: the tasks initiated or completed; the findings to date; and future tasks of each of the resource topics.

PUBLIC PARTICIPATION ACTIVITIES:

The committee members were informed that a Public Liaison Committee meeting would be held at 7:00 p.m.

Bill Beckett announced that a display about the Chippewa Creek Watershed Management Study would be on exhibit at the Sportsman Shown, September 23, 24, 25, 1994 and asked for volunteers to work at the display. Those who volunteered will receive a reminder prior to the show.

NEXT STEPS:

The next steps in the study include:

- Notice of Study Commencement & Public Liaison
- Complete Environmental Inventory & Assessment
- Identify Opportunities & Constraints
- Prepare Background Review & Assessment Report
- Steering Committee #2

SITE TOUR:

A site tour has been arranged following the adjournment of this meeting. The tour will highlight the many different aspects of the creek.

ADJOURNMENT:

As there was no further new business the members were thanked for their attendance and as a result, the following resolution was presented:

Resolution No. 5-94, Wardlaw/Brown

That the meeting be adjourned and the next meeting be held at the call of the chair.

CARRIED UNANIMOUSLY

.... Paula Scott ....

Jeff Celentano, Chair **Paula Scott, Secretary**

Dated: September 7, 1994

APPENDIX A-2

PUBLIC LIAISON COMMITTEE

CHIPPEWA CREEK WATERSHED MANAGEMENT STUDY

PUBLIC LIAISON COMMITTEE

Vickey Wiemer
1836 McKeown Avenue
North Bay, Ontario
P1B 7N4

Jack D. Adams
34 Summit Drive
North Bay, Ontario
P1A 2V5

Sally Campbell
R.R. No. 5, Site 5, Comp. 4
North Bay, Ontario
P1B 8Z4

Janet Ross
271 Cemetery Road
North Bay, Ontario
P1B 8G4

Bob Lewis
515 Lakeshore Drive
North Bay, Ontario
P1A 2E3

Wayne Penno
R.R. No. 2, Mirimishi Road
Corbeil, Ontario
P0H 1K0

Paul Brazeau
548 Rock Street
North Bay, Ontario
P1B 4M6

Bryan Hall
35 Lovell Avenue
North Bay, Ontario
P1A 3R7

Keith Dillabough
362 Oakwood Avenue
North Bay, Ontario
P1B 5J2

APPENDIX A-3

TERMS OF REFERENCE

CHIPPEWA CREEK WATERSHED MANAGEMENT STUDY
TERMS OF REFERENCE

The detailed workplan is outlined in Proctor & Redfern's proposal dated march 2, 1994. In general, the terms of reference on the study are:

Phase I - Background Review and Assessment of Existing Conditions

Task 1.1 Obtain and Review all available land use planning studies and other data on Chippewa Creek. Notify the public and various agencies of the study commencement and solicit watershed information.

Task 1.2 Summarize and assess existing water quality data and design and implement a water quality sampling program to enhance existing data. Identify sources that likely impact water quality.

Task 1.3 Conduct benthic invertebrate, terrestrial habitat, and vegetation studies. Map the environmentally significant features.

Task 1.4 Update and recalibrate the hydrologic model for Chippewa Creek and prepare a rudimentary mass balance and pollutants.

Task 1.5 Collect geomorphology data and analyze the processes and effects of sedimentation.

Task 1.6 Identify the major soil and aquifer systems, prepare a water budget, and identify groundwater recharge/discharge areas sensitive to urban development.

Task 1.7 Prepare an archaeological study.

Task 1.8 Produce and Opportunity/Constraint Map.

Phase II - Development and Evaluation of Watershed Activities

Task 2.1 Liaise with the Steering Committee to establish watershed goals and advise them of the technical implications.

Task 2.2 Using the opportunity/constraint map, investigate varying release rates of development, assess and rank BMP's against watershed objectives and potential impacts of aquatic and terrestrial biota.

Task 2.3 Develop, evaluate, and screen enhancement strategies and environmental management alternatives.

Phase III - Preparation of Watershed Management Plan

Task 3.1 Develop policies and guidelines based on the issues and resources of the watershed and their associated management objectives.

Task 3.2 Incorporate stormwater management and ecological planning policies and identify their implementation strategies.

Task 3.3 Prepare and submit 10 copies of the draft document.

Task 3.4 Incorporate comments on the draft document and submit 25 copies of the final document.

Task 3.5 Conduct a "Technology Turnover Session" where the use of computer software developed during the study is demonstrated to the City and Conservation Authority Staff. A total of 6 meetings will be held with the Steering Committee throughout the study.

APPENDIX B

HYDROGEOLOGY AND WATER BALANCE

Trow Sudbury Branch

Trow Consulting Engineers Ltd.
1074 Webbwood Drive
Sudbury, Ontario P3C 3B7
Telephone: (705) 674-9681
Facsimile: (705) 674-8271

SO1312E **November 17, 1994**

Proctor & Redfern Limited
45 Green Belt Drive
DON MILLS, Ontario
M3C 3K3

ATTENTION: Mr. G. Epp

Dear Sirs:

PRELIMINARY HYDROGEOLOGICAL REPORT
CHIPPEWA CREEK WATERSHED STUDY
NORTH BAY, ONTARIO

Further to your authorization to proceed, Trow Environmental Services has completed a hydrogeological and water balance evaluation of the Chippewa Creek Watershed. The following discussion of the analysis and results was prepared for inclusion into sections 2.4 and 3.3 of the Proctor & Redfern "Phase I Report - Background Review & Assessment" report (currently in preparation).

1.0 LOCAL HYDROGEOLOGY

The Chippewa Creek Watershed is located within and immediately north of the City of North Bay, covering a land area of approximately 37.3 km^2. The watershed is topographically bisected by a bedrock ridge, which rises over 70 m in elevation above the predominantly level area in the City of North Bay, adjacent to Lake Nipissing. The lower watershed area is primarily urbanized, covering an area of approximately 9 km^2, while the upper area is primarily rural (with some suburban areas) with an undulating topography.

Local geologic mapping (Northern Ontario Engineering Geology Terrain Study 101, p.80) identified several distinct sub-areas within the watershed boundaries. The lower elevations adjacent to Lake Nipissing are mapped as a glaciolacustrine plain, with a silty sand to clayey silt soil cover and occasional bedrock knobs. Within the higher elevation areas of the watershed, the northernmost area is identified as a glacial outwash plain, covered primarily by sand and gravel. This area extends southward in a narrow band within the Chippewa Creek valley area, bounded to the west by a prominent bedrock ridge (with a thin drift of sandy till) and to the west by a more gently sloping discontinuous sandy glacial outwash plain, with some bedrock outcroppings and shallow glacial till deposits. Bedrock within the entire study area is comprised of granitic and metamorphosed sedimentary rock of the Precambrian age. Overall, the local topography and the watershed boundary appears to be strongly bedrock controlled.

For the present study, the watershed has been subdivided into 4 distinct sub-areas (as defined by the geologic mapping), and is presented in Dwg. 1. To further verify soil conditions and the study site hydrogeology, MOEE well records were obtained from the MOEE Regional office (Sudbury). The locations of a representative subset of the available well logs were identified and included in Dwg. 1. The well logs, along with the available soils borehole information (i.e. from unpublished Trow reports) were used to develop 3 cross-sections for the study area (Dwgs. 2 to 4, inclusive).

Cross-section A-A was established east to west, through the approximate mid-point of the watershed, (crossing the main Chippewa Creek channel). The cross-sectional stratigraphy (Dwg. 2) illustrates the thin to absent soil cover (i.e. exposed bedrock) along the western flank of Chippewa Creek. To the east of the Chippewa Creek channel, the soil is of variable thickness (0 m to 10 m) comprised primarily of sand with occasional gravel layers or boulders. Previous borehole studies in the eastern area (by Trow) indicated the presence of a sandy till (i.e. a mixture of silt, sand and gravel) of variable thickness. This information verifies the geologic mapping discussed previously. The interpreted cross-sections indicate that the surficial topography and groundwater movement are controlled by the occurrence and topography of the local bedrock.

Cross section B-B was established east to west, through the northern-most areas of the watershed, in the headwater area. The soil thickness here is variable, ranging from 3 m to 20 m; however, the soil thickness is generally greater in this area, when compared to section A-A. Soils are generally medium sands with occasional gravel layers, and few bedrock outcroppings. Based on our review of the available topographic mapping, this area has been used extensively for gravel extraction and aggregate production.

Cross section C-C was established roughly north to south, along the approximate centre of the main Chippewa Creek channel. This section illustrates a relatively deep sequence of sands and gravel to the north, with the slope gradually decreasing to the south. Based on the topographic mapping and our field observations, it is interpreted that the main channel, leading from the upper area to the lower area, has cut a relatively deep trough through the sand overburden, and lies confined within a bedrock valley. Overburden depths within this reach of the stream channel were interpreted to be thin or absent. The cross-section illustrates the transition to lower permeability silty sand, silts and clay, in the lower elevations of the study area.

Surface water courses (i.e. tributaries) leading to the main Chippewa Creek channel are numerous throughout the watershed, particularly in the northern headwater area. The number of tributaries are less frequent in the lower elevation reaches, and along the western bank of the upper Chippewa Creek channel. The higher frequency of tributaries in the upper sand and gravel areas is attributed to the higher permeability of these soil materials, combined with the undulating subsurface bedrock topography. In this setting, it is not practical to identify distinct widespread groundwater recharge and discharge areas, since groundwater discharges to the channel tributaries are dependent on localized recharge from lands between the tributary channels (i.e. recharge is local to the tributary it supports). Also, it is assumed that groundwater recharge from each sub-area within the watershed reports to the Chippewa Creek channel as "baseflow", without a significant groundwater transfer between sub-areas.

2.0 CONCEPTUAL WATER BALANCE MODEL

An annual budget for the Chippewa Creek watershed was developed, based on historical meteorological data and available stream gauging records, the anticipated runoff characteristics of the sub-watershed areas, and by conventional water balance techniques.

The development of the water balance model was based, in part, on the recognition that the shallow groundwater system does not receive or transfer water to the neighbouring watersheds, and that groundwater discharges are local to groundwater recharges within the same geologic unit, and a significant transfer of groundwater within the sub-areas is not occurring (as discussed previously). The subsequent model development, calibration and an estimation of the watershed characteristics was based on mean daily stream gauging records (1982 to 1992 inclusive) for the Chippewa Creek gauging station (located at Fisher and Chippewa Streets), annual precipitation totals from the North Bay Airport Climatological Station, and a manual baseflow separation of the annual flow hydrographs. A discussion of the analysis is presented in the following sub-sections.

3.0 CHIPPEWA CREEK OUTFLOW CHARACTERISTICS

The Chippewa Creek stream flow gauging station has been in operation since 1974 and is owned and maintained by the North Bay Mattawa Conservation Authority. The gauge calibration and data collection is maintained by Water Survey Canada (Environment Canada) as hydrometric station 02DD014. The mean annual flow rate is reported by WSC as 0.633 m^3/s (1974 to 1990). This equates to a mean annual volume of 2 x 10 m^3. Over the 37.3 km^2 watershed, this volume is calculated as a water surplus (i.e. precipitation minus evapotranspiration) of 535 mm. A published climatological studies (The Climate of Southern Ontario, Brown et al, 1980) indicates a water surplus for North Bay on the order of 330 mm, plus 100 mm (an arbitrary soil moisture figure), totalling 430 mm. Therefore, the value is similar to the calculated water surplus value obtained from our analysis of the gauging station information.

Stream gauging data were obtained from the Ministry of Natural Resources for the period 1982 to 1992 (inclusive) as mean daily discharge in digital format. The data was entered into a computer spreadsheet and annual outflow volumes and stream flow hydrographs were developed. The outflow volumes for the indicated period ranged from 1.40×10^7 m^3 (in 1987) to 2.59×10^7 m^3 (in 1990). No perceptible change in runoff volume was noted (in terms of an overall increase or decrease) however 1984, 1985 and 1990 were above average runoff years, while 1986 and 1987 were below average runoff years.

4.0 BASEFLOW CHARACTERISTICS

Baseflow in a river system is considered to be the component of flow that is not directly related to a specific precipitation or snow melt event. The source of baseflow is attributed to groundwater discharges, and is ultimately derived from infiltrated surplus precipitation.

The direct separation of baseflow from stream gauging data is somewhat subjective in any watershed system. In the present study, however, an attempt was made to separate the baseflow by following the Chippewa Creek discharge that was not related to a precipitation or snow melt event for each of the 11 annual stream flow hydrographs (1982 to 1992, inclusive). As a check and control on maintaining a constant level of subjectivity on the baseflow separation, the baseflow volume was calculated and plotted as a function of the total flow volume for each year. For a given watershed system, the ratio of baseflow to the total volume should be approximately constant and would plot as a straight line.

The analysis indicated annual baseflow volumes ranging from 5.25×10^6 m^3 (1987) to 8.25×10^6 m^3 (1984). A plot of the baseflow as a function of total runoff volume is presented in Dwg. 5. The relationship presented in Dwg. 5 indicates a relatively consistent relationship between baseflow volume and total runoff volume. Baseflow volumes are on the order of 33% of the total runoff from the Chippewa Creek watershed.

5.0 PRECIPITATION AND EVAPOTRANSPIRATION

The North Bay Airport precipitation data was used in the development of a water budget for the watershed. This station is located at the eastern edge of the watershed, and the data from this single point observation is considered suitable for a watershed of this size. The mean annual precipitation at this location (and for the watershed) is 974.2 mm (1961 - 1990).

Total annual precipitation data was obtained from the North Bay Climatological Office for the period of analysis (1982 to 1992, inclusive) and entered into the stream gauging database. Total precipitation ranged from 891.5 mm (1987) to 1186.2 mm (1990).

The difference between the precipitation and the total outflow from Chippewa Creek was calculated for each year, and represents the evapotranspiration from the basin. A evapotranspiration of 391 mm (1985) to 592 mm (1988) was calculated. Using the average precipitation and stream flow data, an average annual evapotranspiration of 438.4 mm is therefore, calculated for this basin.

6.0 ANALYSIS OF WATERSHED SUB-AREAS

The contribution of total flow and baseflow components from the previously identified sub-areas within the Chippewa Creek basin was analyzed by considering the soil conditions and general hydrogeology of the sub-areas. The highest level of recharge and baseflow generation is interpreted to be in the headwater area, which is characterized by deep sand and gravel sequence with a high permeability water table aquifer and numerous tributaries leading to the main Chippewa Creek channel. This area has been identified as Area 1.

The second highest contributor to baseflow is interpreted to be the eastern flank of the watershed, characterized by a discontinuous sand and till overburden of variable thickness.

Minor water table aquifers in this area are interpreted to contribute to the overall baseflow for the basin. This sub-area is identified as Area 2.

The western flank of the Chippewa Creek channel is characterized by a thin, discontinuous layer of glacial drift. This area does not support a significant water table aquifer within the overburden, and recharge to the bedrock aquifer (and subsequent discharge to Chippewa Creek) is likely limited. Overland runoff will be the primary contribution from this area, identified as Area 3.

The lower elevation area, occupied by the urbanized position of the City of North Bay is underlain by sands and silts, and some silty clays. Although this area is primarily urban, some recharge to the local water table aquifer is anticipated, and discharges will report to the creek and (closer to the lake) to Lake Nipissing. This area is interpreted to contribute the second lowest level of baseflow generation.

Preliminary infiltration values were assigned to each of the sub-areas, and a water balance was computed for each of the study years (1982 to 1992). The generated baseflow volumes were then compared to the separated baseflow volumes (discussed previously). The infiltration factors were then adjusted iteratively until the generated baseflow volumes matched the actual baseflow volumes. A range of infiltration for each sub-area were then identified, and the water balance for an "average" year (i.e. mean annual runoff, 1974 to 1990, and mean precipitation, 1961 to 1990) was developed. The final results of this analysis are presented in Dwg. 6.

The results indicate that Area 1 contributes an estimated 55% to 66% of the annual baseflow volume for the basin via the local aquifers within that area (or 3.64×10^6 m^3/year), and Area 4 is estimated to contribute 11% to 18% of the annual baseflow (7.25×10^5 m^3/year to 1.21×10^6 m^3/year). Area 3 is estimated to contribute very little to the annual baseflow runoff volume (0% to 1%).

7.0 DEVELOPMENT CONSTRAINTS

In terms of the overall water balance and maintaining the Chippewa Creek baseflow runoff, the most sensitive area in the watershed is Area 1, within the headwater sands and gravels. This area has been developed in the past for gravel extraction; however, urbanization may result in lower levels of deep aquifer recharge and higher overland runoff, which will act to lower the available baseflow appearing in the creek. Area 3 is the least sensitive area in terms of affecting baseflow by development, since overland flow in this area is interpreted to be dominant. Area 4, while contributing 11% to 18% of baseflow, is already urbanized at this time, and is probably not the focus of future development. Area 2 is partly developed (i.e. suburban), and contributes a significant portion of water surplus recharge to baseflow. Further development in this area should consider the reduction in aquifer recharge and (therefore) baseflow.

Once the overall planning constraints have been further established, the developed water balance model can be used to evaluate the effect of development and zoning proposals on the water budget, through a sensitivity analysis.

8.0 CLOSURE

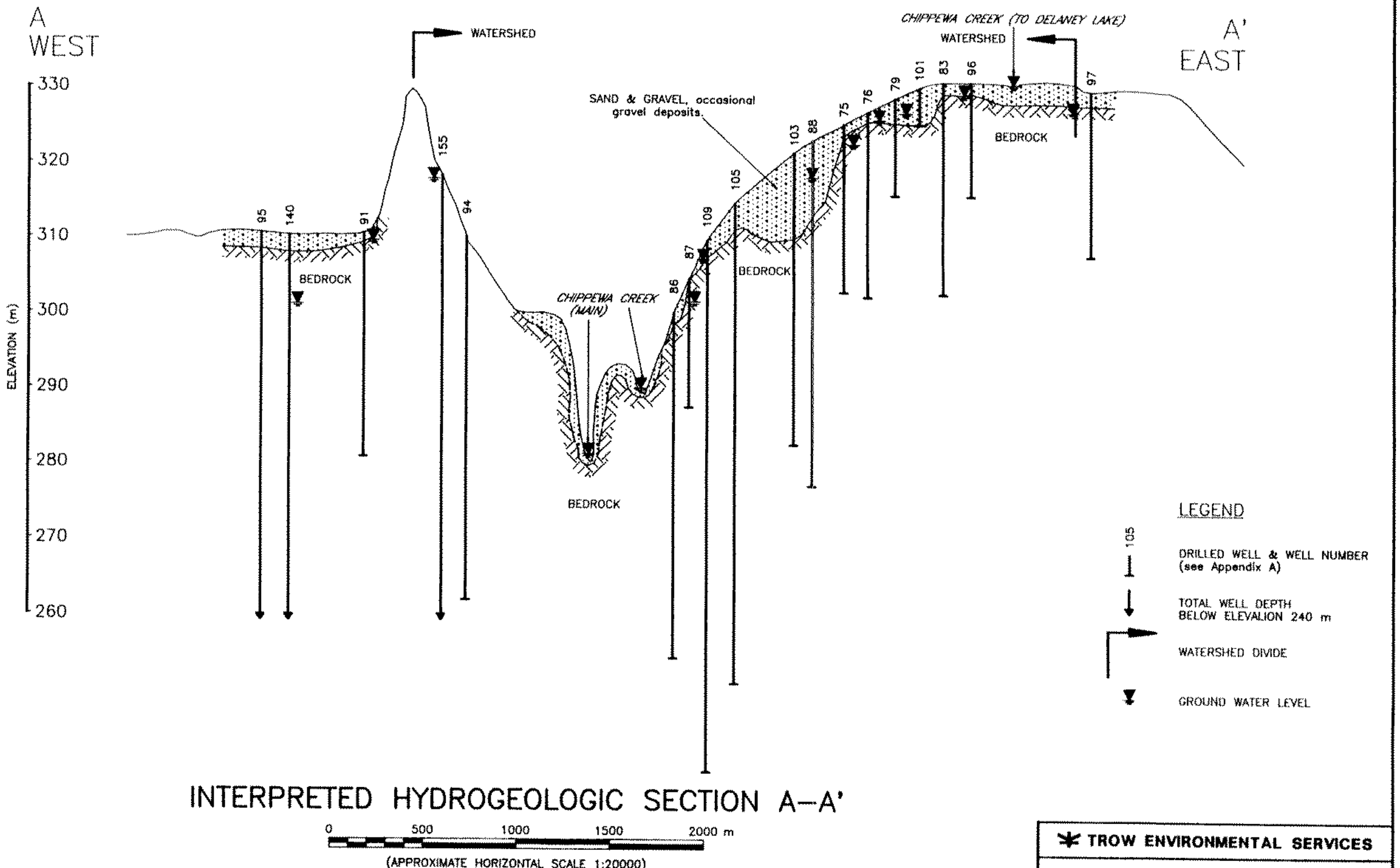
We trust the progress to date is sufficient for the preparation of your draft phase I report. If you have any questions regarding the content of this report, please do not hesitate to contact the undersigned.

Yours truly,
TROW CONSULTING ENGINEERS LTD.

B.R. Grant, P.Eng.

P.A. Richards, P.Eng.
Manager, Environmental Services

BRG:lstp.11
Encl.

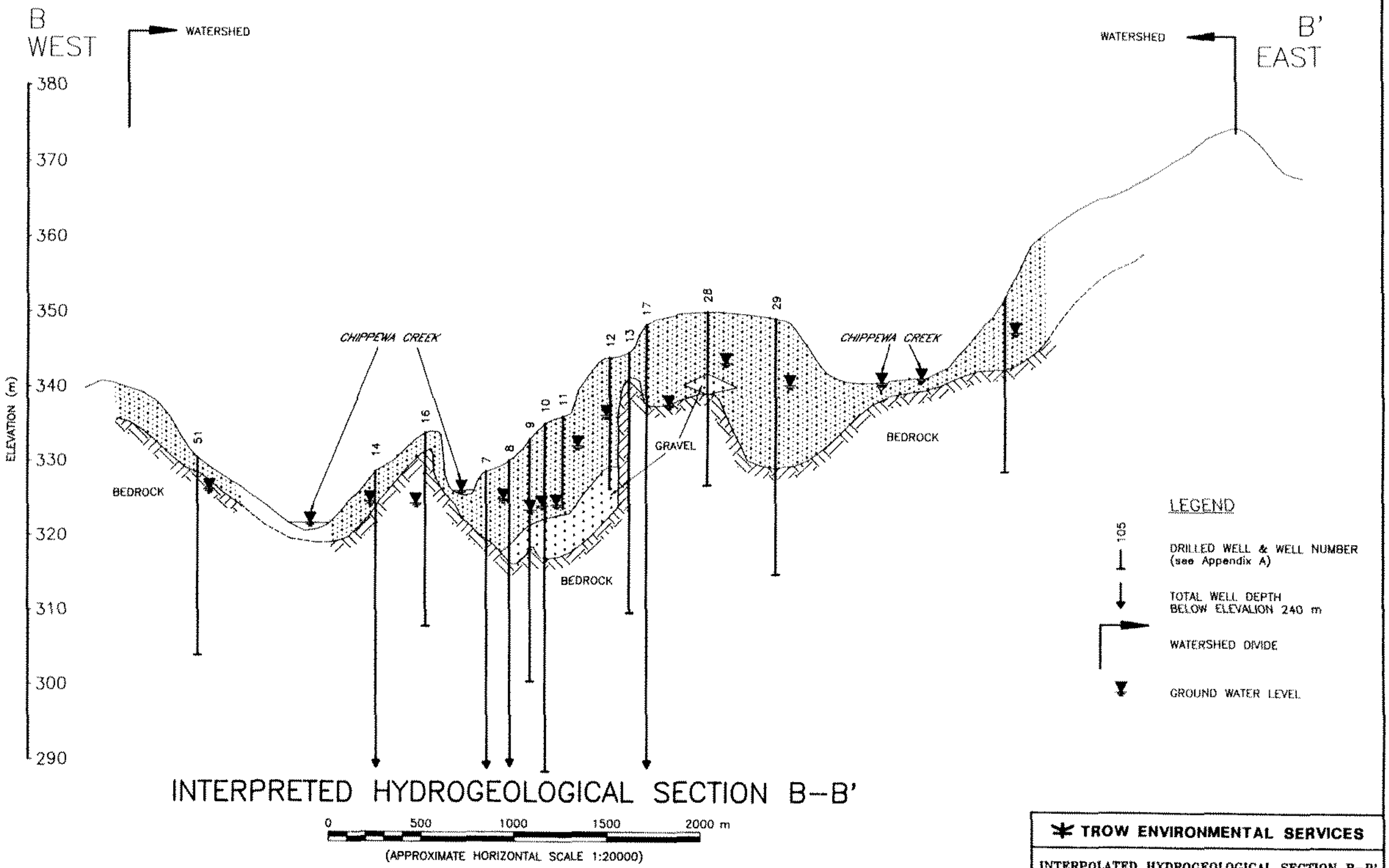


INTERPRETED HYDROGEOLOGIC SECTION A–A'

✱ TROW ENVIRONMENTAL SERVICES

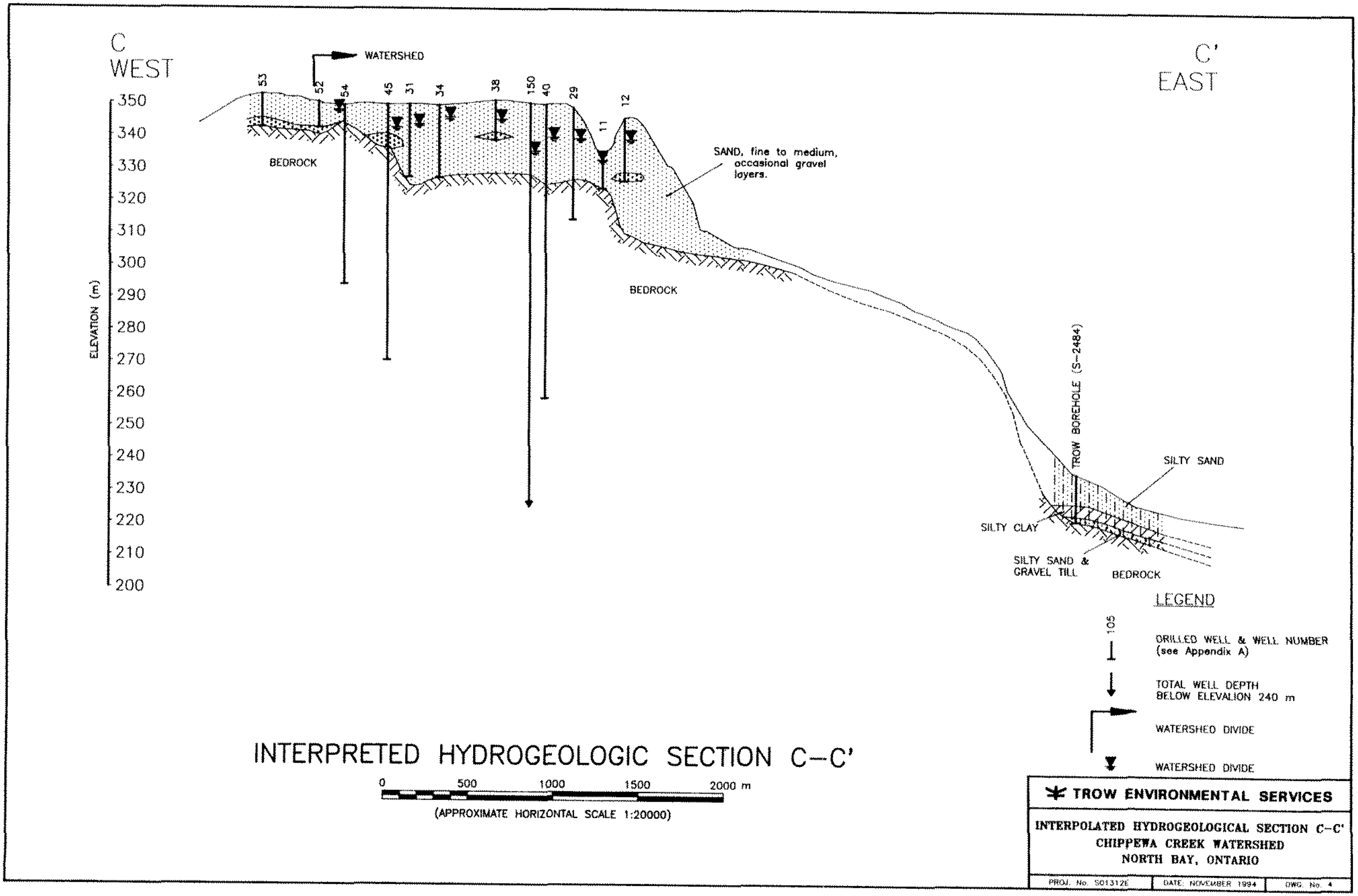
INTERPOLATED HYDROGEOLOGICAL SECTION A–A'
CHIPPEWA CREEK WATERSHED
NORTH BAY, ONTARIO

PROJ. No. S01312E	DATE: NOVEMBER 1994	DWG. No. 2



INTERPRETED HYDROGEOLOGICAL SECTION B--B'

TROW ENVIRONMENTAL SERVICES
INTERPOLATED HYDROGEOLOGICAL SECTION B-B' CHIPPEWA CREEK WATERSHED NORTH BAY, ONTARIO
PROJ. No. S01312E · DATE: NOVEMBER 1994 · DWG. No. 3



INTERPRETED HYDROGEOLOGIC SECTION C–C'

TROW ENVIRONMENTAL SERVICES

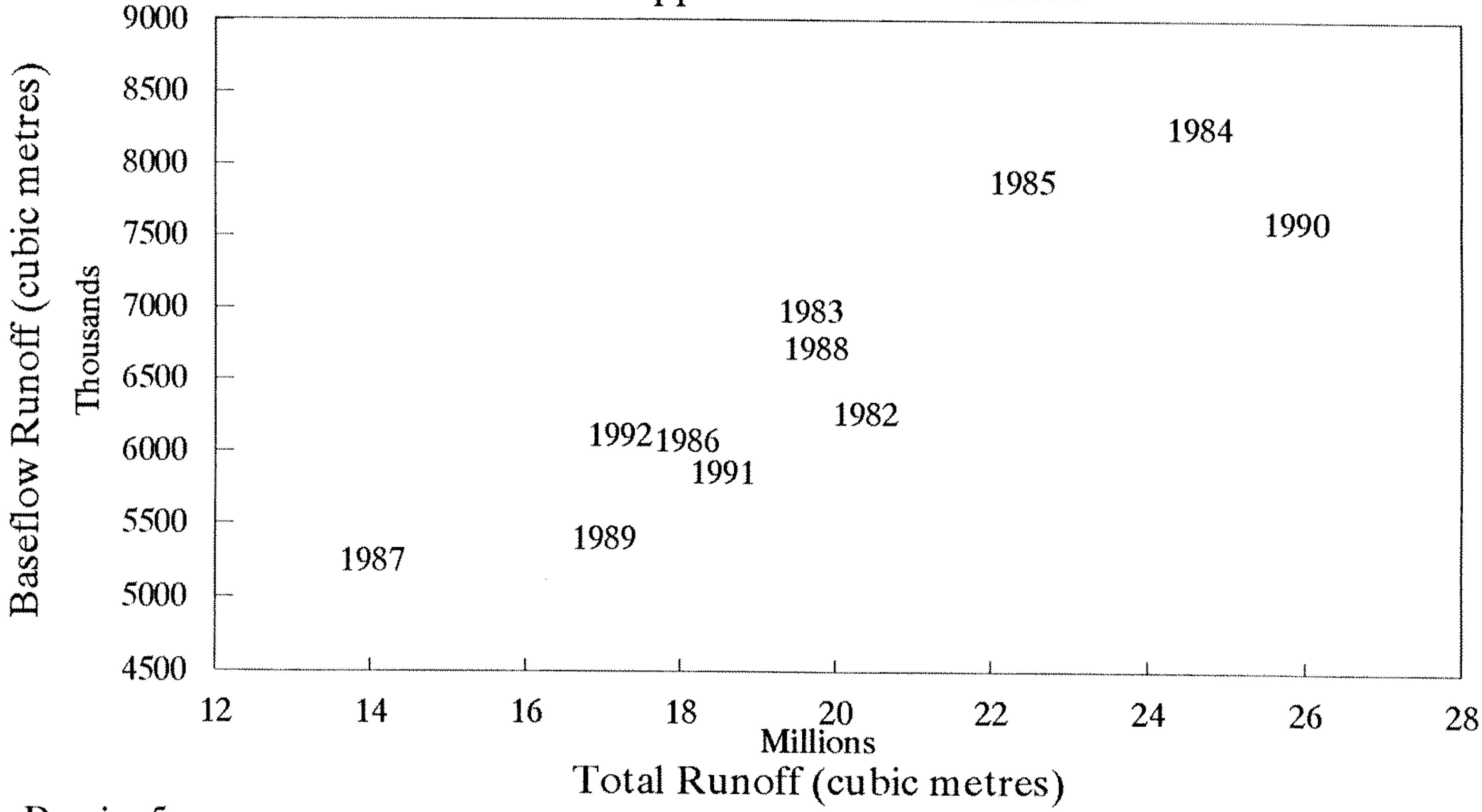
INTERPOLATED HYDROGEOLOGICAL SECTION C–C'
CHIPPEWA CREEK WATERSHED
NORTH BAY, ONTARIO

PROJ. No. S01312E | DATE: NOVEMBER 1994 | DWG. No. 4

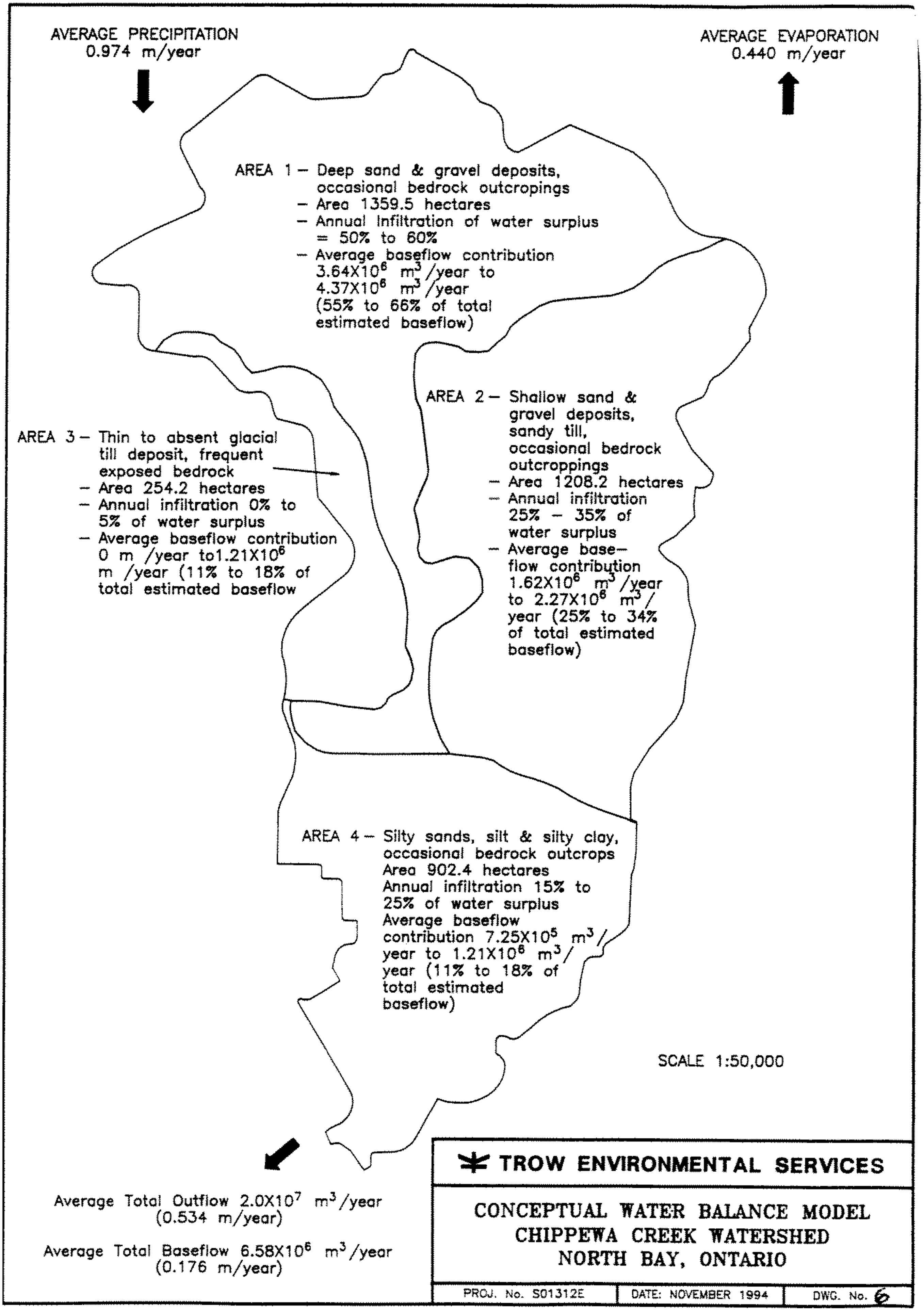
Year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Days	365	365	366	365	365	365	366	365	365	365	366
Ave Flow (cms)	0.646	0.624	0.780	0.710	0.573	0.444	0.624	0.539	0.821	0.588	0.54
Total Runoff (m^3)	2.04E+07	1.97E+07	2.47E+07	2.24E+07	1.81E+07	1.40E+07	1.97E+07	1.70E+07	2.59E+07	1.85E+07	1.72E+07
Interpreted Baseflow (m^3)	6.26E+06	6.98E+06	8.25E+06	7.88E+06	6.07E+06	5.25E+06	6.72E+06	5.40E+06	7.60E+06	5.85E+06	6.11E+06

Baseflow Separation

Chippewa Creek Watershed



Drawing 5



AVERAGE PRECIPITATION
0.974 m/year
AVERAGE EVAPORATION
0.440 m/year
AREA 1 – Deep sand & gravel deposits, occasional bedrock outcropings
– Area 1359.5 hectares
– Annual Infiltration of water surplus = 50% to 60%
– Average baseflow contribution $3.64X10^6$ m^3/year to $4.37X10^6$ m^3/year (55% to 66% of total estimated baseflow)
AREA 2 – Shallow sand & gravel deposits, sandy till, occasional bedrock outcroppings
– Area 1208.2 hectares
– Annual infiltration 25% – 35% of water surplus
– Average base-flow contribution $1.62X10^6$ m^3/year to $2.27X10^6$ m^3/year (25% to 34% of total estimated baseflow)
AREA 3 – Thin to absent glacial till deposit, frequent exposed bedrock
– Area 254.2 hectares
– Annual infiltration 0% to 5% of water surplus
– Average baseflow contribution 0 m /year to$1.21X10^6$ m /year (11% to 18% of total estimated baseflow
AREA 4 – Silty sands, silt & silty clay, occasional bedrock outcrops
Area 902.4 hectares
Annual infiltration 15% to 25% of water surplus
Average baseflow contribution $7.25X10^5$ m^3/year to $1.21X10^6$ m^3/year (11% to 18% of total estimated baseflow)
SCALE 1:50,000
Average Total Outflow $2.0X10^7$ m^3/year (0.534 m/year)
Average Total Baseflow $6.58X10^6$ m^3/year (0.176 m/year)
TROW ENVIRONMENTAL SERVICES
CONCEPTUAL WATER BALANCE MODEL
CHIPPEWA CREEK WATERSHED
NORTH BAY, ONTARIO
PROJ. No. S01312E
DATE: NOVEMBER 1994
DWG. No. 6

APPENDIX C

FLUVIAL GEOMORPHOLOGY

CHIPPEWA CREEK
FLUVIAL GEOMORPHOLOGY

INTRODUCTION

The objectives of the fluvial geomorphology component were to assess the stability of the channel, determine the effects and processes of sedimentation and, determine opportunities and constraints with respect to enhancement and restoration of the watershed. The objectives were addressed through a background review of existing information, field reconnaissance and data collection, data analysis and interpretation of results.

Including fluvial geomorphology in a watershed study has several additional benefits. A review of background information, such as air photos from several years of coverage permits a historical perspective. Changes to the channel such as width or course can be identified and these channel adjustments can often be linked to changes in land use. This is important in evaluating the impact on the creek to future land use scenarios. Data collected and interpretation of results from a fluvial geomorphological investigation can be applied to other disciplines, such as hydrology, aquatic biology and water quality, improving the integration of the watershed study.

BACKGROUND REVIEW

The background review of the fluvial geomorphology for Chippewa Creek included air photos from 1969, 1970 and 1989, topographic maps at scales varying from 1:20,000 to 1:50,000, and background reports including the Chippewa Creek Watershed Background Inventory Document, and various geological documents. Fluvial geomorphology was not addressed specifically in the reports but related information on flow conditions and geological materials was reviewed and aided in the interpretation of the condition and stability of the creek. The air photos provide an historical perspective on previous conditions of the creek, as well as being useful in characterizing the existing creek morphology. The topographic maps provided valuable information on morphometric parameters such as gradient, sinuosity and bifurcation ratios. These parameters provide an indication on drainage basin function in regards to the movement of water and sediment through the system (Gregory and Walling, 1973). Completion of the morphometric analysis enables the identification of stream reaches, or lengths of the creek exhibiting similar characteristics. Field study sites were then tentatively selected on four different stream reaches at locations with good access and minimal interference from structures such as bridges. Study site location was finalized after field reconnaissance and inspection.

Chippewa Creek is a third-order stream with a drainage basin of approximately 39.6 km^2. The basin is composed primarily of unconsolidated silt, sand and gravel, with several outcrops of Precambrian rock, including an escarpment which divides the basin into upper and lower areas. The creek in the lower area has gradients over a kilometer reach varying from 0.4% near Lake Nipissing to 0.8% near the escarpment. The soils are derived from glacial lacustrine deposits and are fine-grained silt to sand. The sinuosity of the creek is 1.15, indicating a straight to slightly sinuous channel. Chippewa Creek, as it crosses the escarpment, has a gradient from 1.1% to 3.6% and the surrounding material is mainly bedrock although there are thick deposits of coarse sand and cobble gravel of glacio-fluvial origin. Through these steep reaches the sinuosity is low at 1.05, indicating a straight channel. The creek within the upper area of the basin, has varying gradients from 1.0% immediately above the escarpment to 1.8% through aggregate operations, and decreases to 0.8% near the headwaters. Materials in this area are coarse-grained sand and gravels, also of glacio-fluvial origin. Thickness of these deposits can vary from up to ten metres in some aggregate operations, to a few centimetres over bedrock with occasional outcrops of bedrock. The sinuosity of the creek in the upper area is approximately 1.10. The gradients and sinuosity of the creek suggest a narrow hydrograph with a short lag time and rapid peak as water is conveyed quickly through the system (Chorley, 1969). This is supported by the mean bifurcation ratio. This ratio is a measure of stream branching, with high values suggesting a creek with one long main channel and few tributaries (Chorley, 1969). This condition also supports and indicates a short, peaked hydrograph. The mean bifurcation ratio for Chippewa Creek, based on 1:20,000 topographic base maps, published in 1982 is 5.14. The same measure taken from 1:25,000 topographic map, published in 1977 was 3.8. This increase may simply be due to map detail, but indicates fewer tributaries, possibly due to urban growth.

FIELD DATA COLLECTION

Fluvial geomorphology of Chippewa Creek was initially assessed through field reconnaissance and inspection. The exercise had several purposes including: the identification of areas of erosion, deposition or other channel instabilities; assess flow conditions and characteristics; determine pool-riffle or step-pool sequence and spacings; and, finalize study site locations.

The creek in the lower reaches is exhibiting visible signs of adjustment. The signs include developing in-channel bars, a lack of continuous pool-riffle patterns, and unstable banks due to undercutting and scour. The lower reaches have been subjected to numerous changes over the years, such as: the numerous bridges and crossings which have exerted some influence on channel shape and location: extensive large-scale bank erosion, created through increased flow velocities and lack of riparian vegetation, which contributed large volumes of sediment to the system; and, bank stabilization works which have reduced sediment loadings but altered flow distribution. The creek adjusts to each one of these changes, but each adjustment can take many years to reach equilibrium, and in several instances the creek is altered or an input such as flow or sediment is altered before the creek has reached an equilibrium from a previous change. The result is the existing state of Chippewa Creek, with its inconsistent form and pattern given the slope and discharge of the basin.

Field observations indicated that the Chippewa Creek basin moves a vast amount of sediment through its system. There are several instances where the sediment is not being effectively moved resulting in sedimentation problems. These problems, if ignored can reduce channel capacity resulting in a greater chance of flooding. Sedimentation occurs as a result of abundant supply of sediment, a reduction in channel competency, usually created by decreased flow velocities, or, a combination of both. The recently completed bank stabilization works have significantly reduced sediment supply, although there were several locations where significant sedimentation has occurred within the last three months. There are obvious sediment loadings from properties along the Golf Club Road near the base of the escarpment. However, the locations of sedimentation were areas where flow competency had been reduced due to in-stream obstructions or areas of increased channel width.

Upon completing the field observations, detailed field work was conducted at four sites (Figure 1). At each site, representing different reach conditions such as gradient and sinuosity, data was collected on channel dimensions, flow conditions, bank properties and bed material. Specifically, the water width and bankfull width were measured. Bankfull is a high flow condition which has a frequency of approximately 1.5 years and represents the stage which defines the geomorphic characteristics (Leopold et al, 1964). The bankfull channel is determined through a variety of field markers such as the location of lichens on rocks or breaks in vegetation. For each width, the depth of the channel was measured every 20cm. The water width was then divided into three to five panels for flow velocity measurements. The velocity was measured with an electro-magnetic current meter at several depths, including the bed and surface, within each panel. The bed material was measured at each site through a random selection of bed particles. The three axes of the particles were measured and a sample of the bed subpavement collected for grain size analysis. Information collected on bank properties included: measurement of bank height; angle; root depths; in-situ shear strength (through a Torvane device); stratigraphy of material; and a sample of material for grain size analysis.

HYDRAULIC GEOMETRY

The data collected on the channel dimensions and flow velocities were analyzed to determine the hydraulic geometry of the creek. Hydraulic geometry is defined by a set of empirical relations which describe how the creek adjusts to increases in discharge (Leopold et al, 1964). As flow or discharge of the creek increase, the width, depth and speed of the water increase accordingly. In larger rivers, increases in discharge are accommodated through a larger increase in channel width to dissipate the energy in the stream. These relations are important to understand how the creek adjusts to changes in flow conditions. Data on the channel dimensions and flows for Chippewa Creek are presented in Table 1.

The average velocity for bankfull conditions were calculated using Manning's equation. To perform the calculations, the grain size of the bed material was determined to give a roughness factor. The sites on the main channel (F.G.1 to F.G.3) indicate that velocity is the most sensitive parameter. With increasing discharge the speed of the water increases much more than the width and depth, thus increasing the potential of the creek to erode and transport sediment. The site on the Johnston Tributary responds to an increase in discharge by increasing the width. This section has been subjected to erosion control works and is moderately channelized. The effect of the increasing width is a lower velocity and stream energy is spread over a larger area.

Table 1 Study Site Dimensions and Characteristics

Cross-Section	Flow Regime	Width (m)	Avg Depth (m)	Avg Vel (m/s)	Discharge (m3/s)	Gradient (%)	Hydraulic Radius
F.G. 1	Low Flow	4.90	0.429	0.367	0.774	0.377	0.471
(near 2nd St)	Bankfull	4.85	0.765	3.02	10.55		
F.G. 2	Low Flow	6.69	0.165	0.512	0.556	2.38	0.479
(base of escarpmt)	Bankfull	7.80	0.492	2.24	8.243		
F.G. 3	Low Flow	2.40	0.125	0.143	0.047	1.72	0.473
(N. of Marsh Rd)	Bankfull	2.70	0.273	1.45	1.003		
F.G. 4	Low Flow	2.40	0.275	0.135	0.080	0.85	0.454
(Johnston Rd Trib)	Bankfull	8.60	0.392	1.05	3.215		

SEDIMENT CHARACTERISTICS

Information collected in the field on the particle sizes of the bed material, properties and conditions of the banks and subsequent laboratory analysis of collected samples, were used to determine conditions for movement and channel stability. The data and results are presented in Table 2. The Manning's N value was calculated based on the mean or D_{50} grain size. The tractive force or boundary shear stress, is an average value for the entire cross-section or wetted perimeter. The critical velocity for movement of the bed material was computed following Andrews (1984) formula. This formula provides a more realistic estimate for movement as it considers both the smaller size fraction (D_{84}) and coarse fraction (D_{16}) of the bed material.

Reviewing the results from Table 2, the size of bed material at F.G.2 and F.G.3 is coarse, mainly cobbles with a few boulders, which is expected given the gradients (Table 1) and close proximity to the escarpment and bedrock. The site on the Johnston Rd Tributary (F.G.4) has finer sediment, likely fill from the nearby road and alluvial deposits. The downstream site (F.G.1) also has fine sediment which originated upstream. The sediment on the bed rests on bedrock and likely represents a periodic deposit. During field work, fine sand was observed moving along the bed. The critical velocity for movement of bed material at this location is quite low at 0.284m/s, which is lower then the average velocity measured. During the next high flow event, the bed material at this location will be transported downstream. As flows subside, fine sand and silt will again be deposited on the bedrock surface. The critical velocities at the other sites are just below the calculated bankfull velocity in Table 1, indicating a stable channel.

The bank conditions at F.G.2 and F.G.3 indicate a stable condition with a low to moderate potential for erosion. These sites have low banks, good vegetative cover and fairly fine, cohesive material. The downstream left bank at F.G.2 has coarser material and a steeper slope. If vegetation were to be removed the bank would likely become unstable leading to erosion. The banks at F.G.1 are relatively unstable as there is little vegetation and undercutting at the base is occurring. Approximately 10m downstream of this location, bank erosion is occurring, especially to the downstream left bank. The bank erosion is due to a mid-channel bar which forces flow to the sides of the channel exerting greater stress to the banks.

The site at F.G.4 has the greatest potential to become unstable. It is currently fairly stable as documented by the hydraulic geometry results and sediment data. The bed though is composed primarily of sand which is easily transported. The high critical velocity is based on a high Manning's N of 0.047 to account for the grass in the bankfull channel area. The low flow channel area is unvegetated and moderate flow events will scour and transport the sand bed. A large scour hole was observed approximately 40m upstream at a confluence with a small tributary. As the bed becomes deeper or entrenched, more stress is exerted to the toe of the banks, eventually leading to erosion. Further, an entrenched stream cannot reach the top of the banks, thus reducing the area to dissipate energy during high flow conditions.

Table 2 Study Site Sediment Summary

Cross-Section	Bed Material D_{16} (cm)	D_{50} (cm)	D_{84} (cm)	Manning's N	Tractive Force (m^2/kg)	Susp Sed Concen. (mg/L)	Critical Velocity (m/s)
F.G. 1 (near 2nd St)	0.20	0.12	0.05	0.017	1.77	10.8	0.284
F.G. 2 (base of escarpmt)	12.46	7.30	0.66	0.43	11.40	17.3	2.31
F.G. 3 (N. of Marsh Rd)	6.62	4.50	2.40	0.38	8.14	2.8	1.49
F.G. 4 (Johnston Rd Trib)	0.19	0.07	0.03	0.47 (veg)	3.86	11.4	1.12

Cross-Section	Bank D_{50} (cm)	Bank Characteristics

F.G. 1 (near 2nd St)	Rt: 0.001 Lf: 0.003	Rt: 0.5m, 20° rise, little veg, ($4.7cm^2/kg$) Lf: 0.7m steep, little veg ($3.5cm^2/kg$)
F.G. 2 (base of escarpmt)	Rt: 5.4 Lf:0.0012	0.5m high, gradual, grass, shrubs ($2.4\ cm^2/kg$) 0.6m high, steep, good roots ($5.4\ cm^2/kg$)
F.G. 3 (N. of Marsh Rd)	0.002	Rt: 0.3m, 10° slope, shrubs Lf: 0.2m, 15° rise, trees
F.G. 4 (Johnston Rd Trib)	0.025	Rt: 5m high, 40° slope, grass Lf: 2m high, 15° rise, grass

CONCLUSIONS

Based on the above observations and measurements, Chippewa Creek is relatively stable. There are some areas of erosion in the lower reaches, but for the most part are not contributing a significant amount of sediment and can be stabilized. The most significant erosion areas, based on review of background documents, have been stabilized. The upper reaches, once removed from industrial areas, including the airport and aggregate operations, are stable, with only minor bank undercutting and significant riparian vegetation to aid in protecting the creek banks. The lower reaches, although experiencing some adjustments and sedimentation problems, are not entrenched except for a few locations near Main Street. The areas most susceptible to degradation and instability are tributaries which have been modified by urban development.

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GLOSSARY

Alluvial: a unconsolidated deposit (sand and gravels) from rivers and streams

Bifurcation Ratio: a quantitative relationship between different stream orders within the same drainage basin, expressed as the number of streams of one order divided by the number of streams of the next highest order

Fluvial Geomorphology: the science which studies the processes and interactions within a watercourse, such as volume and speed of water, sediment characteristics and channel form

Morphometric: pertaining to the quantification of shape characteristics of the drainage basin

Sinuosity: used to differentiate straight or sinuous channels from meandering channels, determined by dividing the stream length by the valley length

3rd Order Stream: when two 1st order streams (the first watercourse near the upper limits of a basin) meet they form a 2nd order stream, thus when two 2nd streams meet they form a 3rd order

APPENDIX D

HYDROLOGY

CHIPPEWA CREEK

HYDROLOGY

Hydrologic Modelling

- The hydrologic modelling of Phase 1 entailed the following:
    - calibrate an hydrologic model using information from the Northland Engineering study done in 1984 and the up-to-date OTTHYMO.89 model which would better reflect the hydrologic regime within the watershed as compared to the old HYMO model,
    - use this new calibrated OTTHYMO.89 model to establish the existing watershed conditions, and
    - incorporate the information from the planning documents for future land use within the Chippewa Creek watershed in the calibrated model to calculate the increase in flows due to watershed development.

2.3.1.1 Background

- The Northland HYMO model was calibrated to four historic events: November 1, 1974 (56.9 mm), June 24, 1977 (79.0 mm), September 14, 1978 (56.4 mm), and October 18, 1981 (36.1 mm).
- The Northland calibrations which best fit the corresponding measured historic outflow were for the November 1974 and October 1981 events as was observed from an inspection of the plotted measured and simulated hydrographs. Consequently, we proceeded with the calibration of our hydrologic model using these two events. The historic rainfall data for the November 1974 and October 1981 events indicated that a significant amount of precipitation had occurred, prior to each event. This could have possibly saturated the ground and led to a wet antecendent moisture condition for the soil.
- The OTTHYMO.89 hydrologic model was chosen to update the 1984 Northland HYMO model. The OTTHYMO.89 model was used because of its ability to better simulate the runoff conditions from urbanized catchments, hence, creating an

hydrologic model which better reflects the existing runoff condition for the urbanized lower reaches of the Chippewa Creek watershed.

- It was noted that a different set of CNs were used in each event calibration for the 1984 study. This was to account for the antecedent moisture condition of the soil in each case.

- The existing Chippewa Creek watershed has been divided into four distinct zones in the Northland study based upon the similarity of the runoff characteristics for the subwatersheds within a given zone. The zones defined in the previous study are the Laurentian Upland, Escarpment, Upper Urban, and Lower Urban. Understanding the nature of the hydrologic regimes of these zones will be of great benefit in the calibration of the hydrologic model.

- The total drainage area of the Chippewa Creek watershed is approximately 4,100 hectares which is comprised of approximately 3,200, 280, and 620 hectares drained by the main branch of Chippewa Creek, Eastview Tributary, and Johnston Creek, respectively.

- The Laurentian Upland zone constitutes approximately 48 percent of the watershed and is almost fully rural. The zone is characterized by expansive treestands and fine sandy loam and sandy loam soils. The ground slopes range from flat, 2%, to mildly steep, 10%. The surficial runoff from this zone is not expected to be a large component of the watershed's storm runoff, even during intense precipitation events, due to the low runoff potential of the sandy soils. However, these sandy soils may cause the interflow component to contribute greatly to the storm runoff in the form of stream baseflow.

- The Escarpment zone constitutes approximately 28 percent of the watershed and has comparable vegetation and soils as the Laurentian Upland. The zone is approximately 10 percent urbanized. The ground slope varies from mildly steep, 5%, to very steep, 25%. Surficial runoff from this zone is not expected to contribute greatly to the storm runoff, however, the steep slopes characterized in this zone greatly increases the amount of interflow which contributes to the total storm runoff for the watershed.

- The Upper Urban zone constitutes approximately 14 percent of the watershed and is about 80 percent urbanized. The urbanized areas are composed primarily of residential and commercial catchments and are drained by roadside ditches and storm sewers. The lot grades vary between 2% and 5%. A significant amount of this zone is paved. The predominant soil is a sandy loam. The potential for surface runoff from this area exceeds that of the two previous zones because of the impervious nature of the urbanized areas. The surface runoff rate is expected to be high, but the roadside ditches which convey runoff to the collecting storm sewers tends to damp out the peak runoff rate and lengthen the time to peak. This has an overall effect of making the system less efficient as compared to a more intensely urbanized area where runoff is directly conveyed from the impervious areas via curbs, gutters and catchbasins into the storm sewer system. These, more conventional, urban areas are characterized by high peak runoff rates and shorter time to peaks.

- The remainder of the watershed, approximately 10 percent, makes up the Lower Urban zone and is almost fully urbanized. The only significant areas in this zone that are not developed are the wetlands in the Johnson Creek watershed (i.e. Delaney/Mud Lake). The Lower Urban zone is characterized by the same type of development and drainage system as the Upper Urban zone. The soils in this zone are clayey type soils which possesses high potential for storm runoff rates. The ground slopes are milder in this zone as compared to those in the Upper Urban zone.

2.3.1.2 Model Calibration

- The OTTHYMO.89 subroutines CALIB WILHYD (William's hydrograph) and CALIB STANDHYD were used to model the rural and urbanized areas, respectively.

- The hydrologic parameters from the 1984 Chippewa Creek Flood and Erosion Control Study HYMO model were used. These parameters included catchment sizes, unit hydrograph time to peaks, hydrograph recession constants and soil curve numbers. The impervious ratios for those subwatersheds with urbanized areas were estimated with the use of existing mapping available for the watershed.

- Initial calibrations using the previous model parameters yielded results that did not closely match the recorded hydrographs for the historic events. The simulated peak flows were much greater and peaked much earlier than the recorded event. The shapes of the simulated hydrographs did not match their recorded counterparts as they were characterized by the occurrence of two separate and distinct peaks.

- The soil curve numbers were lowered and initial abstractions increased to account for the overestimation of the simulated peak flows and to better represent the existing soil conditions.

- The soil curve numbers for any undeveloped (forest/woodlot/treestand) would have a CN and initial rainfall abstraction of 45 and 15 millimeters, respectively. The urbanized portions of the Escarpment and Upper Urban zones would have a CN of 55 whereas the urbanized areas of the Lower Urban zone would have a CN of 75. All urbanized areas would have an initial rainfall abstraction of 2 millimeters.

- The early calibration simulations showing an early time-to-peak and two hydrograph peaks was thought to be caused by the urbanized areas which were modelled to drain too efficiently, as compared to the actual existing conditions. In the first attempts at calibration, the urbanized portions of the watershed would have drained away first, hence the first peak, before the remainder of the watershed could respond, as was evident by the second peak.

- The urbanized areas were then modelled to drain less efficiently by increasing the length of the impervious areas up to 10 and 12 times the normal length (as calculated by the model to be 1.5 times the effective width of the drainage area). This was done also to account for the ditch storage and conveyance characteristics having an attenuation and lagging effect upon flows.

- The changes to the model had a positive effect upon the simulated hydrographs. The recorded hydrograph for the November 1, 1974 event was closely followed by the computer simulation. The result was that the simulated peak flow and runoff volume were to be both within 5 percent of the corresponding recorded values and the simulated hydrograph shape and timing closely matched the recorded event hydrograph.

- The November 1, 1974 event proved to be the best calibration out of the 4 recorded events and the October 18, 1981 event was the next closest. The July 24, 1977 event calibration could not be calibrated at all. The 1984 Northland Engineering study also came to the same conclusions.

Comparison of Flows (Existing vs. Future as per O.P.)

Watercourse	Subarea	Drainage Area	1:2 Year Event (Ptot = 21.72 mm)								
			Existing Conditions				Future Conditions				ΔQ
			% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.	
		(ha)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)	(%)
Chippewa Creek	4	194.3	0	0.01	12.83	0.14	7	0.30	6.00	0.88	2900
	5	152.8	0	0.01	12.58	0.14	33	0.96	6.08	3.70	9500
	6	240.9	0	0.01	13.75	0.14	17	0.95	6.08	2.27	9400
	7	251.2	50	0.03	9.92	0.36	41	0.89	6.08	2.35	2867
Eastview Tributary	11	108.8	40	0.99	6.08	5.50	56	1.87	6.08	9.21	89
	12	54.4	0	0.00	10.25	0.14	33	0.54	6.08	5.79	13400
	13	77.7	50	0.71	6.08	5.46	100	1.59	6.08	11.13	124
Johnston Creek	15	77.7	0	0.01	10.50	0.75	71	1.28	6.17	10.32	12700
	16	204.6	0	0.01	11.00	0.14	53	1.21	6.25	4.32	12000
	17	57.0	20	0.01	9.67	0.35	35	0.58	6.00	5.29	5700
Confluence-3	1 to 20	3799.6	± 20	3.10	6.17	1.36	± 30	5.39	6.50	2.59	74
Mouth	1 to 22	4089.7	± 25	5.33	6.17	1.97	± 35	6.08	6.67	3.11	14

Watercourse	Subarea	Drainage Area	1:5 Year Event (Ptot = 28.96 mm)								
			Existing Conditions				Future Conditions				ΔQ
			% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.	
		(ha)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)	(%)
Chippewa Creek	4	194.3	0	0.03	11.92	0.60	7	0.41	6.00	1.58	1267
	5	152.8	0	0.03	11.17	0.60	33	1.34	6.08	5.35	4367
	6	240.9	0	0.03	13.00	0.59	17	1.32	6.08	3.44	4300
	7	251.2	50	0.11	8.83	1.06	41	1.25	6.08	3.69	1036
Eastview Tributary	11	108.8	40	1.39	6.00	7.96	56	2.60	6.00	12.81	87
	12	54.4	0	0.01	9.58	0.59	33	0.75	6.08	8.18	7400
	13	77.7	50	0.99	6.00	7.88	100	2.27	6.00	15.33	129
Johnston Creek	15	77.7	0	0.03	10.17	1.80	71	1.84	6.08	14.33	6033
	16	204.6	0	0.04	10.00	0.60	53	1.75	6.17	6.21	4275
	17	57.0	20	0.02	8.33	1.05	35	0.80	6.00	7.58	3900
Confluence-3	1 to 20	3799.6	± 20	4.60	6.08	2.37	± 30	8.62	6.50	4.01	87
Mouth	1 to 22	4089.7	± 25	7.94	6.17	3.23	± 35	9.33	6.75	4.75	18

Watercourse	Subarea	Drainage Area	1:25 Year Event (Ptot = 36.83 mm)								
			Existing Conditions				Future Conditions				ΔQ
			% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.	
		(ha)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)	(%)
Chippewa Creek	4	194.3	0	0.07	11.25	1.43	7	0.55	6.00	2.67	686
	5	152.8	0	0.07	10.67	1.43	33	1.76	6.08	7.41	2414
	6	240.9	0	0.07	12.67	1.42	17	1.76	6.00	5.00	2414
	7	251.2	20	0.24	8.58	2.20	41	1.65	6.08	5.50	588
Eastview Tributary	11	108.8	40	1.85	6.00	10.91	56	3.42	6.00	16.95	85
	12	54.4	0	0.03	8.58	1.43	33	1.01	6.08	11.01	3267
	13	77.7	50	1.31	6.00	10.79	100	2.97	6.00	20.06	127
Johnston Creek	15	77.7	40	0.06	9.92	3.38	71	2.43	6.08	18.93	3950
	16	204.6	0	0.11	9.42	1.43	53	2.34	6.17	8.53	2027
	17	57.0	20	0.05	8.08	2.20	35	1.05	6.00	10.36	2000
Confluence-3	1 to 20	3799.6	± 20	6.68	6.08	3.81	± 30	12.12	6.42	5.88	81
Mouth	1 to 22	4089.7	± 25	10.95	6.17	4.94	± 35	13.32	6.67	6.86	22

Comparison of Flows (Existing vs. Future as per O.P.)

Watercourse	Subarea	Drainage Area	1:50 Year Event (Ptot = 40.00 mm)								
			Existing Conditions				Future Conditions				ΔQ
			% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.	
		(ha)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)	(%)
Chippewa Creek	4	194.3	0	0.09	11.17	1.86	7	0.61	6.00	3.20	578
	5	152.8	0	0.08	10.58	1.86	33	1.99	6.08	8.32	2388
	6	240.9	0	0.09	12.58	1.84	17	1.95	6.00	5.71	2067
	7	251.2	20	0.30	8.50	2.77	41	1.87	6.08	6.33	523
Eastview Tributary	11	108.8	40	2.06	6.00	12.18	56	3.79	6.00	18.68	84
	12	54.4	0	0.04	8.42	1.85	33	1.12	6.08	12.22	2700
	13	77.7	50	1.47	6.00	12.04	100	3.29	6.00	22.01	124
Johnston Creek	15	77.7	40	0.08	9.83	4.14	71	2.70	6.08	20.84	3275
	16	204.6	0	0.14	9.25	1.86	53	2.61	6.17	9.54	1764
	17	57.0	20	0.07	8.00	2.77	35	1.16	6.00	11.56	1557
Confluence-3	1 to 20	3799.6	± 20	7.82	6.08	4.49	± 30	13.88	6.33	6.72	77
Mouth	1 to 22	4089.7	± 25	12.39	6.17	5.72	± 35	15.15	6.67	7.79	22

Watercourse	Subarea	Drainage Area	1:100 Year Event (Ptot = 50.67 mm)								
			Existing Conditions				Future Conditions				ΔQ
			% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.	
		(ha)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)	(%)
Chippewa Creek	4	194.3	0	0.18	10.83	3.66	7	0.79	6.00	5.33	339
	5	152.8	0	0.17	10.33	3.66	33	2.61	6.00	11.68	1435
	6	240.9	0	0.18	12.33	3.63	17	2.56	6.00	8.43	1322
	7	251.2	20	0.58	8.42	5.09	41	2.47	6.08	9.47	326
Eastview Tributary	11	108.8	40	2.91	6.00	16.75	56	5.19	6.00	24.71	78
	12	54.4	0	0.08	8.17	3.66	33	1.49	6.00	16.53	1763
	13	77.7	50	2.04	6.00	16.54	100	4.32	6.00	28.78	112
Johnston Creek	15	77.7	40	0.13	9.75	7.15	71	3.66	6.08	27.51	2715
	16	204.6	0	0.28	9.00	3.67	53	3.55	6.08	13.22	1168
	17	57.0	20	0.13	7.92	5.09	35	1.57	6.00	15.90	1108
Confluence-3	1 to 20	3799.6	± 20	11.69	6.25	7.12	± 30	19.65	6.33	9.87	68
Mouth	1 to 22	4089.7	± 25	16.76	6.08	8.71	± 35	21.32	6.58	11.27	27

Watercourse	Subarea	Drainage Area	Timmins Storm Event (Ptot = 193.0 mm)								
			Existing Conditions				Future Conditions				ΔQ
			% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.	
		(ha)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)	(%)
Chippewa Creek	4	194.3	0	3.14	12.33	64.61	7	3.15	12.00	69.21	0
	5	152.8	0	2.79	12.00	64.69	33	4.19	7.00	86.83	50
	6	240.9	0	3.09	13.25	64.11	17	3.83	7.00	77.43	24
	7	251.2	20	6.62	10.08	75.12	41	7.29	9.08	86.55	10
Eastview Tributary	11	108.8	40	6.68	7.08	106.37	56	8.16	7.00	127.02	22
	12	54.4	0	1.14	9.92	64.73	33	2.68	7.00	100.24	135
	13	77.7	50	4.69	7.08	104.89	100	6.33	7.00	136.95	35
Johnston Creek	15	77.7	40	1.52	11.67	87.69	71	5.62	7.00	137.51	270
	16	204.6	0	4.30	10.67	64.71	53	7.73	7.17	91.08	80
	17	57.0	20	1.51	9.67	75.15	35	2.34	7.00	103.39	55
Confluence-3	1 to 20	3799.6	± 20	53.51	9.08	76.84	± 30	68.89	9.08	84.21	29
Mouth	1 to 22	4089.7	± 25	65.95	9.17	82.35	± 35	82.89	9.08	89.20	26

Chippewa Creek Watershed Management Study
EO: 94408, WH1, Cat1

Comparison of Flows (Existing, Future as per O.P., and Ultimate)

Location in Chippewa Creek Watershed	Subarea	Drainage Area	1:2 Year Event (Ptot = 21.72 mm)											
			Existing Conditions				Future Conditions				Ultimate Conditions			
			% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.
		(ha)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)
Chippewa Creek at Airport Road	1 to 7	2595.2	20	0.07	15.58	0.20	41	2.16	6.25	0.86	41	2.22	6.17	0.83
Main branch upstream of confluence point with Eastview and Johnston	1 to 10	2900.9	10	1.77	6.08	0.80	16	2.45	6.58	1.39	16	2.76	6.58	1.39
Eastview Tributary drainage area	11 to 14	282.3	50	1.18	6.25	4.55	69	3.14	6.25	8.63	69	3.28	6.25	8.71
Johnson Creek at Ski Club Road	15 to 16	282.3	11	0.02	11.00	0.31	58	2.15	6.33	5.97	58	2.63	6.17	6.02
Johnston Creek drainage area	15 to 19	575.0	44	2.34	6.08	2.97	68	4.02	6.17	6.23	68	4.76	6.17	6.22
Johnston routed thru Delaney Lake	15 to 19	575.0	44	0.16	12.08	2.13	68	0.51	10.00	5.31	68	0.51	9.83	5.29
Eastview + Johnston drainage area	11 to 19	857.3	44	1.19	6.25	2.92	69	3.16	6.33	6.40	69	3.31	6.25	6.41
Chippewa, Eastview, Johnston confl.	1 to 20	3799.6	± 20	3.10	6.17	1.36	± 30	5.39	6.50	2.59	± 30	5.83	6.50	2.59
Mouth	1 to 22	4089.7	± 25	5.33	6.17	1.97	± 35	6.08	6.67	3.11	± 35	6.67	6.75	3.13

Location in Chippewa Creek Watershed	Subarea	Drainage Area	1:5 Year Event (Ptot = 28.96 mm)											
			Existing Conditions				Future Conditions				Ultimate Conditions			
			% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.
		(ha)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)
Chippewa Creek at Airport Road	1 to 7	2595.2	20	0.26	14.58	0.71	41	3.39	6.25	1.58	41	3.49	6.17	1.54
Main branch upstream of confluence point with Eastview and Johnston	1 to 10	2900.9	10	2.63	6.08	1.54	16	4.32	6.58	2.32	16	4.78	6.58	2.32
Eastview Tributary drainage area	11 to 14	282.3	50	1.83	6.25	6.68	69	4.51	6.25	12.06	69	4.87	6.17	12.16
Johnson Creek at Ski Club Road	15 to 16	282.3	11	0.08	10.17	0.93	58	3.11	6.25	8.45	58	3.71	6.08	8.52
Johnston Creek drainage area	15 to 19	575.0	44	3.45	6.08	4.70	68	6.16	6.17	9.04	68	7.05	6.17	9.01
Johnston routed thru Delaney Lake	15 to 19	575.0	44	0.32	10.75	3.78	68	0.80	9.83	8.06	68	0.80	9.75	8.04
Eastview + Johnston drainage area	11 to 19	857.3	44	1.84	6.25	4.73	69	4.59	6.25	9.37	69	4.94	6.25	9.39
Chippewa, Eastview, Johnston confl.	1 to 20	3799.6	± 20	4.60	6.08	2.37	± 30	8.62	6.50	4.01	± 30	9.38	6.42	4.02
Mouth	1 to 22	4089.7	± 25	7.94	6.17	3.23	± 35	9.33	6.75	4.75	± 35	10.19	6.67	4.78

Chippewa Creek Watershed Management Study
EO: 94408, WH1, Cat1

Comparison of Flows (Existing, Future as per O.P., and Ultimate)

Location in Chippewa Creek Watershed	Subarea	Drainage Area	1:25 Year Event (Ptot = 36.83 mm)											
			Existing Conditions				Future Conditions				Ultimate Conditions			
			% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.
		(ha)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)
Chippewa Creek at Airport Road	1 to 7	2595.2	20	0.61	13.92	1.58	41	4.50	6.17	2.68	41	4.56	6.17	2.63
Main branch upstream of confluence point with Eastview and Johnston	1 to 10	2900.9	10	3.80	6.08	2.66	16	6.04	6.58	3.64	16	6.68	6.58	3.65
Eastview Tributary drainage area	11 to 14	282.3	50	2.64	6.25	9.29	69	6.21	6.25	16.02	69	6.70	6.17	16.15
Johnson Creek at Ski Club Road	15 to 16	282.3	11	0.17	9.67	1.97	58	4.19	6.25	11.39	58	5.15	6.08	11.48
Johnston Creek drainage area	15 to 19	575.0	44	4.80	6.00	6.97	68	8.24	6.17	12.40	68	9.98	6.17	12.36
Johnston routed thru Delaney Lake	15 to 19	575.0	44	0.52	10.50	5.98	68	1.15	9.67	11.39	68	1.15	9.50	11.34
Eastview + Johnston drainage area	11 to 19	857.3	44	2.68	6.25	7.07	69	6.40	6.25	12.90	69	6.87	6.17	12.92
Chippewa, Eastview, Johnston confl.	1 to 20	3799.6	± 20	6.68	6.08	3.81	± 30	12.12	6.42	5.88	± 30	13.26	6.33	5.89
Mouth	1 to 22	4089.7	± 25	10.95	6.17	4.94	± 35	13.32	6.67	6.86	± 35	14.20	6.67	6.89

Location in Chippewa Creek Watershed	Subarea	Drainage Area	1:50 Year Event (Ptot = 40.00 mm)											
			Existing Conditions				Future Conditions				Ultimate Conditions			
			% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.
		(ha)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)
Chippewa Creek at Airport Road	1 to 7	2595.2	20	0.80	13.83	2.02	41	5.02	6.17	3.21	41	5.06	6.08	3.16
Main branch upstream of confluence point with Eastview and Johnston	1 to 10	2900.9	10	4.45	6.08	3.21	16	6.90	6.58	4.27	16	7.48	6.50	4.27
Eastview Tributary drainage area	11 to 14	282.3	50	3.02	6.25	10.43	69	6.95	6.17	17.68	69	7.51	6.17	17.82
Johnson Creek at Ski Club Road	15 to 16	282.3	11	0.21	9.50	2.49	58	4.69	6.25	12.65	58	5.78	6.08	12.75
Johnston Creek drainage area	15 to 19	575.0	44	5.54	6.08	7.98	68	9.40	6.17	13.84	68	11.32	6.17	13.79
Johnston routed thru Delaney Lake	15 to 19	575.0	44	0.61	10.75	6.98	68	1.28	9.58	12.81	68	1.28	9.33	12.76
Eastview + Johnston drainage area	11 to 19	857.3	44	3.08	6.25	8.11	69	7.18	6.25	14.41	69	7.72	6.17	14.42
Chippewa, Eastview, Johnston confl.	1 to 20	3799.6	± 20	7.82	6.08	4.49	± 30	13.88	6.33	6.72	± 30	14.96	6.33	6.73
Mouth	1 to 22	4089.7	± 25	12.39	6.17	5.72	± 35	15.15	6.67	7.79	± 35	16.08	6.67	7.83

Chippewa Creek Watershed Management Study
EO: 94408, WH1, Cat1

Comparison of Flows (Existing, Future as per O.P., and Ultimate)

Location in Chippewa Creek Watershed	Subarea	Drainage Area	1:100 Year Event (Ptot = 50.67 mm)											
			Existing Conditions				Future Conditions				Ultimate Conditions			
			% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.
		(ha)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)
Chippewa Creek at Airport Road	1 to 7	2595.2	20	1.61	12.92	3.88	41	6.75	6.17	5.34	41	6.91	6.08	5.28
Main branch upstream of confluence point with Eastview and Johnston	1 to 10	2900.9	10	6.38	6.08	5.40	16	9.86	6.50	6.71	16	10.74	6.50	6.72
Eastview Tributary drainage area	11 to 14	282.3	50	4.47	6.17	14.58	69	9.73	6.17	23.50	69	10.09	6.17	23.67
Johnson Creek at Ski Club Road	15 to 16	282.3	11	0.41	9.25	4.62	58	6.56	6.17	17.15	58	7.87	6.08	17.27
Johnston Creek drainage area	15 to 19	575.0	44	8.04	6.00	11.78	68	13.78	6.08	19.01	68	15.67	6.17	18.94
Johnston routed thru Delaney Lake	15 to 19	575.0	44	0.94	10.58	10.71	68	1.68	9.67	17.91	68	1.68	9.58	17.85
Eastview + Johnston drainage area	11 to 19	857.3	44	4.57	6.17	11.98	69	10.12	6.17	19.74	69	10.50	6.17	19.76
Chippewa, Eastview, Johnston confl.	1 to 20	3799.6	± 20	11.69	6.25	7.12	± 30	19.65	6.33	9.87	± 30	21.12	6.25	9.89
Mouth	1 to 22	4089.7	± 25	16.76	6.08	8.71	± 35	21.32	6.58	11.27	± 35	22.92	6.58	11.31

Location in Chippewa Creek Watershed	Subarea	Drainage Area	Timmins Storm Event (Ptot = 193.0 mm)											
			Existing Conditions				Future Conditions				Ultimate Conditions			
			% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.	% Urban	Q	T_p	R.V.
		(ha)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)	(%)	(m^3/s)	(hrs)	(mm)
Chippewa Creek at Airport Road	1 to 7	2595.2	20	26.95	13.08	64.53	41	26.01	12.08	68.52	41	25.88	12.08	68.36
Main branch upstream of confluence point with Eastview and Johnston	1 to 10	2900.9	10	30.34	12.00	69.90	16	32.05	9.25	73.47	16	32.59	7.33	73.61
Eastview Tributary drainage area	11 to 14	282.3	50	14.02	7.17	100.39	69	19.15	7.08	124.01	69	19.96	7.08	124.39
Johnson Creek at Ski Club Road	15 to 16	282.3	11	5.75	11.00	71.03	58	13.13	7.17	103.86	58	14.09	7.08	104.13
Johnston Creek drainage area	15 to 19	575.0	44	20.90	7.08	96.24	68	33.12	7.08	115.16	68	34.72	7.08	114.84
Johnston routed thru Delaney Lake	15 to 19	575.0	44	15.15	9.75	94.80	68	22.06	9.33	113.91	68	22.12	9.33	113.58
Eastview + Johnston drainage area	11 to 19	857.3	44	25.27	9.17	96.63	69	34.66	9.00	117.23	69	35.57	7.25	117.13
Chippewa, Eastview, Johnston confl.	1 to 20	3799.6	± 20	53.51	9.08	76.84	± 30	68.89	9.08	84.21	± 30	69.91	7.33	84.30
Mouth	1 to 22	4089.7	± 25	65.95	9.17	82.35	± 35	82.89	9.08	89.20	± 35	83.46	9.08	89.32

Chippewa Creek Watershed Management Study
EO: 94408, WH1, Cat1

Comparison of Flows (Existing, Future as per O.P., and Future with Existing Improved)

Location in Chippewa Creek Watershed	Subarea	Drainage Area	% Urban Existing	1:2 Year Event (Ptot = 21.72 mm)				1:5 Year Event (Ptot = 28.96 mm)			
				Future to Existing		Ultimate to Existing		Future to Existing		Ultimate to Existing	
				% Urban	ΔQ	% Urban	ΔQ	% Urban	ΔQ	% Urban	ΔQ
		(ha)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Chippewa Ceek at Airport Road	1 to 7	2595.2	20	41	2986	41	3071	41	1204	41	1242
Main branch upstream of confluence point with Eastview and Johnston	1 to 10	2900.9	10	16	38	16	56	16	64	16	82
Eastview Tributary drainage area	11 to 14	282.3	50	69	166	69	178	69	146	69	166
Johnston Creek at Ski Club Road	15 to 16	282.3	11	58	10650	58	13050	58	3788	58	4538
Johnston Creek drainage area	15 to 19	575.0	44	68	72	68	103	68	79	68	104
Johnston routed thru Delaney Lake	15 to 19	575.0	44	68	219	68	219	68	150	68	150
Eastview + Johnston drainage area	11 to 19	857.3	44	69	166	69	178	69	149	69	168
Chippewa, Eastview, Johnston confl.	1 to 20	3799.6	± 20	± 30	74	± 30	88	± 30	87	± 30	104
Mouth	1 to 22	4089.7	± 25	± 35	14	± 35	25	± 35	18	± 35	28

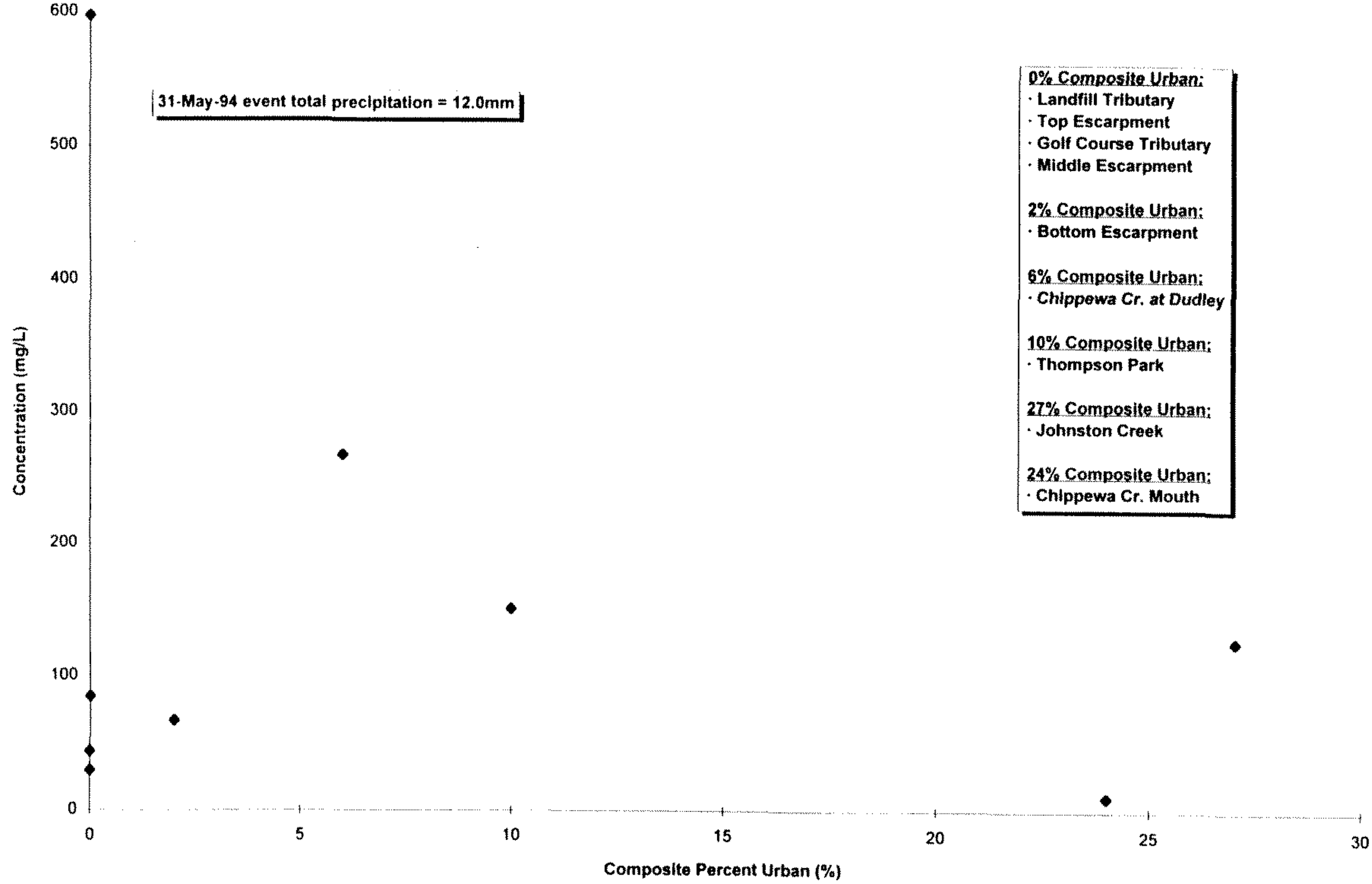
Location in Chippewa Creek Watershed	Subarea	Drainage Area	% Urban Existing	1:25 Year Event (Ptot = 36.83 mm)				1:50 Year Event (Ptot = 40.00 mm)			
				Future to Existing		Ultimate to Existing		Future to Existing		Ultimate to Existing	
				% Urban	ΔQ	% Urban	ΔQ	% Urban	ΔQ	% Urban	ΔQ
		(ha)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Chippewa Ceek at Airport Road	1 to 7	2595.2	20	41	638	41	648	41	528	41	533
Main branch upstream of confluence point with Eastview and Johnston	1 to 10	2900.9	10	16	59	16	76	16	55	16	68
Eastview Tributary drainage area	11 to 14	282.3	50	69	135	69	154	69	130	69	149
Johnston Creek at Ski Club Road	15 to 16	282.3	11	58	2365	58	2929	58	2133	58	2652
Johnston Creek drainage area	15 to 19	575.0	44	68	72	68	108	68	70	68	104
Johnston routed thru Delaney Lake	15 to 19	575.0	44	68	121	68	121	68	110	68	110
Eastview + Johnston drainage area	11 to 19	857.3	44	69	139	69	156	69	133	69	151
Chippewa, Eastview, Johnston confl.	1 to 20	3799.6	± 20	± 30	81	± 30	99	± 30	77	± 30	91
Mouth	1 to 22	4089.7	± 25	± 35	22	± 35	30	± 35	22	± 35	30

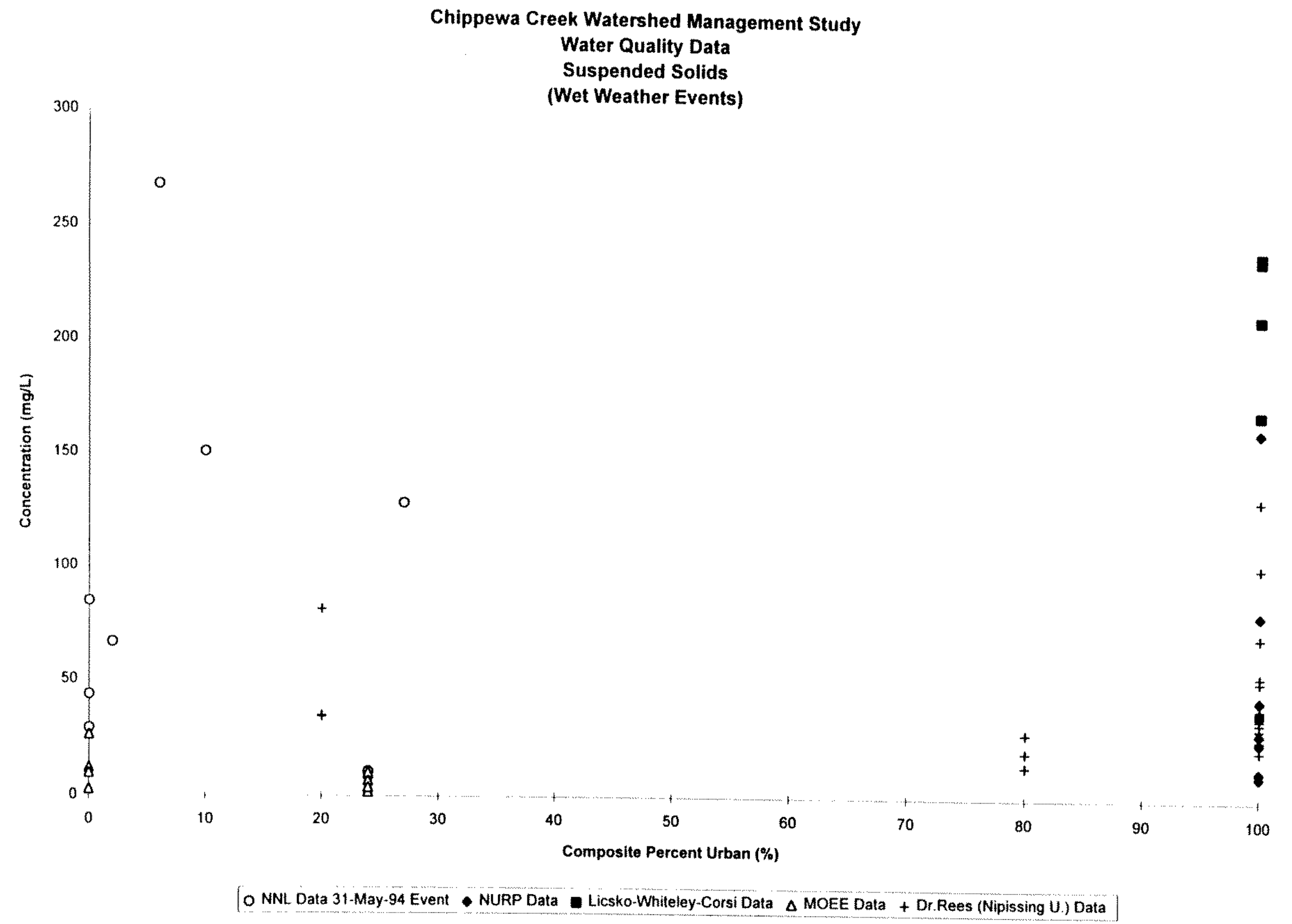
Chippewa Creek Watershed Management Study
EO: 94408, WH1, Cat1

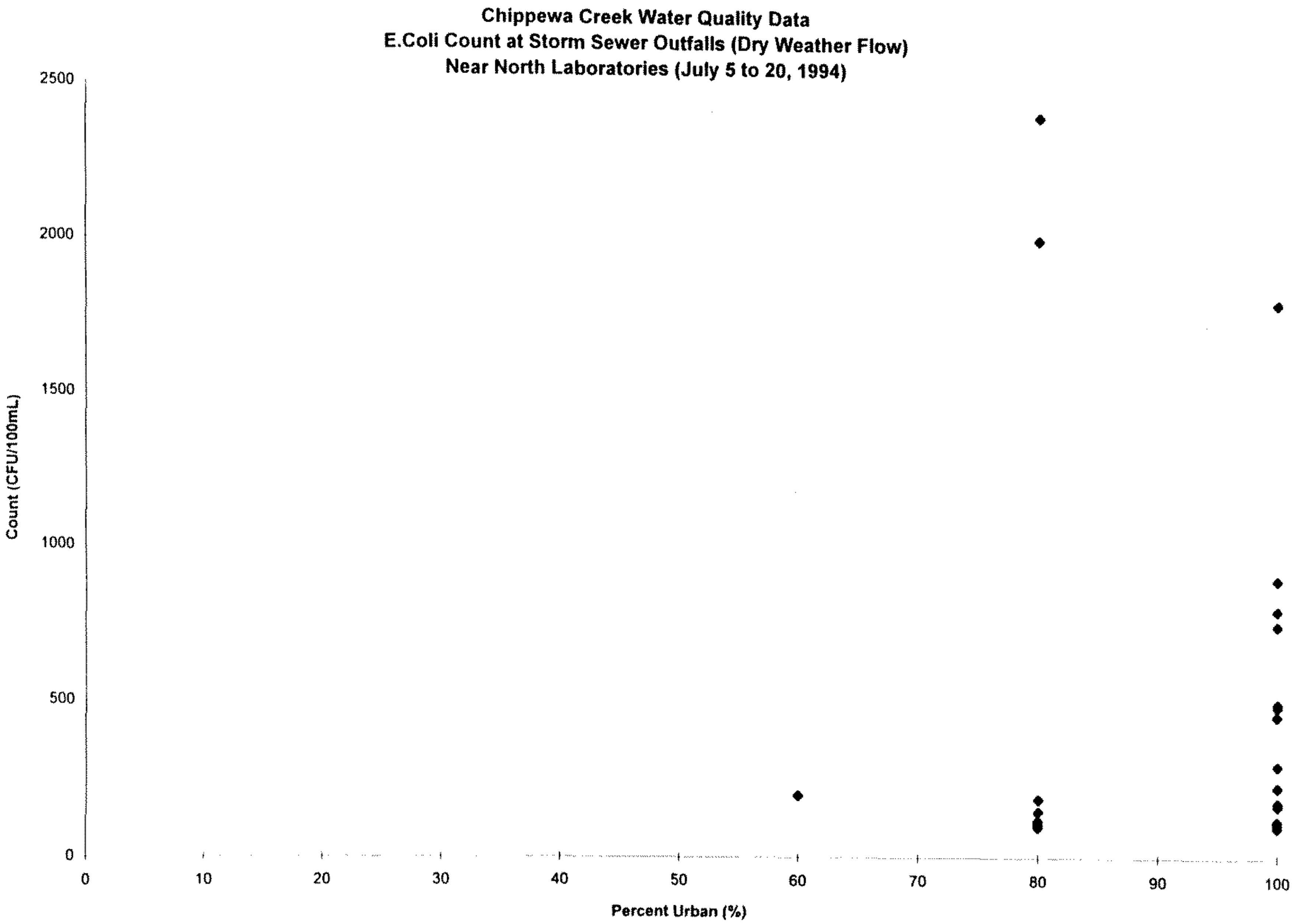
Comparison of Flows (Existing, Future as per O.P., and Future with Existing Improved)

Location in Chippewa Creek Watershed	Subarea	Drainage Area	% Urban Existing	1:100 Year Event (Ptot = 50.67 mm)				Timmins Storm Event (Ptot = 193.0 mm)			
				Future to Existing		Ultimate to Existing		Future to Existing		Ultimate to Existing	
				% Urban	ΔQ	% Urban	ΔQ	% Urban	ΔQ	% Urban	ΔQ
		(ha)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Chippewa Ceek at Airport Road	1 to 7	2595.2	20	41	319	41	329	41	-3	41	-4
Main branch upstream of confluence point with Eastview and Johnston	1 to 10	2900.9	10	16	55	16	68	16	6	16	7
Eastview Tributary drainage area	11 to 14	282.3	50	69	118	69	126	69	37	69	42
Johnston Creek at Ski Club Road	15 to 16	282.3	11	58	1500	58	1820	58	128	58	145
Johnston Creek drainage area	15 to 19	575.0	44	68	71	68	95	68	58	68	66
Johnston routed thru Delaney Lake	15 to 19	575.0	44	68	79	68	79	68	46	68	46
Eastview + Johnston drainage area	11 to 19	857.3	44	69	121	69	130	69	37	69	41
Chippewa, Eastview, Johnston confl.	1 to 20	3799.6	± 20	± 30	68	± 30	81	± 30	29	± 30	31
Mouth	1 to 22	4089.7	± 25	± 35	27	± 35	37	± 35	26	± 35	27

Chippewa Creek Watershed Management Study
Near North Labs Data - Suspended Solids
(31-May-94 Wet Weather Event)

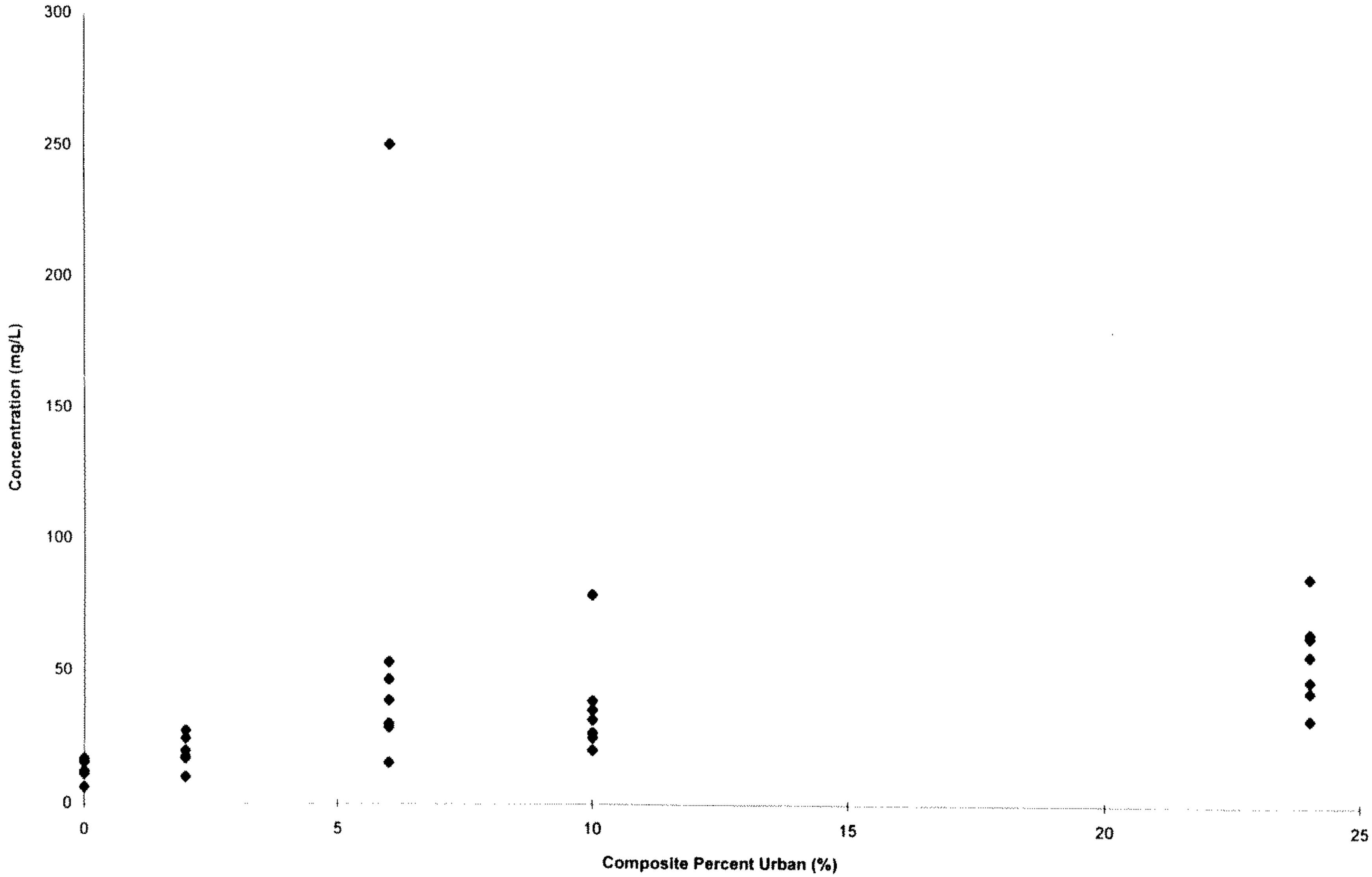



Chippewa Creek Watershed Management Study
Water Quality Data
Suspended Solids
(Wet Weather Events)
Concentration (mg/L)
300
250
200
150
100
50
0
0
10
20
30
40
50
60
70
80
90
100
Composite Percent Urban (%)
NNL Data 31-May-94 Event
NURP Data
Licsko-Whiteley-Corsi Data
MOEE Data
Dr.Rees (Nipissing U.) Data



Chippewa Creek Water Quality Data
E.Coli Count at Storm Sewer Outfalls (Dry Weather Flow)
Near North Laboratories (July 5 to 20, 1994)
Count (CFU/100mL)
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
70
80
90
100
Percent Urban (%)

Chipewa Creek
Near North Labs Data
Chlorine Concentration



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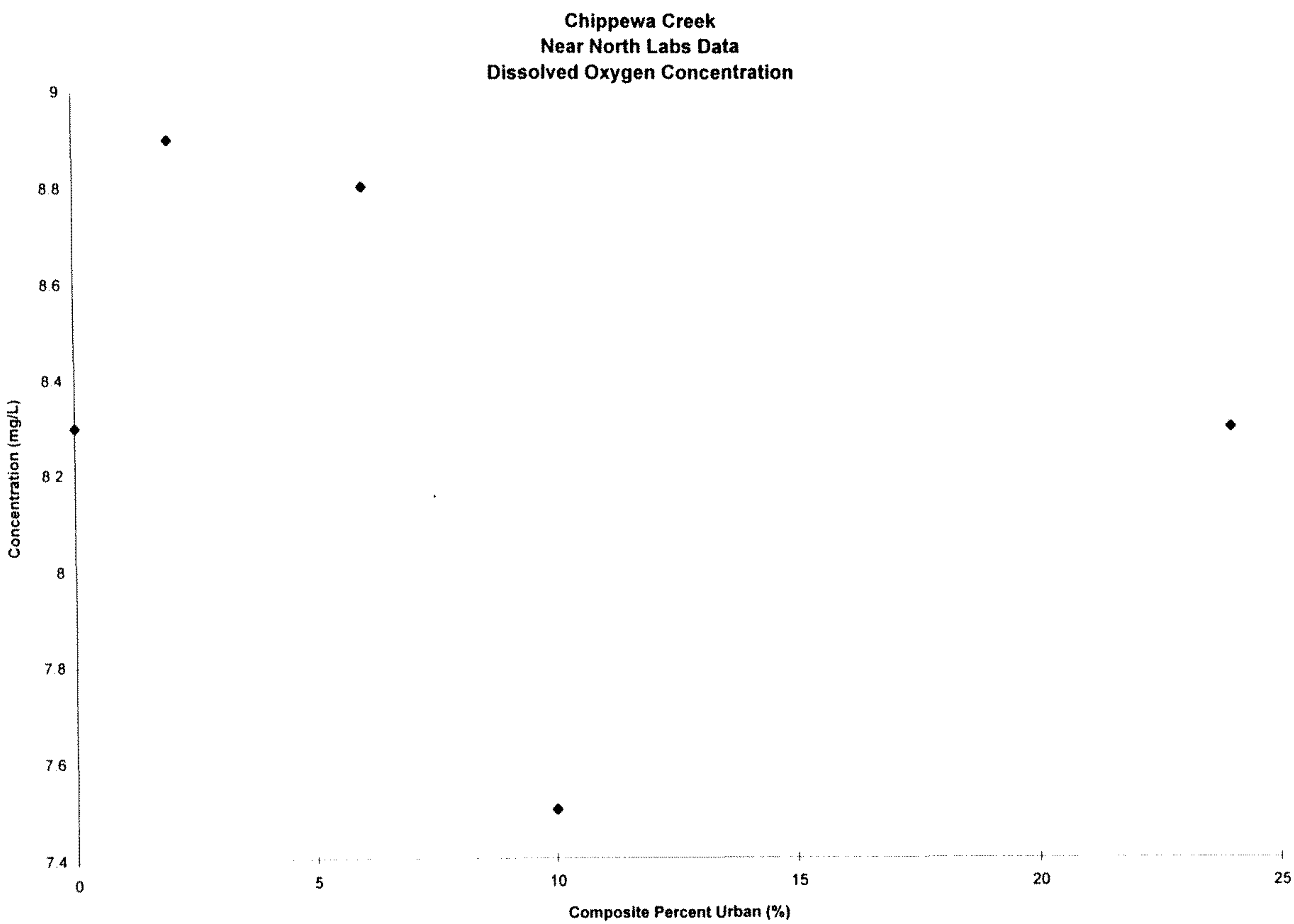
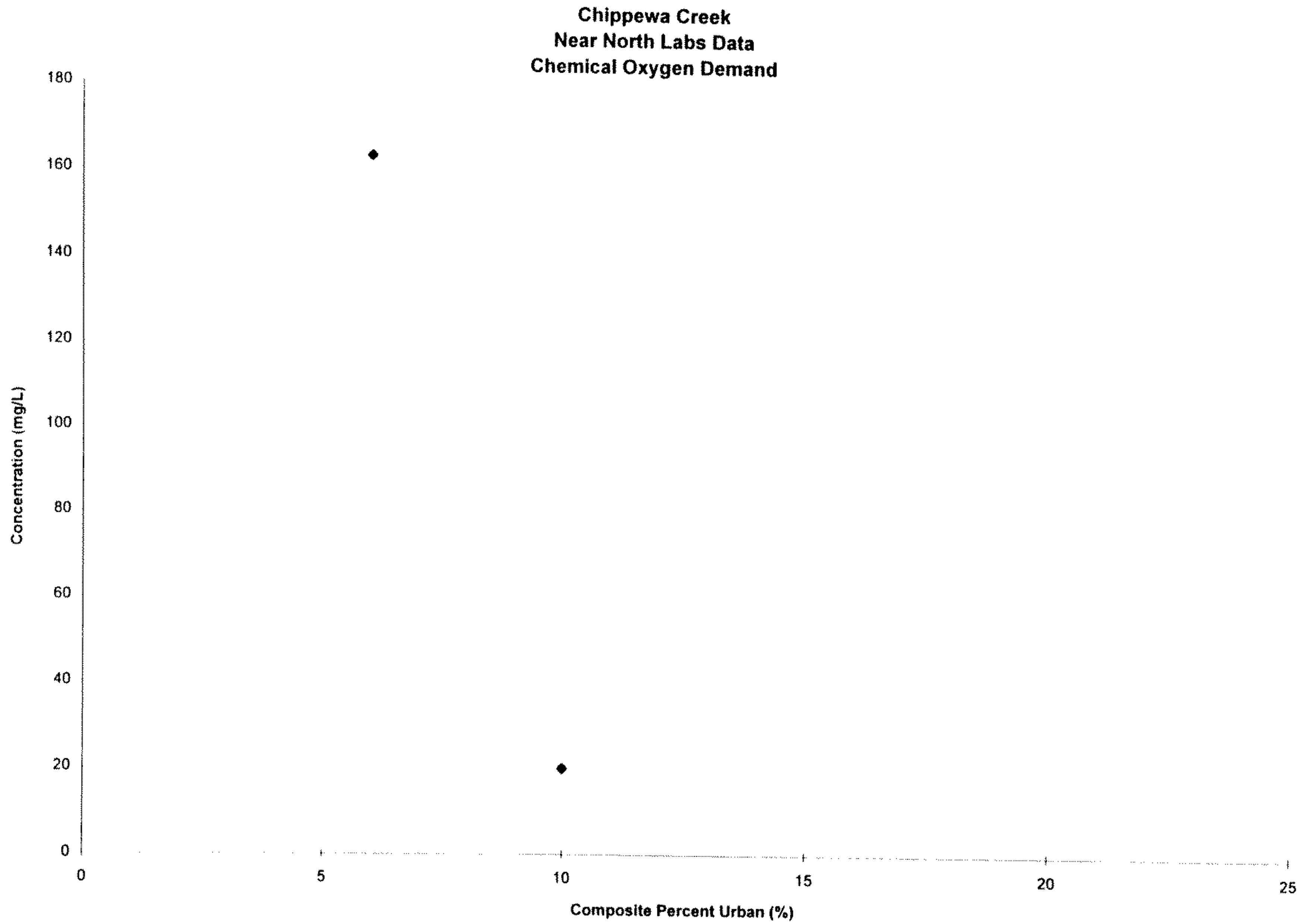

Chippewa Creek
Near North Labs Data
Dissolved Oxygen Concentration
Concentration (mg/L)
9
8.8
8.6
8.4
8.2
8
7.8
7.6
7.4
0
5
10
15
20
25
Composite Percent Urban (%)



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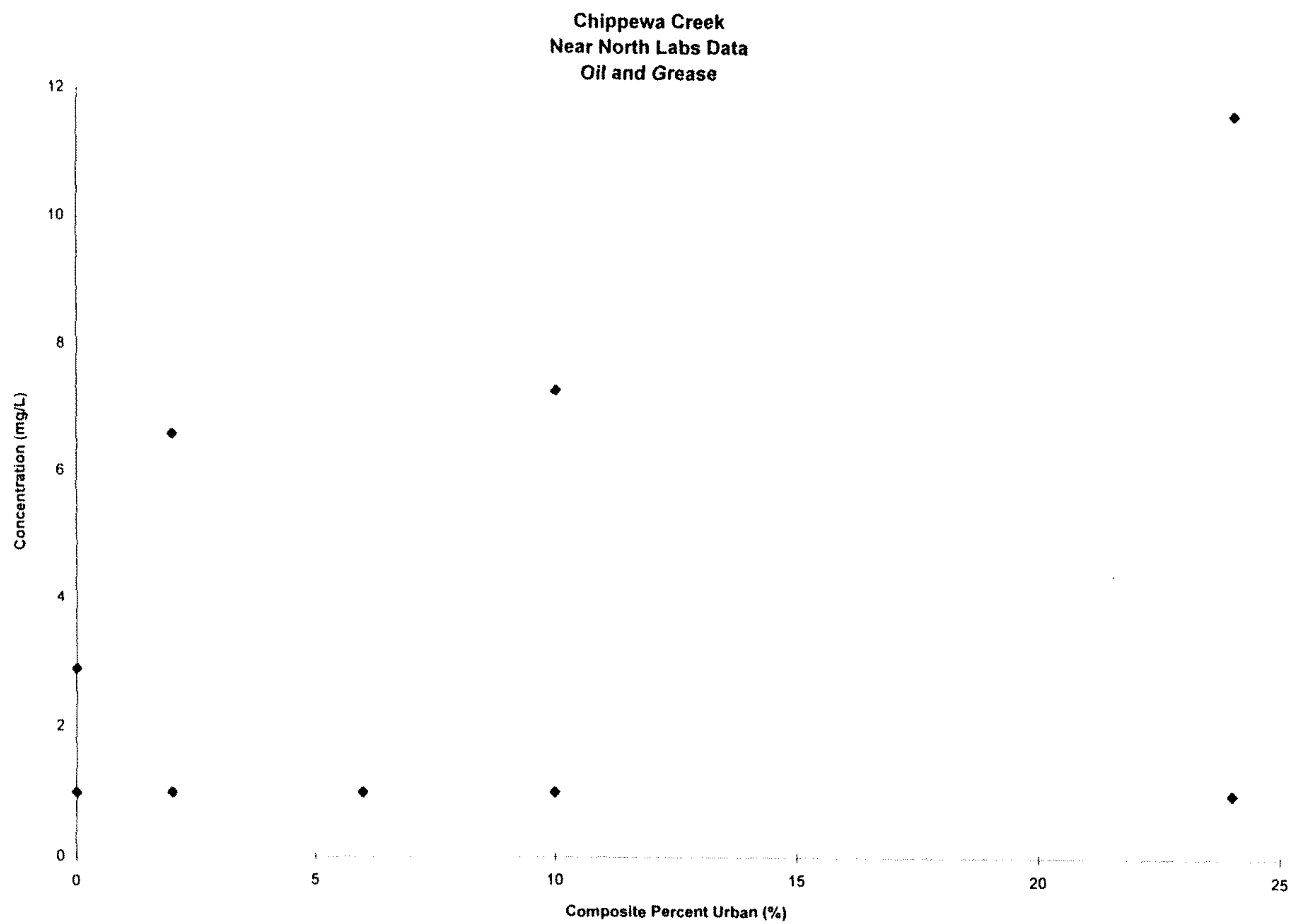


Chippewa Creek
Near North Labs Data
Oil and Grease
Concentration (mg/L)
0
2
4
6
8
10
12
Composite Percent Urban (%)
0
5
10
15
20
25

APPENDIX E

WATER QUALITY

CHIPPEWA CREEK

WATER QUALITY

1.0 Historical Documentation Review

Being the most predominant watershed within the municipal boundaries of North Bay, Chippewa Creek historically water quality observations extend back to the late nineteen hundreds (1891). It was once considered as a potential source for North Bay's drinking water (Steer, 1990). From the tests that were conducted, its existing bacteria flora was too extensive for safe human consumption. The attention was later turned to Trout Lake which is now North Bay's present drinking water supply. Most of the current historical data is documented by the Ontario Ministry of the Environment and Energy through its provincial water survey program. This program was started in the seventies and was continued up to 1991. This program was discontinued for budgetary reasons. Recent water quality monitoring was conducted by the City of North Bay and it focus around the vicinity of the Marsh Drive landfill site. The Ontario Ministry of Health undertook several extensive coliform bacteria surveys from 1965 through to 1990. In addition, several short term studies were conducted by the faculty and students of Nipissing University and Canadore College.

2.0 Documentation Selection

Exclusions Rationale

The sources for historical water quality data of Chippewa Creek are varied. The data obtained from Nipissing University and Canadore College were discounted due to the unavailable of control data recorded during analyses. Though many of the analytical analyses conducted would be considered valid, the majority of the analysts were undergraduates and have since left the facilities.

Data collected by the Ontario Ministry of Health was discounted for two reasons; provincial policy changes and the data parameters measured are related to human contact sensitivities. The Ministry of Health data consist of faecal coliform monitoring which was the indicator for human contact safety. Faecal Coliform indicator has since been discontinued and substituted by the bacteria Escherichia coli. The rational documented by the Ministry of Health indicates that the Escherichia coli bacteria is a more representative coliform bacteria to indicate the possible presence of sewage source contamination. The presence of Escherichia coli in Chippewa Creek is mainly a concern as the creek discharges into Lake Nipissing in the proximity of Marathon Beach public swimming area.

Data collected by Ontario Ministry of the Environment before 1985 was not included. Several influential changes of the water quality of Chippewa Creek have occurred as a result infrastructure improvements (sewage trunk lines) and urban development.

Inclusion Rationale

Two principle sources, Ontario Ministry of the Environment and Energy and the City of North Bay, were used to assess the present water quality of Chippewa Creek.

The Ontario Ministry of the Environment and Energy maintains an extensive control data library in addition to participating in provincial and national laboratory proficiency evaluations. Prior to this watershed management study, the Ontario Ministry of the Environment and Energy has conducted the most extensive water quality study on the main channels of Chippewa Creek. Samples were collected from the creek at Golf Club Road bridge and the mouth of the creek as it discharges into Lake Nipissing.

The City of North Bay has maintained two principle studies on Chippewa Creek. One study has been continued for four years (to present date) in the vicinity of the Marsh Drive Landfill site. This data has been provided by the Ontario Ministry of the Environment and interpreted by the consulting firm Gartner Lee of Ontario. In addition, the city has conducted a series of urban storm water outfall surveys of Escherichia coli levels along Chippewa Creek.

Parameter Rationale

Various studies have been conducted on Chippewa Creek in relation to specific water quality investigations. The Ontario Ministry of the Environment and Energy conducted its studies on the basis to obtaining a data base in which natural variation can be observed. This data base is mainly to be used as a means of comparison to evaluate specific events as to their degree of severity of the impairment on the creek's water quality. The City of North Bay conducted its Marsh Drive Landfill study to delineate the leachate plume of the landfill and its impact on Chippewa Creek's Water quality. Current data collection by the city in this area is to determine the effectiveness of the now operating leachate collection system. The City of North Bay has conducted a series of Escherichia coli analyses program to determine the presence of faecal related contamination within the urban core storm water conveyance system. To support these studies and the Watershed Management Study, the following parameters were conducted.

Alkalinity as CaCO3

Alkalinity is the sum measurement of the bicarbonates (Ca2CO3) and the carbonates present in water. The carbonates group are the principle agents which buffer the impacts of acidic inputs into a watershed. The acid sources can be from natural sources such as from the biological decomposition of organic material (organic acids). The acid sources can also be from industrial sources (acid rain). The principle sources of alkalinity is from the erosion of limestone baring rock and soils. The main consideration for alkalinity when judging water quality is to assess the occurrence of pH depressions. The alkalinity of water helps ensure the maintenance of pH levels and to buffer inputs of contaminants which may depress pH levels. This especially becomes important when toxic elements are also present in the water (e.g. lead). In accordance to the 1994 water quality objectives (Ontario Ministry of the Environment and Energy), the alkalinity of water should not be decreased more than 25% of its natural level.

pH

The parameter pH is the ionic measurement of the ratio of hydrogen and hydroxide ions. Hydrogen ions is the principle ion contributing to the acidity of water. Hydroxide ions are the principle ion contributing to alkaline water. The pH ratios (hydrogen to hydroxide) are judge on a scale of zero to fourteen. Seven on the scale is considered pH neutral. Less then seven, the water is considered becoming more acid and greater than seven the water is considered becoming more basic. The major concern of water having a lower than 6.5 pH units is increased ability of heavy metals to dissolved into the water. Some of the dissolved metals become biologically available for absorptions by aquatic organisms. Another element influence by pH is ammonia. The pH of a water course should be maintain between 6.5 - 8.5 pH units in accordance to the recommendations of the Ontario Ministry of the Environment and Energy.

Un-ionized Ammonia NH3

Low levels of ammonia in the aquatic environment is typically in the non-toxic ionized form. As pH is increased, ammonia becomes un-ionized and toxic to certain aquatic organisms. Another influence on ammonia is the temperature of the water. As temperature is increased, the presence of un-ionized ammonia is also increased. The recommended level of un-ionized ammonia is 0.02 mg/L or less to protect aquatic ecosystems.

Temperature °C

Temperature is a measurement of the latent heat contained in the water. Temperature has both biological influences of a water course in addition to influencing other water quality parameters. Several aquatic organisms are influence by the temperature of water course. Warm water temperatures can influence the survivability of organisms adapted to a colder water environment. Temperature influences the toxic affects of ammonia. As temperature increasing the presence of ammonia in its un-ionized also increases. Also temperature is one of the factors which influence the ability of oxygen to dissolved in water. An increase in temperature may result in the decrease of oxygen dissolved in water.

Chloride Cl

Chlorides are naturally found in the environment. Excess chlorides in the environment can contribute to the leachability of heavy metals found in the surrounding parent material. The levels of Chlorides are also used to identified the influences of road contaminations, landfill plumes and septic infiltrations.

Oxygen O2

The presence of oxygen is essential for aquatic organisms. Ideally should be not lower than 6 mg/L and is typically greater than 8 mg/L in stream courses. Excess decaying plants and water stagnation can lead to the reduction of oxygen in an aquatic ecosystem.

Copper Cu

Copper is one of the principle heavy metals which under certain conditions (soft water) can be toxic to the aquatic environment. Copper toxicity is especially a concern as smaller aquatic organism survival may become impaired which in turned stress larger aquatic organisms. When hardness levels are below 20 mg/L as CaCO3, copper toxicity may become evident.

Iron Fe

Iron is one of the principle elements found in water. In its oxidized form, iron can impaired water quality by precipitating out on aquatic plants which interferes in the plants ability to photosynthesize. Iron can also stress aquatic organisms by the excessive coating of gills. The current guidelines are 0.3 mg/L but many areas natural background level exceeds this level.

Conductivity (Cond)

Conductivity is the electrical measurement of dissolved ions in water. This parameter is used to indicate an excess of ions which may be present but not measured by a specific list of chemistries. Sudden increases in conductivity may indicate the presence of a contaminant introduced into the water course.

Total Dissolved Solids (TDS)

Dissolved solids is the gravimetric measurement of solids less than 4.7 um in size. Much like conductivity, dissolved solids is a measurements of total ions in water. This parameter is more sensitive than conductivity as it also measures the presence of non-conductive material.

Total Suspended Solids (TSS)

Total Suspended solids are particulates which are suspended in a water course. Erosions of creek banks and sediment disturbance contribute to suspended solids. Excessive suspended solids can stress aquatic organisms and can smother spawning beds. Ideally suspended solids should not exceed 15 mg/L.

Lead Pb

This heavy metal is toxic in the aquatic environment with soft waters. Lead is especially a concern if the water hardness is less than 80 mg/L as CaCO3. Urban sources of lead can result from the combustion of fossil fuels and the leaching from storm water pipes. Ideally lead should not be detectable in aquatic systems.

Nickel Ni

Nickel when present in soft waters can become toxic to aquatic organisms. Used widely in the manufacturing of steel, Nickel can be introduced into the environment by metal refuse deposit within a watershed.

Zinc Zn

The maximum levels of zinc acceptable in the aquatic environment has recently been revised by the Ontario Ministry of the Environment and Energy. Zinc can be introduced into the aquatic systems from the degrading of metal culverts and metal refuse. The maximum acceptable of zinc in an aquatic ecosystem is 20 ug/L.

Aluminum Al

The toxicity of Aluminum in an aquatic ecosystem has been well documented. The severity of its toxicity is pH depended. As pH becomes depress in an aquatic ecosystem the leachability and the toxicity of Aluminum will increase. Ideally Aluminum should not exceed 15 ug/L in water to ensure its toxic effects are minimized.

Calcium and Magnesium: Hardness Ca, Mg

Calcium and Magnesium are referred to as alkaline metals. Their presence in an aquatic ecosystems contributes to the water hardness. The hardness of water can determine the extent of heavy metal toxicity in water. Ideally Hardness should be 80 mg/L or greater as $CaCO_3$ in aquatic ecosystems.

Phenols

Low levels of phenols can contribute to the tainting of fish. Though phenols can exist naturally in the environment, levels of phenol should not exceed 1 ug/L to ensure against the spoiling of recreational fish.

Oil and Grease

Oil and Grease is the determination of the presence of mineral, animal and vegetable grease. Mineral grease are the lubricants used in machinery and vehicles. Typical sources of animal and vegetable grease is domestic cooking. These greases are harmful to the environment. Grease can be a barrier on the surface of the water and prevent the exchange of gases between the water and atmosphere. Grease can also prevent the absorption of oxygen by plants and aquatic organisms. Ideally the presence of Oil and Grease should not be detectable.

3.0 Sampling Site Criteria

Historical

The Ontario Ministry of the Environment and Energy has maintained until recent two sampling locations. One location is at the mouth of Chippewa Creek at Lake Nipissing (Mouth Site) This sampling location signifies the quality of the contribution of the Chippewa Creek watershed to the Lake Nipissing's aquatic ecosystem. The second location used by the Ontario Ministry of the Environment and Energy is the Golf Club street bridge (Mid Escarpment Site). These sampling locations allows for the geographical distinction between the upper escarpment portion of the watershed from the lower escarpment. Although not all contaminates will be transported throughout a water course (e.g. Suspended Solids), the majority of the parameters can be compared by distinguishing between the upper watershed contribution and the lower watershed contribution.

The City of North Bay has maintained the monitoring of seven surface sampling sites within the Chippewa Creek watershed. These sites are located within the vicinity of the Marsh Drive landfill site. These sampling locations are principally used to determine the landfill leachate plume's impact on the water quality of Chippewa Creek. Two of these sites coincide with the watershed management study sampling sites. Site S30 is just before the landfill and coincides with this study Pre-Landfill sampling site. Sampling location S90 coincides with the landfill tributary sampling site. Sampling location S10 coincides with the top Escarpment sampling site.

Watershed Management Study Sampling sites

All sampling sites are located mid channel within the creek area being sampled. With exception of the Bottom Escarpment sampling site, in stream site locations were chosen based on greatest stream depth (typically less than one meter) and not within the location of rapids. Areas of higher stream velocity can transport larger solids a short distance and cause misleading analytical results (Suspended Solids). In addition, small falls can contribute to air/water mixture which may cause elevated readings of dissolved oxygen and non-represented readings of temperature. Straight stream banks locations were selected to help ensure sampling in areas with consisted stream velocity across its profile. Urban area sampling sites were examine for the presence of storm outfalls. These sites were located upstream of the immediate area of an outfall to help ensure against the measurements of an inadequately mixed storm water contribution. All tributary sampling sites were chosen to represent the various sub-watershed inputs to Chippewa Creek. The main channel sites were chosen to evaluate the potential impact each sub-watershed may contribute.

Sampling Site Description and Representation

The Mouth sampling site is located approximately 200 meters upstream of Chippewa Creek just before the Memorial Drive bridge. This location was chosen to determine the watersheds contribution to Lake Nipissing's water quality. The upstream location was chosen to ensure that influences of the backup water from Lake Nipissing is eliminated. Hydraulic backup flows have been experienced on Parks Creek (NBMCA flow records) therefore the same condition was considered for the selection of this site. This sampling site also allows for distinguishing between contributions of the mature urban center of North Bay (city core) and its residential subdivisions.

Travelling upstream, the next sampling location is the Laurier Woods tributary. Located east of the end of Second Avenue, Laurier Woods Tributary is from the drainage of an area that is primary a wetland (at time of monitoring). The perimeter of the wetlands is mainly industrial land and railway.

Further upstream is the Thompson Park sampling site. Located just upstream from the Johnston Creek inflow, this main channel sampling site allows for the distinguishing of the upper urbanized area of Chippewa Creek from the city core. In addition, this site allows for the comparison of the quality of the contribution of the Johnston Creek watershed to Chippewa Creek's water quality.

Johnston Creek Tributary sampling site is located just east of the pedestrian footbridge and prior to its inflow into Chippewa Creek. Johnston Creek watershed drains an area that is largely residential with two provincial highways (Hwy 17 & Hwy 63). There is industrial land located upstream from Mud Lake and a railway passes through the watershed (Ontario Northern Railway). Eastview creek is a major residential tributary to Johnston Creek which enters as Johnston Creeks passes beneath highway 17.

The Dudley Avenue sampling site is located just downstream from Hwy 17 on the main channel of Chippewa Street. After careful examination of the City of North Bay Storm Outfall map, this area receives the majority of the storm water from surrounding roadways (O'Brien, Hwy 17). This location would be considered the first urban sampling site once the watershed drops from the upper escarpment area. Future water quality collected from this site will help to evaluate the effectiveness of the upper portion of the current urban watershed improvement program.

The Lower Escarpment sampling site is located in the main channel of the creek below the intersection of O'Brien and Golf Club road. This site is shallow in depth and has a fast velocity of water. The site was chosen to provide baseline data to evaluate the impact of future urban development along Golf Club Road. This site also allows for the examination of the Golf Club Tributary contribution to Chippewa Creek's water quality.

The Mid-escarpment sampling site is located halfway up the escarpment and just north of the old Widdifield City Yards. This sampling site can be considered the first undisturbed area outside the urban development of the City of North Bay. From this sampling area and north the overhead canopy is relatively complete with exception to the landfill area and Highway 11 north. This sampling site represents all contributions to the watershed that occur on the upper escarpment.

The landfill Tributary is located east of Highway 11 north. Its approximately one kilometer south of Marsh Drive and one kilometer east of the highway. Located well downstream of the landfill location, this sampling site represents the contribution of the landfill area. This location also represents the geological boundary between the stream course traveling over bedrock and silt/sand clay loam.

Just upstream from this tributary is the location of the Top Escarpment main channel sampling site. This site was chosen to allow for comparison of the contribution of the landfill tributary with respect to the main channel of Chippewa Creek.

Just east of the landfill is located the Pre-Landfill Site. This site was chosen for comparison with the landfill tributary sampling site. An important consideration for this site was that it represents silt/sand clay loams watershed area which will help ensure proper representation of the landfill contribution and geological contribution. This sampling site also represents the northeast arm of the Chippewa Creek watershed.

The wetland sampling site is located just west of the TransCanada PipeLines compression station and at the end of Barnet Road. This sampling site represents the northwest arm of Chippewa Creek as it leaves a wetland area and channels down to the Highway 11 North. The stream course is located on bedrock with an almost complete canopy overhead. This area of the water course is relatively undisturbed.

Just north of the intersection of Marsh Drive and Highway 11 north is the Psychiatric Tributary. This sampling site represents north channel drainage of the area located south of the North Bay Psychiatric Hospital. There are several abandon and operating gravel pits within this section of the watershed.

Sampling Protocol

All sample were collected mid-stream and below surface. Sampling containers were pre-rinse several times and were inserted into the creek inverted prior to filling. The field sampler always approached the site from downstream and faced upstream during sample collection. Random selected duplicate samples were taken during the course of this study. Separate containers, prepared by the laboratory, were used for the collection of solids, general chemistry, and metals. All metal samples were preserved with nitric acid. Immediate chemistries were conducted within 24 hours of the sampling period. Metal samples were acid digested prior to analyses on an atomic absorption analyzer. All analyses in the laboratory were conducted with blanks, spikes, replicates, and control standards where applicable.

Field Measurements

In-field analyses was conducted for pH, conductivity, total dissolved solids, temperature and dissolved oxygen. With exception of temperature, all measurements were taken using a field calibrated Corning multi-probe. Temperature was taken using a hand thermometer.

Lab Analyses

Field samples were collected and transported same day to the laboratory. pH analyses were conducted by probe. Alkalinity was determined by titration. Chloride was determined using ion selective probe. Copper, Iron, Lead, Zinc, Calcium and Magnesium were determined by acid digestion and atomic absorption analyses. Total Suspended Solids were determined gravimetricly. Hardness was calculated from the results obtained from the calcium and magnesium determinations. Total Oil and Grease was determined by solvent extraction. All analyses procedures were conducted according to the recommendations of Standard Methods for the Analyses of Water and Wastewater, 16th edition.

4.0 Dry Weather Flow Water Quality Assessment

Wetland

Located northwest of the city of North Bay, this area was first sampled during 1994. This site was sampled five times over the spring and summer season. Alkalinity at this site was relatively low (< 20 mg/L), pH of the site was relatively constant (6.5 - 7.0). Chloride levels measured (19 - 55 mg/L) in this area is slightly higher when compared to the other northern channels of Chippewa Creek but not excessive. Copper concentrations vary at the upper acceptable limit of 1 ug/L. These events of elevated copper coincide with the slight drops in the measured hardness levels. Lead concentrations were less than 5 ug/L which is ideal since the level of measure alkalinity is relatively low. Iron concentrations exceed the objective of 0.3 mg/L but is relatively consistent at 5 mg/L. Zinc concentrations at this site fluctuates above and below the objective of 30 ug/L. Total Suspended Solids levels were around 9 mg/L with the exception of one sampling event in which levels of 59 mg/L were measured. Oil and Grease was relatively low or undetectable throughout the monitoring season.

Psychiatric Tributary

Located north of the City of North Bay, this area was first sampling during 1994. This sampling site was introduced into the study at a later period. This site was sampled three times over the spring and summer season. Alkalinity at this site was relatively low (< 20 mg/L) and the pH of the site was relatively constant (6.4 - 6.8). Chloride levels measured in this area is relatively low (<5 mg/L) with the exception of one sample occasion when the level measured was 18 mg/L. Copper concentrations measured are of no immediate concern given hardness levels were consistently greater than 30 mg/L. The June 28 sampling event measured levels of lead concentrations of 10 ug/L. With the low alkalinity, this level of Lead can effect the aquatic ecosystem. Measured iron concentrations exceed the objective of 0.3 mg/L but is relatively consistent around 1 mg/L. Zinc concentrations at this site was within the water quality objectives with a maximum level measured at 20 ug/L. Total Suspended Solids remained around 4 mg/L with thee exception of one sampling event in which levels of 18 mg/L were measured. Oil and Grease was below detectable limits based on one sampling event.

Pre-Landfill Tributary

Located northeast of the City of North Bay, this area was first sampled during 1985 by the City of North Bay (Gore and Storrie, Sample site S20). Historically the pH of the site was relatively constant (6.7 - 7.7). Un-ionized ammonia measured typically less than the objective of 0.02 mg/L. Chloride levels in this area is relatively low (<10 mg/L) with exception of two sample occasions when the levels measured was between 10 - 15 mg/L. Copper concentrations were not measured until 1994. The levels measured exceeded the water quality guidelines of 5 ug/L (hardness >20mg/L) and was typically around 15 ug/L. Hardness levels ranged around 26 mg/L or greater with one exception. Lead levels were first measured during 1994. Levels of lead were typically undetectable with the exception of one event. The June 28, 1994, sampling event measured levels of lead concentrations of 22 ug/L. With the low alkalinity (12 mg/L), this level of lead can effect the aquatic ecosystem. Iron concentrations historically exceeded the objective of 0.3 mg/L but was relatively consistent around 1 mg/L. During 1994, iron levels during dry weather flows were typically around 3 mg/L. Zinc concentrations at this site was within the water quality objectives with a maximum level measured at 29 ug/L. Total Suspended Solids was measured during 1994 and ranged from 24 to 156 mg/L and consistently exceeded the 15 mg/L objective. Oil and Grease was 6 mg/L during one sampling event and non- detectable during the other.

Upper Escarpment

Located northeast of the City of North Bay, this area was first sampled during 1988 by the City of North Bay (Gore and Storrie, Sample site S80). Historically the pH of the site ranged from 6.4 - 7.2. Un-ionized ammonia levels remained below the objective of 0.02 mg/L. Chloride levels in this area is range between 15 - 30 mg/L typically. The 1994 measured levels of Chloride was consistent with historical data. Copper concentrations were not measured until 1994. The levels of copper measured exceeded the water quality guidelines of 5 ug/L (hardness >20mg/L) only once. Hardness levels ranged from 66 mg/L to 148 mg/L. Lead levels were first measured during 1994. Levels of lead were detectable on three occasions. The measured lead values ranged from 9 ug/L to 19 ug/L. With the low alkalinity (<10 mg/L), this level of lead can effect the aquatic ecosystem. Iron concentrations historically exceed the objective of 0.3 mg/L and show a continuous increase from 0.5 mg/L to 2.6 mg/L over the 1994 sampling season. Historical data reflects this trend with the levels of iron decreasing in the fall. Zinc concentrations at this site was typically within water quality objectives with few exceeded. The dry weather flows of Total Suspended Solids measured during 1994 ranged from 4 to 10 mg/L. Oil and Grease was 1 mg/L during one sampling event and non-detectable during the other.

Middle Escarpment

Located north of Golf Club Road, this area was first sampled during 1994. This site was sampled seven times over the spring and summer season. Alkalinity at this site was relatively low (< 20 mg/L). The pH of the site was relatively constant (6.7 - 7.4). Chloride levels in this area ranged from 6 to 15 mg/L. Copper levels consistently exceeded the provincial objective of 5 ug/L (hardness >20mg/L). Hardness levels ranged from 14 mg/L to 25 mg/L. Lead concentrations was only detectable during the early season (11 - 15 ug/L). With the low alkalinity (<20 mg/L), this level of lead can effect the aquatic ecosystem. Iron levels concentrations exceed the objective of 0.3 mg/L and was typically around 2.0 mg/L. Zinc concentrations at this site varied considerably with the measured values ranging from 15 to 45 ug/L. The measured dry weather flows of Total Suspended Solids was at and or exceeded the guideline of 15 mg/L. The maximum Total

Suspended Solids level measured was 84 mg/L. Oil and Grease was 3 mg/L during one sampling event and non-detectable during the other.

Golf Club Tributary

Located north of Golf Club Road, this tributary drains the airport road subdivision area. This site was sampled seven times over the spring and summer season. Alkalinity at this site ranged from 28 to 40 mg/L. The pH of the site was relatively constant (7.1 - 7.7). Measured Chloride levels in this area ranged from 26 to 56 mg/L. Copper levels measured were typically at the guideline of 5 ug/L. (hardness >20mg/L). Hardness levels ranged from 42 mg/L to 60 mg/L. Lead levels fluctuated from undetectable to 20 ug/L. The higher levels of lead coincide with elevated levels of Alkalinity (37 - 40 mg/L) whereby reducing the impact on an aquatic environment. The alkalinity levels gradually increased from 28 mg/L during the spring to levels of 34 to 40 mg/L during summer. Iron concentration levels exceeded the objective of 0.3 mg/L and range in concentration from 1.0 to 3.4 mg/L. Zinc concentrations at this site range near 30 ug/L with a maximum level measured of 109 ug/L. Dry weather flows of Total Suspended Solids was less than the guidelines of 15 mg/L. Oil and Grease levels were non-detectable during the sampling season.

Lower Escarpment

Located at the intersection of O'Brien and Golf Club, this area is closely represented with the Ontario Ministry of the Environment and Energy sampling site "Golf Club. Historically the pH of the site ranged from 7.0 - 7.9. The 1994 pH data is consistent with these levels. Un-ionized ammonia levels exceeds levels of 0.02 mg/L typically during spring months. Historical Chloride levels in this area typically range between 9 - 28 mg/L. The 1994 measured levels of Chloride was consistent with historical data. Historical Copper concentrations were not typically not detectable. Occasional levels were typically around 3 ug/L. During 1994, measured levels ranged from 4 to 8 ug/L. The levels measured exceeded or were at the water quality guidelines of 5 ug/L (hardness >20mg/L). Hardness levels ranged from 22 mg/L to 32 mg/L. Historical Lead levels were typically undetectable. The 1994 monitoring program reflects this with exception of two occasions when lead levels ranged from 17 -19 ug/L. The values ranged from 9 ug/L to 19 ug/L. With the low alkalinity (<20 mg/L), this level of can effect the aquatic ecosystem. Iron levels concentrations historically exceed the objective of 0.3 mg/L and showed a measured level from 0.5 mg/L to 2.3 mg/L over the 1994 sampling season. Historical data reflects levels around 1 mg/L of iron. Zinc concentrations at this site was typically within water quality objectives with few exceeded. Dry weather flows of Total Suspended Solids measured during 1994 and ranged from 5 to 85 mg/L. Oil and Grease was 7 mg/L during one sampling event and non-detectable during the other.

Dudley Avenue

Located just south of highway 17 and 11 on the main channel of Chippewa Creek, this areas represents the contribution of the upper urban of North Bay. This site was sampled seven times over the spring and summer season. Alkalinity at this site ranged from 15 to 30 mg/L. The pH of the site was relatively constant (6.9 -7.4). Chloride levels in this area ranged from 16 to 47 mg/L. Copper levels measured were typically exceeded the guideline of 5 ug/L (hardness >20mg/L). Hardness levels ranged from 26 mg/L to 32 mg/L. Lead levels fluctuated from undetectable to 24 ug/L. With the low alkalinity (<20 mg/L), this level of can effect the aquatic ecosystem. Iron levels concentrations exceed the objective of 0.3 mg/L and range in concentration from 1.6 to 2.4 mg/L. Zinc concentrations at this site range near 30 ug/L with a maximum level measured of 47 ug/L. Dry weather flows of Total Suspended Solids fluctuated above the guidelines of 15 mg/L on several occasions. Oil and Grease non-detectable during one sampling event.

Johnston Creek Tributary

The Johnston Creek Tributary flows into Chippewa Creek at Fisher Street. This site was sampled seven times over the spring and summer season. Alkalinity at this site ranged from 35 to 40 mg/L. The pH of the site was relatively constant (6.9 -7.1). Chloride levels in this area ranged from 66 to 159 mg/L. Copper levels measured exceeded the guideline of 5 ug/L (hardness >20mg/L). Hardness levels ranged from 44 mg/L to 53 mg/L. Lead levels fluctuated from undetectable to 37 ug/L. The alkalinity levels (>20 mg/L) reduces the adverse effects of the measured levels of lead. Iron levels concentrations exceed the objective of 0.3 mg/L and range in concentration from 1.4 to 1.8 mg/L. Zinc concentrations at this site range near 30 ug/L with a maximum level measured of 40 ug/L. Dry weather flows of Total Suspended Solids never exceeded the guideline of 15 mg/L. Oil and Grease was detectable (7 mg/L) during one sampling event.

Thompson Park

The Thompson Park sampling site is located just upstream from the inflow of Johnston Creek. This site was sampled seven times over the spring and summer season. Alkalinity at this site ranged from 18 to 31 mg/L. The pH of the site fluctuated (6.4 -7.3) During the dry flow season. Chloride levels in this area ranged from 21 to 39 mg/L. Copper levels measured exceeded the guideline of 5 ug/L (hardness >20mg/L). Hardness levels ranged from 29 mg/L to 35 mg/L. Lead levels fluctuated from undetectable to 22 ug/L. The alkalinity levels (>20 mg/L) reduces the adverse effects of the measured levels of lead. Iron levels concentrations exceed the objective of 0.3 mg/L and range in concentration from 1.7 to 2.6 mg/L. Zinc concentrations at this site typically exceeded 30 ug/L with a maximum level measured of 43 ug/L. Dry weather flows of Total Suspended Solids exceeded the guideline of 15 mg/L on two occasions with a maximum level measure at 108 mg/L. Oil and Grease was detectable (7 mg/L) during one sampling event.

Laurier Woods Tributary

The Laurier Woods Tributary flows into Chippewa Creek at Second Avenue. This site was sampled seven times over the spring and summer season. Alkalinity at this site ranged from 35 to 40 mg/L. The pH of the site was relatively constant (7.0 - 7.1). Chloride levels in this area ranged from 289 to 676 mg/L. Copper levels measured ranged near the guideline of 5 ug/L (hardness >20mg/L). Hardness levels ranged greater than a 100 mg/L. Lead levels fluctuated from undetectable to 32 ug/L. The alkalinity levels (>20 mg/L) reduces the adverse effects of the measured levels of lead. Iron levels concentrations exceed the objective of 0.3 mg/L and range in concentration from 1.8 to 12.9 mg/L. Zinc concentrations at this site range below 30 ug/L with a maximum level measured of 21 ug/L. Dry weather flows of Total Suspended Solids fluctuated near the guideline of 15 mg/L. Maximum measured level of suspended solids was 31 mg/L. Oil and Grease was detectable (6 mg/L) during one sampling event.

Mouth

Located just upstream from the Lake Nipissing inflow, this area is closely represented with the Ontario Ministry of the Environment and Energy sampling site "Mouth". Historically the pH of the site ranged from 7.1 - 7.9. The 1994 pH data ranged from 6.4 - 7.4. Un-ionized ammonia levels never exceeds levels of 0.02 mg/L during recent years. Chloride levels in this area typically ranged between 50-70 mg/L with seasonal fluctuations. The 1994 measured levels of Chloride was consistent with historical data. Historical Copper concentrations were near the guideline of 5 ug/L with a reduction of levels evident during recent years. During 1994, measured levels ranged from 5 to 12 ug/L. Hardness levels ranged from 35 mg/L to 42 mg/L. Historical Lead levels were typically undetectable. The 1994 monitoring program reflects this with exception of two occasions when lead levels ranged from 20 - 31 ug/L. With the alkalinity (>20 mg/L and <40 mg/L), this level of can effect the aquatic ecosystem. Iron concentration levels historically exceeded the objective of 0.3 mg/L and showed a typical measured level of 0.7 mg/L. The 1994 Iron data indicated a range of 1.7 - 3.2 mg/L. Zinc concentrations at this site typically exceeded the water quality objectives of 30 ug/L with a maximum measured level of 45 ug/L. Historical dry weather flows of Total Suspended Solids occasionally exceeded the guideline of 15 mg/L. Levels measured during 1994 ranged from 5 to 123 mg/L. Oil and Grease was 12 mg/L during one sampling event and non-detectable during the other.

5.0 Storm Outfalls Dry Weather Flows

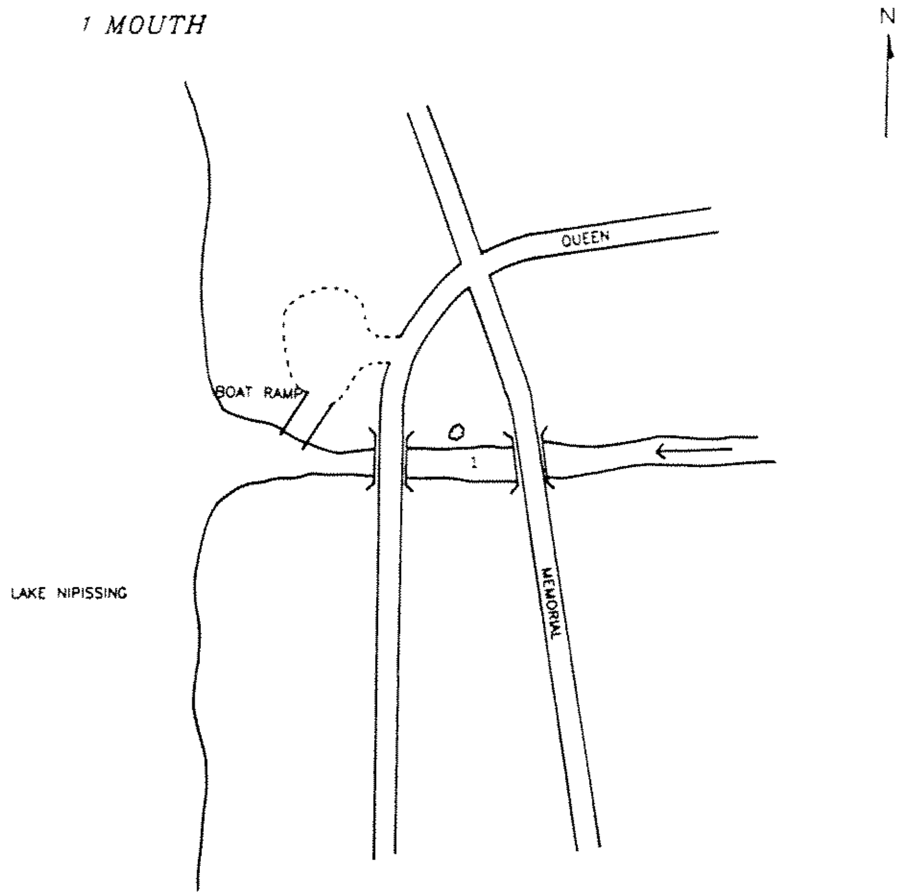
During 1994 sixteen urban outfalls and the mouth of Chippewa Creek at Lake Nipissing were sampled. The parameter conducted on these sites was Escherichia coli bacteria levels. Samples were taken during dry flow conditions which reflect the levels of the outfalls continuous contribution to Chippewa Creek's water quality. The levels measured at the mouth reflects Chippewa Creek's contribution to the lake's shoreline within the creek's vicinity. Escherichia coli was detectable in all samples collected from the outfalls. This reflects typical mature urban sources as storm water collects faecal contribution from animals and organic sources. Sampling sources which indicates significant bacteria contributions during 1994 were Cassell, Duke, Haig, and Hammond. Levels measured at Oak Street were marginal. Its important to note the Escherichia coli levels at the mouth of the creek were not significant during 1994.

6.0 Future Tasks

- examine contributions to Chippewa Creek's water quality during wet flows.
- identify contributing physical sources that impaired Chippewa Creek's water quality.
- incorporate the water quality related objectives of the Steering and Public Liason committee.

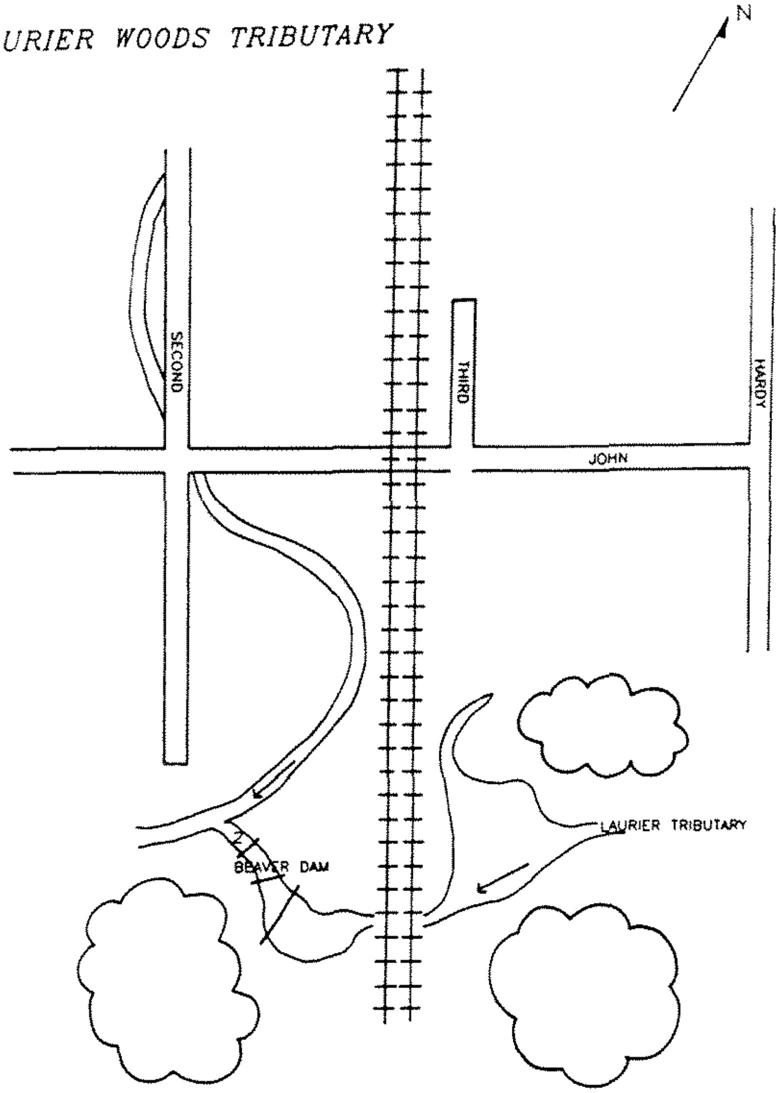
Appendix E-1
Sampling Site Sketches and Descriptions

1 MOUTH

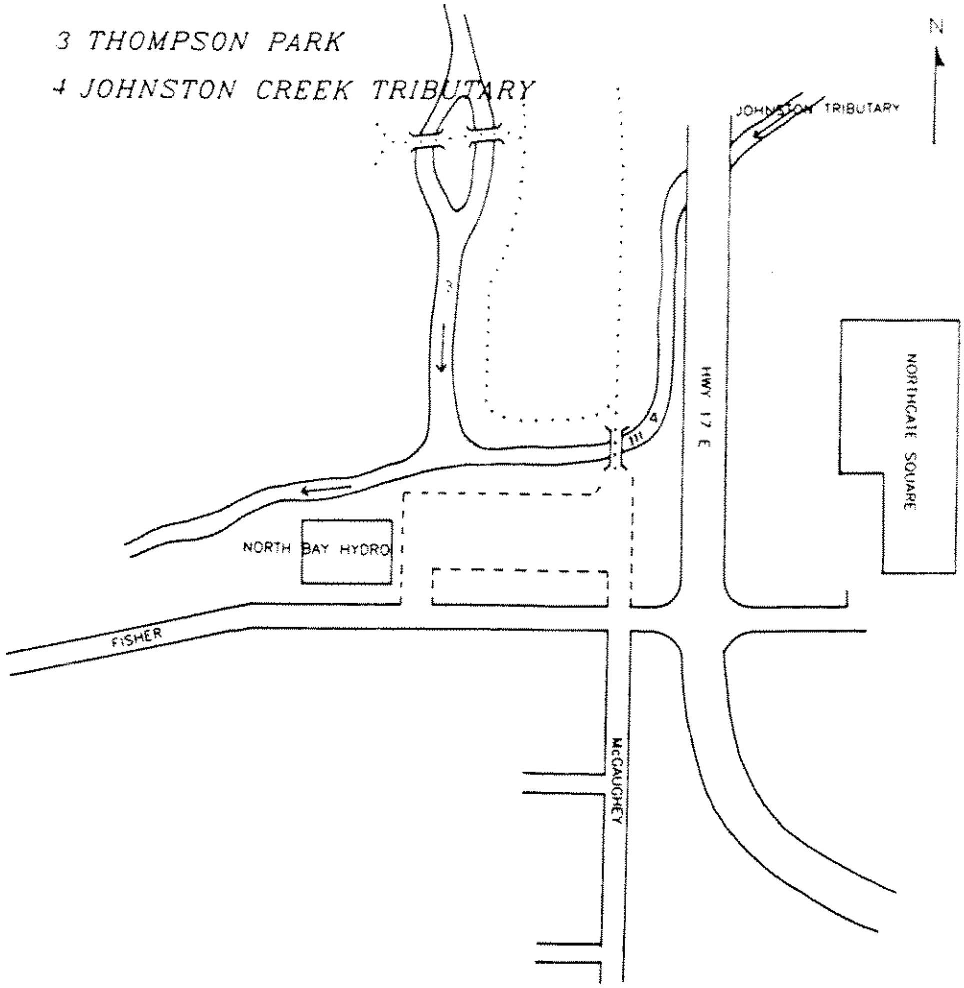


The Mouth sampling site (Site #1) is located approximately 200 meters upstream of Chippewa Creek, just before the Memorial Drive bridge. This area is extensively represented as the OMOEE sampling site "Mouth". It was located this distance upstream to ensure that any influences from the hydraulic backup flows (water flowing upstream in the creek from the lake) from Lake Nipissing were minimized. The Mouth sampling site also distinguishes between storm water contributions from the mature urban center of North Bay (city core) and from its residential subdivisions located above the city core.

2 LAURIER WOODS TRIBUTARY



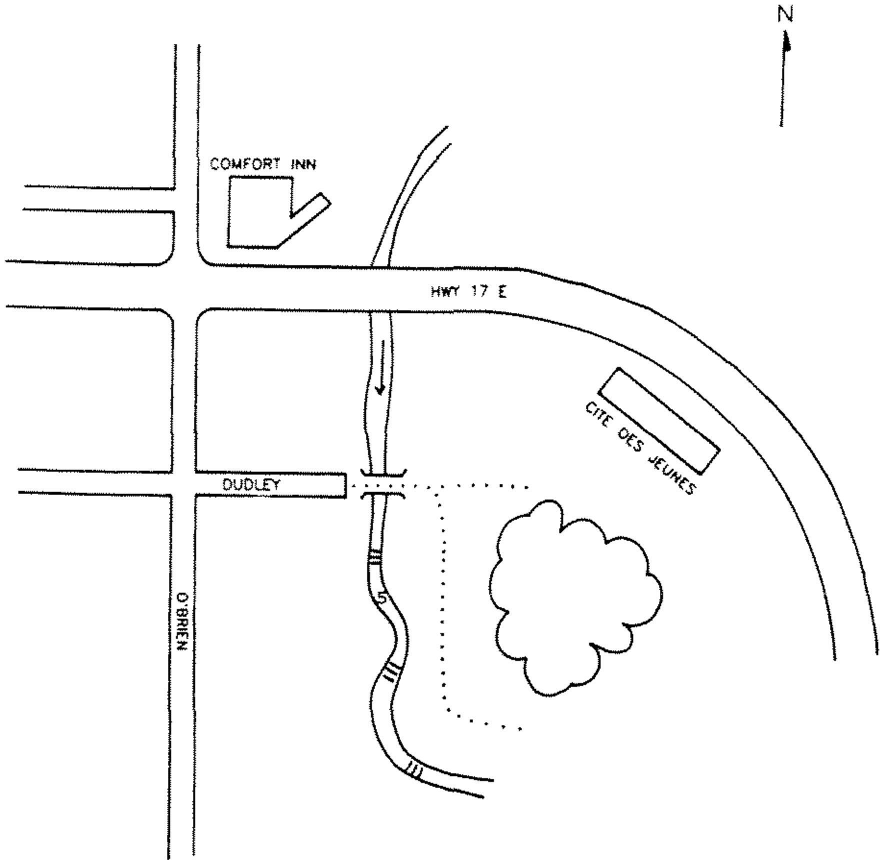
The next upstream sampling location is the Laurier Woods tributary (Site #2). Located east of the end of Second Avenue, the Laurier Woods tributary drains an area that is primarily a wetland (at time of monitoring;see figure 2.5-2). The perimeter of the wetland is mainly industrial land and railway.



The Thompson Park sampling site (Site #3) is located just upstream of the Johnston Creek inflow. This main channel sampling site allows for differentiation between the upper urbanized area of Chippewa Creek and the city core. This site also allows for the measurement of the contribution of the Johnston Creek watershed to Chippewa Creek's water quality.

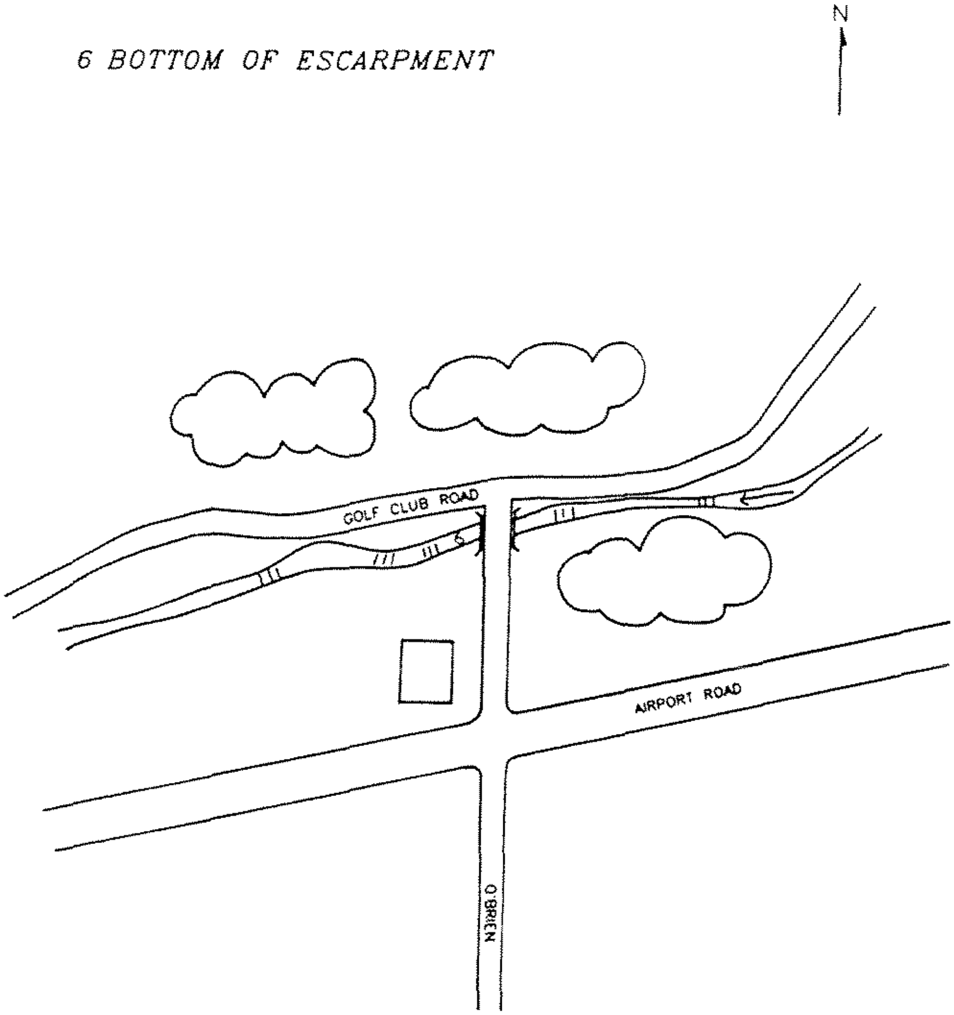
The Johnston Creek tributary sampling site (site #4) is located prior to the Johnston Creek inflow into Chippewa Creek and east of the pedestrian footbridge. The Johnston Creek watershed drains an area that is largely residential and contains two provincial highways (Hwy 17 & Hwy 63). There is industrial land located upstream of Mud Lake and a railway which passes through this watershed (Ontario Northland Railway). Eastview Creek is a major residential tributary, which enters Johnston Creek as it passes beneath Highway 17.

5 DUDLEY AVE.

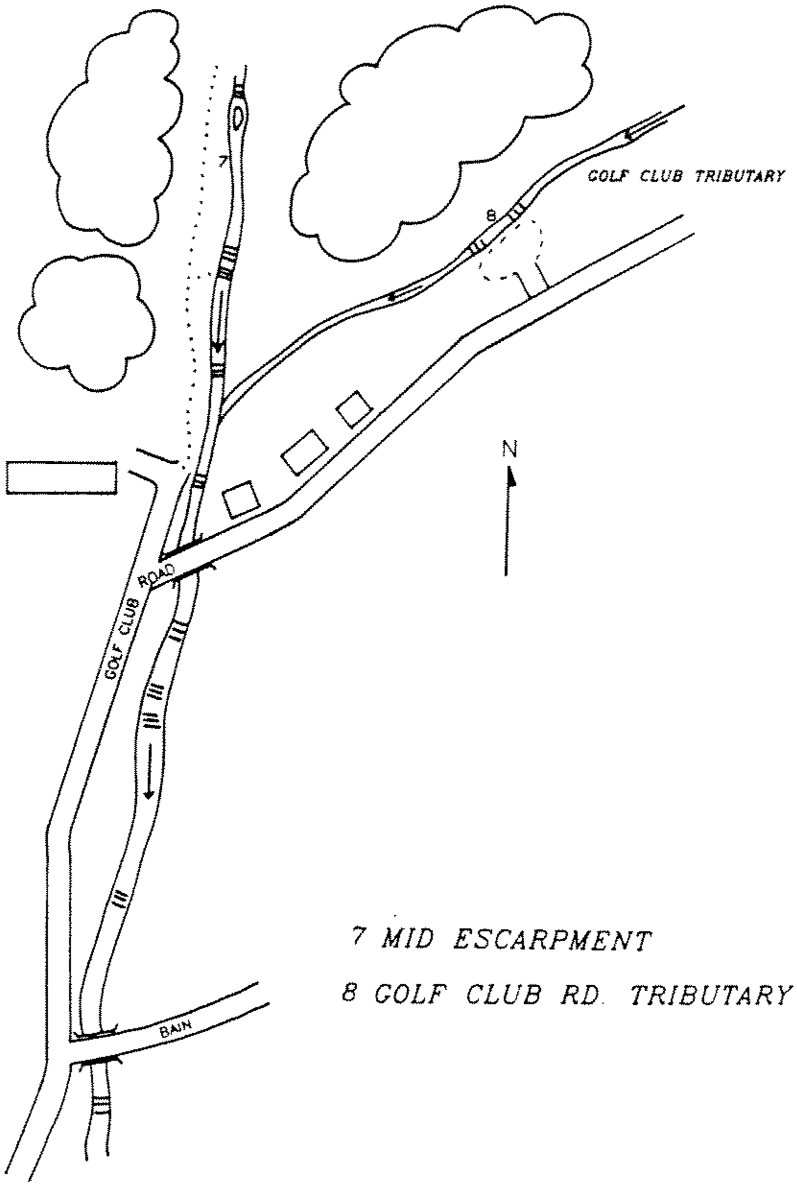


The Dudley Avenue sampling site (Site #5) is located immediately downstream of Highway 17 on the main channel of Chippewa Creek. From careful examination of the City of North Bay's storm outfall map, this area was shown to receive the majority of the storm water from surrounding roadways (O'Brien, Hwy 17). This location is considered the first urban sampling site after the watershed drops from the upper escarpment area. Future water quality data from this site will help to evaluate the effectiveness of the improvement program on the upper portion of the watershed.

6 BOTTOM OF ESCARPMENT



The Bottom of Escarpment sampling site (Site #6) is located in the main channel of the creek, below the intersection of O'Brien Street and Golf Club Road and is extensively represented as the MOEE sampling site "Golf Club." This site is shallow and has a rapid velocity. The site was chosen to provide baseline data to evaluate the impact of future urban development along Golf Club Road. This site also allows for the examination of the Golf Club tributary's contribution to Chippewa Creek's water quality.

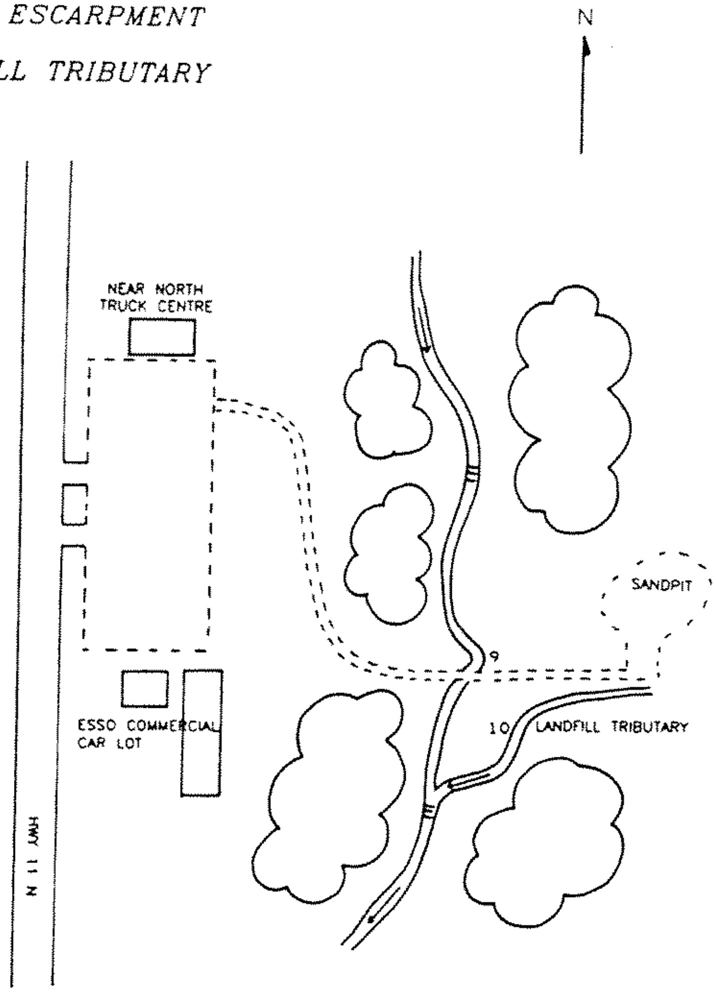


The Mid-Escarpment sampling site (Site #7) is located halfway up the escarpment and immediately north of the old Widdifield City Yards. This sampling site is considered the first undisturbed area outside the urban development of the City of North Bay. North of this sampling area the overhead canopy is relatively complete, with the exception of the landfill area and Highway 11 north. This site represents all contributions to the watershed from the upper escarpment.

The Golf Club Road Tributary (Site #8) is located on the north side of Golf Club Road adjacent to an empty lot which is south of the entrance to the golf club. This sampling site represents the drainage area encompassing the airport subdivisions and the North Bay Golf and Country Club.

9 UPPER ESCARPMENT

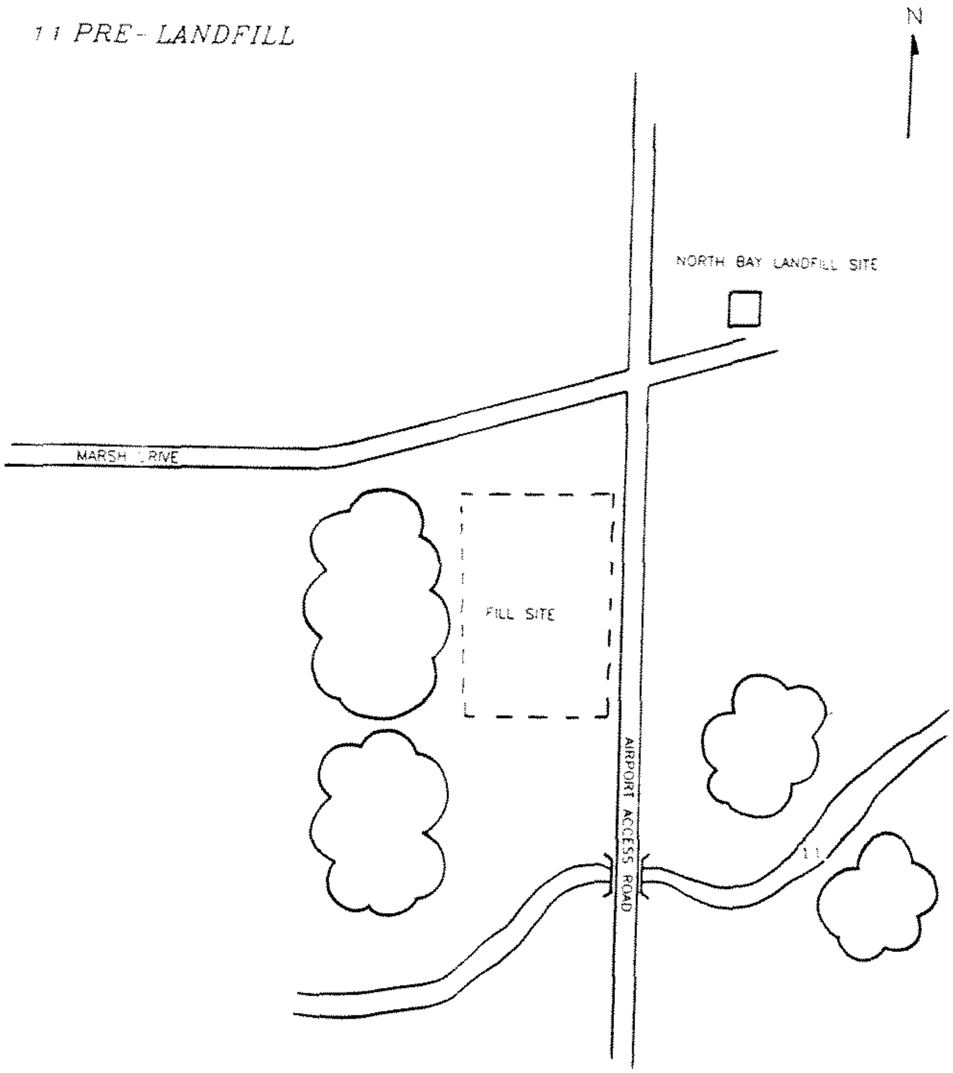
10 LANDFILL TRIBUTARY



The Upper Escarpment sampling site (Site #9) is located in the main channel of the creek flowing east of Highway 11 North and south of Marsh Drive. It is above a bridge road that leads from the Near North Truck Center. This site was chosen to allow for comparison between the contributions from the landfill tributary and the main channel of Chippewa Creek.

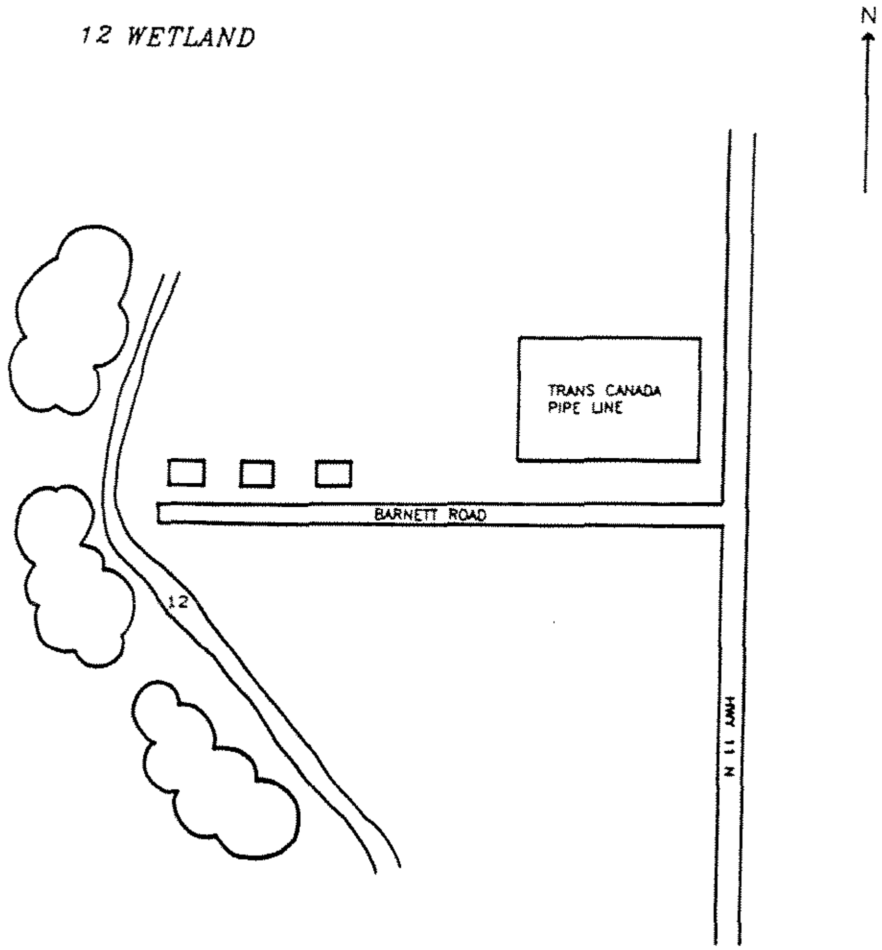
The Landfill Tributary sampling site (Site #10) is located east of Highway 11 North. It is approximately one kilometer south of Marsh Drive and one kilometer east of the highway. Located downstream of the landfill location, this sampling site represents the contribution of the landfill area. This location also represents the geological boundary between the silt/sand/ clay/loam and bedrock of the streambed (visual observation).

11 PRE- LANDFILL



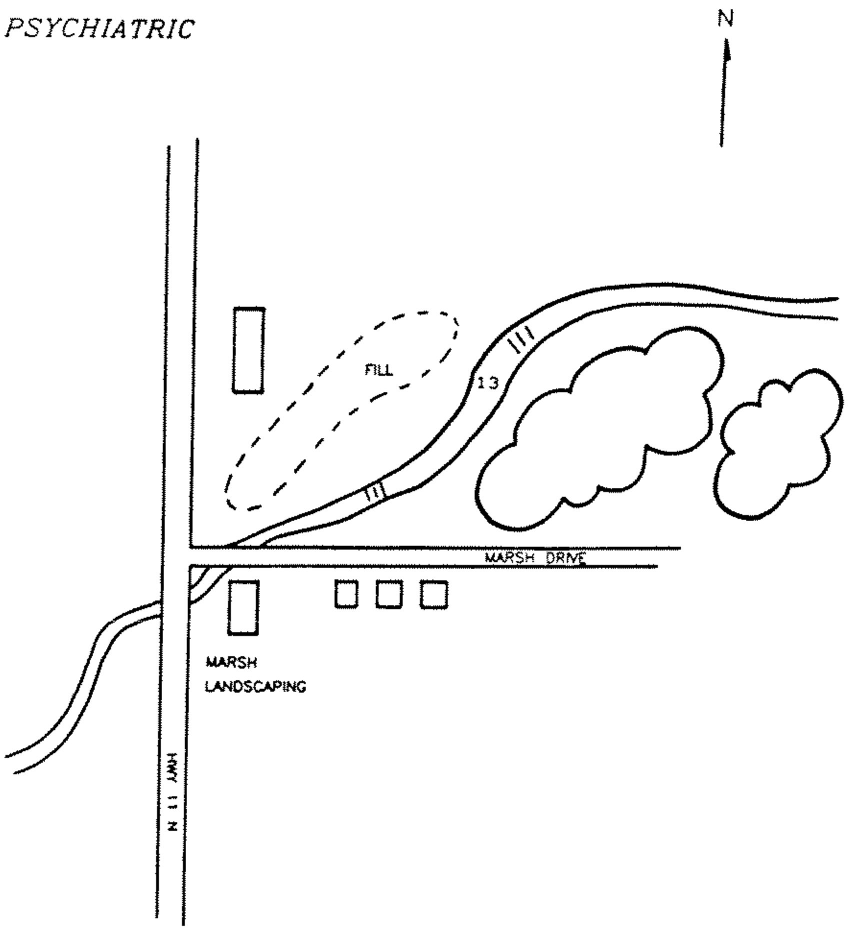
Immediately east of the landfill is the Pre-Landfill sampling site (Site #11). This site was chosen for comparison with the landfill tributary sampling site. An important consideration with respect to this site is that it consists of glaciofluvial sands and gravel and bedrock (Gartner Lee, 1993) which is representative of the landfill's geological base. This sampling site also represents the northeast arm of the Chippewa Creek watershed.

12 WETLAND



The Wetland sampling site (Site #12) is located immediately west of the TransCanada PipeLine compression station at the end of Barnet Road. This sampling site represents the northwest arm of Chippewa Creek as it leaves a wetland area and channels down to Highway 11 North. The stream winds through bedrock with an almost complete canopy overhead. This area of the water course is relatively undisturbed.

13 PSYCHIATRIC



Immediately north of the intersection of Marsh Drive and Highway 11 North is the Psychiatric Tributary Site (Site #13) that represents the channel drainage area south of the North Bay Psychiatric Hospital. There are several abandoned and operating gravel pits within this section of the watershed.

Appendix E-2
Historical Water Quality Data

Chippewa Creek Water Quality Data Base 1985 - present

Data Source / Abbreviations used in Data Table

Garlee : Gartner Lee Ltd., Markham, Ontario
City of North Bay Marsh Drive Landfill,
1992 Annual Monitoring Report

MOEE: Ontario Ministry of the Environment and Energy,
Toronto, Ontario

CNB: City of North Bay, North Bay, Ontario

NNL : Near North Laboratories Inc., North Bay, Ontario.

Rain : Environment Canada, Atmospheric Services, North Bay,
Ontario

Alk : Alkalinity

Al : Aluminum

Ca : Calcium

Cl : Chloride

COD : Chemical Oxygen Demand

Cond. : Conductivity

D. Solids : Dissolved Solids

Dis. O2 : Dissolved Oxygen

Hard. : Hardness

Mg : Magnesium

S. Solids : Suspended Solids

Tot P. : Total Phosphorous

Turbid : Turbidity

note:

Site S30 Garlee Chippewa Creek at landfill Site S10 Garlee Chippewa Creek at airport boundary Site S20 Garlee corresponds with Site #11 Pre-Landfill Site S50 Garlee corresponds Chippewa Creek south landfill Site S60 Garlee corresponds with Site #10 Landfill Trib.
Site S80 Garlee corresponds with Site #9 Upper Escarpment Golf Club MOEE corresponds with Site #6 Lower Escarpment Mouth MOEE corresponds with Site #1 Mouth

Chippewa Creek Water Quality Data Base 1985 - present
Compiled: 94/08/23 by Near North Laboratories Inc., North Bay, Ontario.

Site	Date	Source	Rain	Alk	pH	Ammonia	Temp	Cl	Dis. O2	Tot P.	Turbid	Copper	Iron	Lead	Nickel
			mm	mg/L		mg/L	oC	mg/L	mg/L	mg/L	NTU	mg/L	mg/L	mg/L	mg/L
S30	05/01/85	GarLee			7.82	13.40		<0.2		0.600			12.000		
S30	06/01/85	GarLee	5.2		7.54	9.30		33.6		0.040			3.300		
S30	07/01/85	GarLee			7.49	9.30		35.2		0.030			3.400		
S30	08/01/85	GarLee			7.47	10.60		44.0		0.150			4.200		
S30	09/01/85	GarLee	4.8		7.32	10.40		40.0		0.020			3.000		
S30	10/01/85	GarLee	5.8		7.37	9.10		35.6		0.040			3.100		
S30	11/01/85	GarLee			7.31	9.80		30.6		0.040					
S30	12/01/85	GarLee	15.4		7.33	11.30		37.0		0.020			2.900		
S30	01/01/86	GarLee			7.41	11.60		29.4		0.060			2.800		
S30	02/01/86	GarLee			7.40	16.40		48.6		0.030			2.100		
S30	03/01/86	GarLee			7.99	7.50		DI		0.080			3.170		
S30	04/01/86	GarLee	1.8		7.30	1.00		10.1		0.080			1.100		
S30	06/01/86	GarLee	27.4		7.63	3.60		14.1		<0.02			1.400		
S30	07/01/86	GarLee			7.90	7.90		27.9		0.020			2.200		
S30	09/01/86	GarLee			7.22	8.95		30.5		<0.02			2.400		
S30	05/01/87	GarLee			7.68	7.35	13	22.0	14.0	<0.01			2.000		
S30	06/01/87	GarLee	0.4			3.45		10.5							
S30	09/01/87	GarLee			7.41	15.10	12	41.5	10.0	0.030			3.140		
S30	12/01/87	GarLee			7.41	5.85	0	17.3	14.0	0.070			2.300		
S30	04/01/88	GarLee			7.81	7.75	-15	20.3	8.0	<0.02			1.700		
S30	06/01/88	GarLee	0.4		7.79	20.90	18	56.8	3.0	<0.02			3.100		
S30	09/01/88	GarLee	0.8		7.84	14.90	9	41.1	10.0	<0.02			2.690		
S30	11/01/88	GarLee	0.8		7.97	13.70	2	35.7	13.0	<0.02			2.090		
S30	05/01/89	GarLee			7.66	9.25	10	21.3	12.0	<0.02			5.800		
S30	07/01/89	GarLee			7.81	19.70	14	45.5	7.0	<0.02			2.500		
S30	09/01/89	GarLee	2.0		7.92	20.00	12	44.5	11.0	<0.02			8.310		
S30	11/01/89	GarLee	0.6			4.75	5	12.4	11.0	<0.04			0.770		
S30	05/01/90	GarLee	0.4		7.65	1.40		4.7		<0.02			0.680		
S30	07/01/90	GarLee			7.76	5.70	15	14.5	12.0	<0.02			1.100		
S30	09/01/90	GarLee			7.55	4.65	10	12.5	12.0	<0.02			1.000		
S30	11/01/90	GarLee			7.53	3.80		8.9		<0.02			1.500		
S30	05/01/91	GarLee	0.8		7.84	5.65	8	15.1	12.0	<0.02			0.640		
S30	06/01/91	GarLee			7.81	10.80	15	28.0	6.0	<0.02			0.850		
S30	09/01/91	GarLee			7.89	9.55	12	24.4	8.0	<0.02			12.000		
S30	11/01/91	GarLee			6.81	1.70	4	5.9		<0.05			1.700		
S30	05/01/92	GarLee	8.2		7.75	8.45	15	23.8	7.0	<0.02			0.570		
S30	07/01/92	GarLee			7.71	8.30	14	24.8	6.0	<0.02			0.130		
S30	09/01/92	GarLee			7.93	8.20	9	25.1	12.0	<0.06			0.790		
S30	11/01/92	GarLee			7.77	8.45	14	26.9	10.0	<0.06			0.320		
S30	07/01/93	CNB			7.20		15		8.0						
S10	05/01/85	GarLee			5.74	0.02		<0.2		0.040			0.770		
S10	06/01/85	GarLee	5.2		5.26	<0.05		<0.2		0.040			1.500		
S10	07/01/85	GarLee			5.05	<0.05		<0.4		0.050			1.600		
S10	08/01/85	GarLee			6.15	0.10		<0.6		0.030			3.000		
S10	09/01/85	GarLee	4.8		5.59	<0.05		2.0		0.060			2.300		
S10	10/01/85	GarLee	5.8		5.24	<0.05		<1.4		0.060			1.300		
S10	11/01/85	GarLee			4.67	<0.05		<0.2		0.040			0.830		
S10	12/01/85	GarLee	15.4		5.60	0.03		<1.4		0.030			6.500		
S10	01/01/86	GarLee			6.08	0.20		<1.0		0.060			1.200		
S10	02/01/86	GarLee			6.35	0.50		<2.6		0.050			2.000		
S10	03/01/86	GarLee			6.72	0.40				0.140			1.300		
S10	04/01/86	GarLee	1.8		5.20	0.05		1.3		0.040			0.370		
S10	06/01/86	GarLee	27.4		5.07	0.05		1.4		0.020			1.200		
S10	07/01/86	GarLee			5.90	0.15		1.6		0.060			2.100		
S10	09/01/86	GarLee			5.63	0.05		1.9		0.020			1.200		

Chippewa Creek Water Quality Data Base 1985 - present
Compiled: 94/08/23 by Near North Laboratories Inc., North Bay, Ontario.

Site	Date	Source	Rain mm	Alk mg/L	pH	Ammonia mg/L	Temp oC	Cl mg/L	Dis. O2 mg/L	Tot P. mg/L	Turbid NTU	Copper mg/L	Iron mg/L	Lead mg/L	Nickel mg/L
S10	05/01/87	GarLee			6.77	0.05	13	1.5	12.0	0.020			0.800		
S10	06/01/87	GarLee	0.4			0.05		1.5							
S10	09/01/87	GarLee			5.94	0.15	14	3.0	8.0	0.050			2.510		
S10	12/01/87	GarLee			4.40	<0.05	1	2.0	12.0	0.070			0.530		
S10	04/01/88	GarLee			4.90	<0.05	7	1.1	12.0	<0.02			0.330		
S10	06/01/88	GarLee	0.4		5.02	<0.05	21	1.8	8.0	<0.02			1.100		
S10	09/01/88	GarLee	0.8		4.67	<0.05	11	1.2	11.0	<0.02			0.770		
S10	11/01/88	GarLee	0.8		4.85	<0.05	2	1.3	15.0	<0.02			0.390		
S10	05/01/89	GarLee			4.51	<0.05	9	1.0	13.0	<0.04			0.390		
S10	07/01/89	GarLee			5.83	<0.05	15	2.6	9.0	<0.10			2.300		
S10	09/01/89	GarLee	2.0		6.47	<0.05	15	2.0	11.0	<0.02			3.190		
S10	11/01/89	GarLee	0.6		3.95	<0.05	3	2.2	14.0	<0.02			0.700		
S10	05/01/90	GarLee	0.4		4.40	<0.05		1.1		<0.02			0.430		
S10	07/01/90	GarLee			4.68	<0.05	22	1.6	13.0	<0.02			1.100		
S10	09/01/90	GarLee			4.23	<0.05	3	1.6	13.0	<0.02			0.950		
S10	11/01/90	GarLee			4.80	<0.05		<0.4		<0.02			0.430		
S10	05/01/91	GarLee	0.8			<0.05	10	1.2	15.0	<0.02			0.420		
S10	06/01/91	GarLee			6.09	<0.20	23	3.0	8.0	0.050			2.500		
S10	09/01/91	GarLee			5.24	<0.05		1.7	6.0	<0.02			0.950		
S10	11/01/91	GarLee	0.2		5.05	<0.05	7	2.0	12.0	<0.05			0.930		
S10	05/01/92	GarLee	8.2		4.75	<0.05	13	1.3	11.0	<0.05			0.600		
S10	07/01/92	GarLee			5.86	<0.1	19	2.0	6.0	<0.02			2.600		
S10	09/01/92	GarLee			4.33		13	2.1	8.0	<0.04			4.300		
S10	11/01/92	GarLee			4.47	<0.05	1	1.9	8.0	<0.02			0.660		
S10	07/01/93	CNB			7.20		20		8.0						
S20	05/01/85	GarLee			7.22	1.15		4.0		0.040			0.800		
S20	06/01/85	GarLee	5.2		7.01	0.10		4.4		0.050			1.100		
S20	07/01/85	GarLee			7.16	0.30		7.4		0.040			1.300		
S20	08/01/85	GarLee			7.23	0.10		8.4		0.030			0.220		
S20	09/01/85	GarLee	4.8		7.11	<0.05		9.6		0.040			1.400		
S20	10/01/85	GarLee	5.8		7.15	0.30		8.6		0.060			1.100		
S20	11/01/85	GarLee			6.74	1.00		3.6		0.040					
S20	12/01/85	GarLee	15.4		7.06	0.50		4.8		0.040			1.100		
S20	01/01/86	GarLee			7.18	6.20		8.8		0.060			1.100		
S20	02/01/86	GarLee			7.50	5.30		14.8		0.040			1.300		
S20	03/01/86	GarLee			7.71	0.70		DI		0.020			0.940		
S20	04/01/86	GarLee	1.8		7.31	0.70		3.2		0.100			0.620		
S20	06/01/86	GarLee	27.4		7.17	0.35		3.9		0.020			0.720		
S20	07/01/86	GarLee			7.29	0.05		4.8		0.020			1.100		
S20	09/01/86	GarLee			6.99	0.15		11.1		<0.02			0.950		
S20	05/01/87	GarLee			7.38	0.90	13	4.0	12.0	<0.01			0.840		
S20	06/01/87	GarLee	0.4			0.40		3.0							
S20	09/01/87	GarLee			7.10	0.20	14	4.0	9.0	0.030			1.520		
S20	12/01/87	GarLee			6.82	0.35	0	3.6	12.0	0.070			0.710		
S20	04/01/88	GarLee			7.27	0.70	7	3.1	13.0	<0.02			0.640		
S20	06/01/88	GarLee	0.4		7.40	0.45	20	4.1	8.0	<0.02			0.920		
S20	09/01/88	GarLee	0.8		7.15	<0.2	10	2.6	12.0	<0.02			0.940		
S20	11/01/88	GarLee	0.8		7.09	0.45	3	3.7	14.0	<0.02			0.710		
S20	05/01/89	GarLee			7.05	0.70	11	1.7	13.0	<0.02			1.100		
S20	07/01/89	GarLee			7.36	<0.05	15	3.7	9.0	<0.02			1.100		
S20	09/01/89	GarLee	2.0		7.70	<0.2	15	8.7	11.0	<0.02			3.300		
S20	11/01/89	GarLee	0.6			0.30	3	3.1	14.0	<0.06			5.500		
S20	05/01/90	GarLee	0.4		7.39	<0.15		1.7		<0.02			0.590		
S20	07/01/90	GarLee			7.18	0.35	15	1.8	12.0	<0.02			0.910		
S20	09/01/90	GarLee			6.85	0.25	4	2.7	11.0	<0.02			1.500		

Chippewa Creek Water Quality Data Base 1985 - present
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Site	Date	Source	Rain	Alk	pH	Ammonia	Temp	Cl	Dis. O2	Tot P.	Turbid	Copper	Iron	Lead	Nickel
			mm	mg/L		mg/L	oC	mg/L	mg/L	mg/L	NTU	mg/L	mg/L	mg/L	mg/L
S20	11/01/90	GarLee			7.01	<0.2		1.3		<0.02			2.000		
S20	05/01/91	GarLee	0.8		7.54	0.45	7	2.6	14.0	<0.02			0.530		
S20	06/01/91	GarLee			7.21	<0.15	15	1.7	9.0	<0.02			1.200		
S20	09/01/91	GarLee			7.40	0.50	13	5.2	5.0	<0.02			1.200		
S20	11/01/91	GarLee	0.2		6.95	0.30	7	3.1	13.0	<0.05			1.600		
S20	05/01/92	GarLee	8.2		6.98	0.30	15	2.9	11.0	<0.02			0.620		
S20	07/01/92	GarLee			6.97	0.30	12	6.1	6.0	<0.02			1.100		
S20	09/01/92	GarLee			7.04	<0.15	17	2.5	10.0	<0.02			1.900		
S20	11/01/92	GarLee			7.08	0.25	7	2.5	13.0	<0.02			0.970		
S20	07/01/93	CNB			7.80		23		7.6						
S50	05/01/85	GarLee			7.87	20.00		50.6		0.600			16.900		
S50	06/01/85	GarLee	5.2		7.70	4.70		18.8		0.030			1.700		
S50	07/01/85	GarLee			7.49	3.30		17.4		0.040			1.800		
S50	08/01/85	GarLee			7.64	6.00		26.2		0.050			2.000		
S50	09/01/85	GarLee	4.8		7.51	5.30		24.2		0.010			2.300		
S50	10/01/85	GarLee	5.8		7.47	3.50		17.2		0.040			1.500		
S50	11/01/85	GarLee			7.29	3.10		10.4		0.040			1.200		
S50	12/01/85	GarLee	15.4		7.44	4.90		17.6		0.020			1.500		
S50	01/01/86	GarLee			7.52	6.50		15.6		0.040			1.300		
S50	02/01/86	GarLee			7.45	7.50		24.6		0.020			1.300		
S50	03/01/86	GarLee			7.92	3.35		D1		0.060			1.690		
S50	04/01/86	GarLee	1.8		7.40	1.90		4.9		0.080			0.740		
S50	06/01/86	GarLee	27.4		7.51	1.40		6.7		0.020			0.920		
S50	07/01/86	GarLee			7.86	4.15		18.7		0.200			1.500		
S50	09/01/86	GarLee			7.19	4.40		20.1		0.200			1.400		
S50	05/01/87	GarLee			7.72	3.60	13	13.5	13.0	0.010			1.210		
S50	06/01/87	GarLee	0.4		NR	3.50		6.5		NR					
S50	09/01/87	GarLee			7.37	7.75	11	26.0	11.0	0.030			1.500		
S50	12/01/87	GarLee			7.24	2.40	1	9.5	13.0	0.080			1.100		
S50	04/01/88	GarLee			7.62	2.80	7	7.5	8.0	<0.02			0.740		
S50	06/01/88	GarLee	0.4		7.58	135.00	20	19.0	7.0	<0.02			1.300		
S50	09/01/88	GarLee	0.8		7.71	3.05	11	10.3	12.0	<0.02			1.200		
S50	11/01/88	GarLee	0.8		7.50	4.20	2	11.3	14.0	<0.02			0.960		
S50	05/01/89	GarLee			7.41	2.35	10	5.7	12.0	<0.04			0.980		
S50	07/01/89	GarLee			7.83	9.20	16	23.4	8.0	<0.02			1.300		
S50	09/01/89	GarLee	2.0		7.82	7.35	14	21.5	11.0	<0.02			3.170		
S50	11/01/89	GarLee	0.6			1.55	4	6.6	13.0	<0.02			0.770		
S50	05/01/90	GarLee	0.4		6.71	1.05		3.9		<0.02			0.570		
S50	07/01/90	GarLee			7.66	3.40	16	10.1	11.0	<0.02			0.840		
S50	09/01/90	GarLee			7.12	1.70	5	6.0	16.0	<0.02			0.840		
S50	11/01/90	GarLee			7.29	1.70		4.7		<0.02			1.500		
S50	05/01/91	GarLee	0.8		7.12	1.55	8	6.2	14.0	<0.02			0.580		
S50	06/01/91	GarLee			7.73	4.30	15	14.4	9.0	<0.02			0.350		
S50	09/01/91	GarLee			8.06	2.50	10	9.5	7.0	<0.02			0.600		
S50	11/01/91	GarLee			7.20	0.30	4	2.8		<0.05			1.500		
S50	05/01/92	GarLee	8.2		7.26	1.15	10	5.0	12.0	<0.02			0.650		
S50	07/01/92	GarLee			7.55	2.45	15	11.7	7.0	<0.02			0.740		
S50	09/01/92	GarLee			7.27	0.45	17	3.6	9.0	<0.02			1.800		
S50	11/01/92	GarLee			7.21	0.90	2	5.0	15.0	<0.02			0.780		
S50	07/01/93	CNB			7.50		16		10.0						
S60	04/01/88	GarLee			7.62	2.70	8	7.0	9.0	<0.02			0.790		
S60	06/01/88	GarLee	0.4		7.51	4.80	17		6.0	<0.02			1.200		
S60	09/01/88	GarLee	0.8		7.67	2.85	10	9.8	11.0	<0.02			1.300		
S60	11/01/88	GarLee	0.8		7.65	3.85	3	10.8	13.0	<0.02			0.960		
S60	05/01/89	GarLee			7.33	2.50	12	5.9	11.0	<0.02			1.000		

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Site	Date	Source	Rain mm	Alk mg/L	pH	Ammonia mg/L	Temp oC	Cl mg/L	Dis. O2 mg/L	Tot P. mg/L	Turbid NTU	Copper mg/L	Iron mg/L	Lead mg/L	Nickel mg/L
S60	07/01/89	GarLee			6.61	(0.1	16	20.4	8.0	(0.02			2.100		
S60	09/01/89	GarLee	2.0		8.07	6.40	14	20.2	12.0	(0.02			2.600		
S60	11/01/89	GarLee	0.6			1.45	4	5.7	15.0	(0.02			0.550		
S60	05/01/90	GarLee	0.4		7.25	0.95	5	3.7	14.0	(0.02			0.600		
S60	07/01/90	GarLee			7.77	2.90	15	9.7	12.0	(0.02			0.840		
S60	09/01/90	GarLee			7.18	1.90	10	7.1	13.0	(0.02			0.920		
S60	11/01/90	GarLee				1.65	1	4.1	15.0	(0.02			0.690		
S60	05/01/91	GarLee	0.8		7.53	1.85	8	6.2	13.0	(0.02			0.630		
S60	06/01/91	GarLee			7.59	3.70	14	13.8	8.0	(0.02			0.370		
S60	09/01/91	GarLee			7.67	1.95	12	9.3	8.0	(0.02			0.610		
S60	11/01/91	GarLee			7.04	0.80	0	4.0	12.0	(0.1			0.900		
S60	05/01/92	GarLee	8.2		7.43	1.00	8	4.9	12.0	(0.02			0.790		
S60	07/01/92	GarLee			7.40	2.05	14	10.5	9.0	(0.02			0.840		
S60	09/01/92	GarLee			7.35	0.60	8	3.8	11.0	(0.02			1.000		
S60	11/01/92	GarLee			6.94	0.30	2	12.4	10.0	(0.04			0.770		
S60	07/01/93	CNB			7.20		21		9.2						
S80	04/01/88	GarLee													
S80	06/01/88	GarLee	0.4		6.92	(0.05	19	24.4	10.0	(0.02			1.300		
S80	09/01/88	GarLee	0.8		6.80	(0.05	10	15.6	11.0	(0.02			1.130		
S80	11/01/88	GarLee	0.8		6.41	(0.05	2	14.2	13.0	(0.02			0.500		
S80	05/01/89	GarLee			6.35	(0.05	12	16.2	11.0	(0.04			0.660		
S80	07/01/89	GarLee			7.90	9.45	16	23.4	8.0	(0.02			1.700		
S80	09/01/89	GarLee	2.0		6.82	(0.05	15	27.5	11.0	(0.02			2.890		
S80	11/01/89	GarLee	0.6			(0.2	4	21.6	14.0	(0.02			0.620		
S80	05/01/90	GarLee	0.4		7.15	(0.05	8	14.5		(0.02			0.690		
S80	07/01/90	GarLee			6.88	(0.15	18	19.1	10.0	(0.02			1.600		
S80	09/01/90	GarLee			6.35	0.25	10	17.4	13.0	(0.02			1.200		
S80	11/01/90	GarLee			6.40	(0.05	0	15.5	15.0	(0.02			0.790		
S80	05/01/91	GarLee	0.8		7.11	(0.05	8	24.4	13.0	(0.02			0.720		
S80	06/01/91	GarLee			6.84	(0.15	19	23.3	7.0	0.020			1.500		
S80	09/01/91	GarLee			6.87	(0.15	13	34.1	9.0	(0.02			1.300		
S80	11/01/91	GarLee			6.73	0.30	1	16.4	13.0	(0.05			0.740		
S80	05/01/92	GarLee	8.2		6.80	(0.05	12	22.4	11.0	(0.02			0.920		
S80	07/01/92	GarLee			7.20	(0.15	18	30.7	9.0	(0.02			2.000		
S80	09/01/92	GarLee			6.90	(0.10	10	17.8	8.0	(0.02			2.400		
S80	11/01/92	GarLee			6.56	(0.05	1	16.7	9.0	(0.02			0.800		
S70	04/01/88	GarLee													
S70	06/01/88	GarLee	0.4		7.51	2.85	19	21.2	10.0	(0.02			1.300		
S70	09/01/88	GarLee	0.8		7.65	1.40	9	11.9	12.0	(0.02			1.180		
S70	11/01/88	GarLee	0.8		7.11	1.20	2	13.1	13.0	(0.02			0.650		
S70	05/01/89	GarLee			7.03	1.10	11	11.4	11.0	(0.02			0.710		
S70	07/01/89	GarLee			6.70	(0.1	16	20.3	8.0	(0.02			1.800		
S70	09/01/89	GarLee	2.0		7.38	1.95	14	25.3	11.0	(0.02			3.750		
S70	11/01/89	GarLee	0.6			0.40	4	16.5	14.0	(0.02			0.730		
S70	05/01/90	GarLee	0.4		7.11	0.45	7	9.3	15.0	(0.02			0.640		
S70	07/01/90	GarLee			7.44	1.30	16	14.6	11.0	(0.02			1.300		
S70	09/01/90	GarLee			7.00	0.85	5	13.5	16.0	(0.02			1.000		
S70	11/01/90	GarLee			6.97	0.70	5	10.9	16.0	(0.02			1.100		
S70	05/01/91	GarLee	0.8		7.51	1.15	8	12.5	15.0	(0.02			0.590		
S70	06/01/91	GarLee			7.06	0.95	16	20.8	7.0	0.020			1.200		
S70	09/01/91	GarLee			7.06	0.45	10	29.4	7.0	(0.02			1.200		
S70	11/01/91	GarLee			6.82	0.45	0	10.9	12.0	(0.05			0.890		
S70	05/01/92	GarLee	8.2		7.07	0.45	11	14.9	10.0	(0.02			0.870		
S70	07/01/92	GarLee			7.13	0.90	16	21.9	5.0	(0.02			1.500		
S70	09/01/92	GarLee			7.22	0.35	9	11.2	11.0	(0.06			1.800		

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Site	Date	Source	Rain mm	Alk mg/L	pH	Ammonia mg/L	Temp oC	Cl mg/L	Dis. O2 mg/L	Tot P. mg/L	Turbid NTU	Copper mg/L	Iron mg/L	Lead mg/L	Nickel mg/L
S70	11/01/92	GarLee			7.39	0.80	0	4.5	11.0	<0.02			0.860		
Golf club	03/17/85	MOEE		24	7.43	2.04	1	20.5	11.0	0.021	4.6	0.002	0.900	<0.003	0.004
Golf club	05/06/85	MOEE	0.2	14	7.27	0.93	6	10.0	12.0	0.064	21.0		1.275		
Golf club	05/29/85	MOEE		38	7.77	1.48	11	19.3	11.0	0.184	5.4	0.002	1.225	0.006	<0.002
Golf club	06/26/85	MOEE		35	7.74	1.40	14	17.3	11.0	0.028	4.5	<0.001	0.861	<0.003	0.004
Golf club	07/25/85	MOEE	43.8	38	7.80	0.98	19	18.4	10.0	0.016	4.2	0.003	1.500	<0.003	0.002
Golf club	08/22/85	MOEE				1.33	15	20.4	10.0	0.013	3.4	0.002	0.920	<0.003	<0.002
Golf club	09/09/85	MOEE	10.8	42	7.77	1.18	15	22.4	10.0	0.035	5.6	0.002	1.300	<0.003	0.002
Golf club	10/17/85	MOEE	1.2	27	7.48	0.81	5	18.3	14.0	0.018	2.8	0.004	1.000	<0.003	0.002
Golf club	10/21/85	MOEE		33	7.53	1.11	5	18.2	14.0	0.015	3.2	0.002	1.000	<0.003	<0.002
Golf club	10/31/85	MOEE		32	7.70	1.12	4	16.5	14.0	0.014	2.3	0.001	1.200	<0.003	0.003
Golf club	12/06/85	MOEE		24	7.56	1.35		18.7	12.0	0.040	12.2	0.003	1.500	<0.003	0.002
Golf club	01/01/86	MOEE		38	7.77	1.44		18.6	12.0	0.041	4.7	0.001	1.200	<0.003	<0.002
Golf club	05/01/86	MOEE	13.0	17	7.31	1.20	11	22.3	13.0	0.022	4.8	0.002	0.920	<0.003	<0.002
Golf club	06/16/86	MOEE	15.0	27	7.63	1.32	18	14.5		0.038	6.6	0.002	1.300	<0.003	0.002
Golf club	07/21/86	MOEE			7.70			21.8		0.026	3.8		1.400		
Golf club	08/04/86	MOEE	1.0	29	7.55	0.99	15	17.0	11.0	0.018	6.9	0.003	1.300	<0.003	0.003
Golf club	09/03/86	MOEE		42	7.79	1.39		20.0		0.010	3.2	0.001	0.960	<0.003	<0.002
Golf club	10/02/86	MOEE	3.8	28	7.62	0.70	11	13.5	11.0	0.008	4.1	0.002	1.100	0.003	0.004
Golf club	11/03/86	MOEE		22	7.43	0.67		13.0		0.012	4.3	0.002	1.000	<0.003	<0.002
Golf club	01/03/87	MOEE		42	7.66	1.90		22.1		0.012	4.2	0.006	2.300	<0.003	0.014
Golf club	03/05/87	MOEE		49	7.94	2.46		27.8		<0.009	3.8	0.001	1.300	<0.003	0.002
Golf club	05/25/87	MOEE		26	7.63	1.50		16.8		0.012	3.9	0.006	0.900	<0.003	0.002
Golf club	07/19/87	MOEE	6.4	44	7.86	1.10		22.1		<0.007	2.4	0.001	1.200	<0.003	0.002
Golf club	08/10/87	MOEE		50	7.91	1.44		22.5		0.011	3.3	0.005	1.200	0.004	0.003
Golf club	09/28/87	MOEE		46	7.86	0.43		24.8		0.011	2.3	0.003	0.920	<0.003	0.003
Golf club	10/15/87	MOEE		37	7.77	1.41		19.9		<0.009	1.8	0.001	0.810	<0.003	<0.001
Golf club	10/25/87	MOEE		36	7.74	1.24		23.9		0.013	3.5	0.002	0.520	<0.003	0.002
Golf club	11/02/87	MOEE	1.4	21	7.40	0.95		12.4		0.022	3.7	0.001		<0.003	0.003
Golf club	01/02/88	MOEE		41	7.81	1.79		18.6		0.010	2.5	0.008	1.000		0.002
Golf club	04/28/88	MOEE	6.4	29	7.50	2.60		17.0		0.028	5.4	<0.001	0.800	<0.002	<0.002
Golf club	05/31/88	MOEE	1.8	46	7.90	2.30	21	21.0	10.0	0.021	3.6				
Golf club	06/13/88	MOEE		56	7.70	1.40	15	23.0	10.0	0.031	2.0	<0.002	0.521	<0.002	<0.002
Golf club	07/25/88	MOEE	1.6	57	7.70	1.60	16	24.0	10.0	0.022	4.2	<0.002	0.990	<0.002	<0.002
Golf club	08/17/88	MOEE	11.4	41	7.70	1.60	15	20.0	10.0	0.013	3.1	<0.002	1.200	<0.002	<0.002
Golf club	10/03/88	MOEE		16	7.10	0.43	8	12.0	12.0	0.030	7.8	<0.002	1.200	<0.002	<0.003
Golf club	10/31/88	MOEE		30	7.30	1.60	3	14.0	13.0	0.008	2.3	<0.003	0.920	<0.004	<0.002
Golf club	07/12/89	MOEE		64	7.90	3.69		19.0	10.0			<0.002	0.930	<0.002	<0.002
Golf club	08/08/89	MOEE		50	7.70		15		10.0			<0.002	0.770	<0.002	<0.002
Golf club	09/04/89	MOEE		53	7.90	2.42	9	23.0	12.0	0.006		<0.002	0.610	<0.0065	<0.003
Golf club	09/28/89	MOEE		49	7.80	1.98	8	26.0	11.0	0.009		<0.002	0.770	<0.002	<0.002
Golf club	10/23/89	MOEE		32	7.70	1.49	5	19.0	12.0	0.013		<0.002	0.640	<0.002	<0.002
Golf club	10/31/89	MOEE	16.2	40	7.70	1.75	7	22.0	12.0	0.013		<0.002	0.740	<0.002	<0.002
Golf club	11/07/89	MOEE					5		12.0						
Golf club	11/13/89	MOEE	0.8	24	7.40	1.21	2	16.0	14.0	0.013		<0.002	0.730	<0.002	<0.002
Golf club	12/05/89	MOEE		34	7.60	1.47	1	18.0	13.0	0.025		<0.002	1.300	<0.002	<0.002
Golf club	01/02/90	MOEE		46	7.70	2.18	1	25.0	13.0	0.011		<0.002	0.830	<0.002	<0.002
Golf club	03/18/90	MOEE		14	7.30	1.04	2	21.0	14.0	0.043		<0.005	0.650	<0.020	<0.010
Golf club	04/23/90	MOEE		17	7.00	0.89	1	16.0	12.0	0.017		<0.002	0.590	<0.002	<0.002
Golf club	05/21/91	MOEE		24	7.40	0.81	1	19.0	10.0	0.048		<0.002	1.200	<0.003	<0.002
Golf club	06/11/91	MOEE		33	7.60	2.37	15	17.0	11.0	0.016		0.003	0.800	<0.002	<0.002
Golf club	07/09/91	MOEE		35	7.60	0.56	21	22.0	9.0	0.016		<0.0014	0.890	<0.002	<0.001
Golf club	08/06/91	MOEE			7.30	0.94	18		10.0	0.013		<0.0013	0.860	<0.002	<0.001
Golf club	09/15/91	MOEE	11.2	32	7.50	0.50	2	24.0	10.0	0.053		0.003	1.900	<0.002	<0.002
Golf club	10/29/91	MOEE		13	7.10	0.24	5	8.9	12.0	0.031		0.003	0.850	<0.002	<0.002

Chippewa Creek Water Quality Data Base 1985 - present
Compiled: 94/08/23 by Near North Laboratories Inc., North Bay, Ontario.

Site	Date	Source	Rain	Alk	pH	Ammonia	Temp	Cl	Dis. O2	Tot P.	Turbid	Copper	Iron	Lead	Nickel
			mm	mg/L		mg/L	oC	mg/L	mg/L	mg/L	NTU	mg/L	mg/L	mg/L	mg/L
Golf club	11/11/91	MOEE	17.4	18	7.20	0.49	4	13.0	12.0	0.017		<0.0006	0.920	<0.0025	<0.0015
Golf club	08/11/93	MOEE		30	7.50	<0.01	22	21.0	8.3	0.018		0.007	0.940	<0.002	0.006
Golf club	12/19/93	MOEE		25	7.50	0.52	0	21.0	15.0	0.008		<0.0011	1.100	<0.002	<0.001
Mouth	03/17/85	MOEE		31	7.40	2.20	1	75.4	14.0	0.099	6.1	0.004	0.920	<0.003	0.005
Mouth	05/06/85	MOEE	0.2	18	7.10	0.81	6	44.5	12.0	0.137	25.0		1.530		
Mouth	05/29/85	MOEE		44	7.62	0.77	10	82.5	11.0	0.075	5.2	0.002	1.150	0.006	0.004
Mouth	06/26/85	MOEE		32	7.40	0.61	14	74.8	11.0	0.129	5.5	0.006	0.715	<0.003	<0.001
Mouth	07/25/85	MOEE	43.8	46	7.75	0.40	19	77.4	10.0	0.057	15.8	0.004	1.400	<0.003	0.006
Mouth	08/22/85	MOEE		51	7.56		15		10.0	0.029	5.3	0.005	0.980	<0.003	0.007
Mouth	09/09/85	MOEE	10.8	56	7.75	0.38	15	218.5	10.0	0.030	6.8	0.005	1.100	<0.003	0.005
Mouth	10/17/85	MOEE	1.2	36	7.50	0.52	5	94.3	14.0	0.022	4.1	0.002	1.200	<0.003	0.004
Mouth	10/21/85	MOEE		44	7.56	0.71	5	91.7	14.0	0.023	4.2	0.003	1.100	<0.003	0.003
Mouth	10/31/85	MOEE		43	7.71	1.06	4	61.8	14.0	0.023	4.8				
Mouth	12/06/85	MOEE		28	7.51	1.06		92.6	12.0	0.086	20.0	0.005	2.200	0.009	0.003
Mouth	01/01/86	MOEE		41	7.85	0.99		61.5	12.0	0.025	3.8	0.002	1.100	<0.003	0.002
Mouth	05/01/86	MOEE	13.0	18	7.61	0.01	11	66.8	13.0	0.037	5.9	0.006	1.000	<0.003	0.002
Mouth	06/16/86	MOEE	15.0	34	7.54	0.73	18	64.5	10.0	0.025	4.2				
Mouth	08/04/86	MOEE	1.0	36	7.52	0.62	15	53.0	11.0	0.033	7.1	0.003	1.200	<0.003	0.002
Mouth	09/03/86	MOEE		46	7.87	0.12		64.5		0.020	3.1	0.003	0.830	<0.003	<0.002
Mouth	10/02/86	MOEE		33	7.52	0.51	11	42.5	11.0	0.022	6.7				
Mouth	11/03/86	MOEE	2.4	26	7.57	0.52	4	45.0	12.0	0.018	4.9	0.002	1.100	<0.003	0.002
Mouth	01/03/87	MOEE		45	7.58	1.32		85.0	12.0	0.030	5.1	0.006	1.400	<0.003	0.003
Mouth	03/05/87	MOEE		49	7.50	1.41		128.0	11.0	0.048	12.3	0.003	2.000	0.003	0.002
Mouth	05/25/87	MOEE		34	7.71	0.94	10	64.5	6.0	0.020	4.8	0.004	0.980	0.004	0.002
Mouth	07/19/87	MOEE	6.4	55	7.98	0.17		158.0		0.025	3.7	0.004	1.400	0.004	0.002
Mouth	08/10/87	MOEE		53	7.88	0.16						0.014	0.800	0.005	0.002
Mouth	09/28/87	MOEE		50	7.65	0.68		69.5		0.016	2.7	0.003	0.840	<0.003	0.003
Mouth	10/15/87	MOEE		43	7.64	0.82		54.9		0.029	3.6	0.005	0.900	<0.003	0.003
Mouth	10/25/87	MOEE		38	7.64	0.87				0.025	5.1	0.003	0.570	<0.003	0.001
Mouth	11/02/87	MOEE	1.4	25	7.41	0.72		37.1		0.027	6.6	0.002	1.000	<0.003	0.002
Mouth	01/02/88	MOEE		46	7.65	1.24		64.1		0.015	3.1	0.002	0.860		0.002
Mouth	04/28/88	MOEE	6.4	31	7.50	1.50		109.0		0.032	6.6	0.004	0.970		0.005
Mouth	05/31/88	MOEE	1.8	42	7.60	0.95	20	74.0	10.0	0.032	3.4	0.006	0.740	<0.003	<0.003
Mouth	06/13/88	MOEE		41	7.30	0.25	10	57.0	10.0	0.030	5.1	0.003	0.393	<0.003	<0.004
Mouth	07/25/88	MOEE	1.6	43	7.60	0.09	16	55.0	10.0	0.038	2.2	0.004	0.660	<0.002	<0.0025
Mouth	08/17/88	MOEE	11.4	32	7.60	0.35	15	26.0	10.0	0.018	2.5	<0.0014	0.370	<0.002	<0.003
Mouth	10/03/88	MOEE		24	7.10	0.26	8	35.0	12.0	0.036	9.8	0.003	1.100	<0.003	<0.002
Mouth	10/31/88	MOEE		37	7.30	1.20	3	46.0	13.0	0.018	3.0	0.003	0.910	<0.002	<0.0025
Mouth	07/12/89	MOEE		24	7.40	0.18		13.0	10.0	0.016		<0.0024	0.160	<0.002	<0.0015
Mouth	08/08/89	MOEE		25	7.30		15		10.0			<0.0034	0.310	<0.003	<0.003
Mouth	09/04/89	MOEE		26	7.60	0.07	1	13.0	12.0	0.015		<0.0017	0.100	<0.002	<0.0015
Mouth	09/28/89	MOEE		49	7.60	0.44	8	67.0	11.0	0.040		<0.0024	0.150	<0.002	<0.0015
Mouth	10/23/89	MOEE		38	7.70		5	75.0	12.0	0.062		<0.0022	1.100	<0.0035	<0.0015
Mouth	10/31/89	MOEE	16.2	44	7.90	0.78	7	67.0	12.0	0.017		<0.001	0.800	<0.002	<0.0015
Mouth	11/13/89	MOEE	0.8	30	7.40	0.88	2	46.0	14.0	0.017		<0.013	0.930	<0.020	<0.010
Mouth	12/05/89	MOEE		40	7.40	0.64	1	79.0	13.0	0.025		0.003	1.000	<0.0025	<0.002
Mouth	01/02/90	MOEE		48	7.40	1.37	1	87.0	13.0	0.011		<0.0009	0.780	<0.002	<0.0015
Mouth	03/19/90	MOEE		19	7.30	0.75	0	65.0	16.0	0.069		<0.005	1.200	<0.020	<0.010
Mouth	04/23/90	MOEE		23	7.10		1	59.0	12.0	0.023					
Mouth	05/21/91	MOEE		32	7.60	0.40	1	76.0	10.0	0.017		0.006	0.840	<0.003	<0.0036

Chippewa Creek Water Quality Data Base 1985 - present
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Site	Date	Source	Rain mm	Alk mg/L	pH	Ammonia mg/L	Temp oC	Cl mg/L	Dis. O2 mg/L	Tot P. mg/L	Turbid NTU	Copper mg/L	Iron mg/L	Lead mg/L	Nickel mg/L
Mouth	06/11/91	MOEE		38	7.60	0.22	15	68.0	11.0	0.027		0.008	1.100	<0.002	<0.001
Mouth	07/09/91	MOEE		35	7.60	0.18	21	45.0	9.0	0.026		0.003	0.500	<0.002	<0.0021
Mouth	08/06/91	MOEE			7.60	0.37	18		10.0	0.011		<0.0005	0.810	<0.002	<0.001
Mouth	09/15/91	MOEE	11.2	37	7.50	<0.01	18	46.0	10.0	0.067		0.005	2.200	<0.0045	<0.0023
Mouth	10/29/91	MOEE		23	7.20	0.24	5	46.0	12.0	0.031		0.004	1.000	<0.002	<0.0023
Mouth	11/11/91	MOEE	17.4	27	7.30	0.46	4	52.0	12.0	0.020		0.007	0.920	<0.003	<0.0015
Mouth	08/11/93	MOEE		45	7.40	0.07	23	97.0	8.2	0.040		0.008	0.750	<0.003	0.005
Mouth	12/19/93	MOEE		34	7.30	0.48	0	610.0	0.2	0.069		0.010	1.300	<0.003	<0.003
Mouth	05/05/94	NNL		21	7.23			66.1				0.013	0.700	<0.005	
Mouth	05/31/94	NNL		24	7.40			57.5				0.008	1.050	<0.005	
Mouth	06/14/94	NNL		22	7.07			47.9				0.012	3.180	0.031	
Mouth	06/28/94	NNL		26	6.70			43.7				0.005	1.750	0.020	
Mouth	07/12/94	NNL		25	7.13			64.6				0.011	2.250	<0.005	
Mouth	07/27/94	NNL		37	6.92			33.1					1.730	<0.005	
Mouth	08/10/94	NNL												<0.005	
Laurier	05/05/94	NNL		44	6.91			795.0				0.006	4.060	<0.005	
Laurier	05/31/94	NNL		55	6.76			588.8				0.005	6.560	<0.005	
Laurier	06/14/94	NNL		68	7.05			676.1				0.007	4.670	0.032	
Laurier	06/28/94	NNL		87	6.98			289.0				0.005	1.750	0.022	
Laurier	07/12/94	NNL		72	7.07			490.0				0.011	8.490	0.006	
Laurier	07/27/94	NNL		97	7.04			644.0					12.900	<0.005	
Laurier	08/10/94	NNL												<0.005	
Thompson	05/05/94	NNL		16	7.14			35.5				0.005	0.694	<0.005	
Thompson	05/31/94	NNL		13	6.69			31.8				0.016	3.260	0.008	
Thompson	06/14/94	NNL		18	7.14			26.9				0.011	2.620	0.022	
Thompson	06/28/94	NNL		19	7.00			20.4				0.007	1.670	0.020	
Thompson	07/12/94	NNL		20	7.28			38.9				0.009	1.680	<0.005	
Thompson	07/27/94	NNL		31	6.43			25.0					1.960	<0.005	
Thompson	08/10/94	NNL												<0.005	
Johnston	05/05/94	NNL		32	7.10			173.8				0.008	1.140	<0.005	
Johnston	05/31/94	NNL		<1	4.10			107.6				0.061	7.410	0.036	
Johnston	06/14/94	NNL		37	6.90			89.1				0.010	1.640	0.037	
Johnston	06/28/94	NNL		36	6.86			66.1				0.008	1.350	0.023	
Johnston	07/12/94	NNL		35	7.04			159.0				0.010	1.810	<0.005	
Johnston	07/27/94	NNL		40	7.10			120.0					1.350	<0.005	
Johnston	08/10/94	NNL												<0.005	
Dudley	05/05/94	NNL		15	7.23			30.2				0.009	0.468	<0.005	
Dudley	05/31/94	NNL		26	6.93			38.9				0.033	7.390	0.025	
Dudley	06/14/94	NNL		19	7.14			251.0				0.010	2.410	0.018	
Dudley	06/28/94	NNL		18	7.09			15.5				0.005	1.590	0.024	
Dudley	07/12/94	NNL		19	7.32			28.8				0.009	2.150	<0.005	
Dudley	07/27/94	NNL		30	7.40			46.8					1.880	<0.005	
Dudley	08/10/94	NNL												<0.005	
Bottom Es	05/05/94	NNL		12	7.21			20.0				0.006	0.454	<0.005	
Bottom Es	05/31/94	NNL		16	7.21			24.6				0.004	1.350	<0.005	
Bottom Es	06/14/94	NNL		14	7.14			17.8				0.008	2.350	0.017	
Bottom Es	06/28/94	NNL		16	6.90			10.0				0.005	1.710	0.019	
Bottom Es	07/12/94	NNL		17	7.39			17.0				0.006	1.950	<0.005	
Bottom Es	07/27/94	NNL		26	7.43			24.6					1.870	<0.005	
Bottom Es	08/10/94	NNL												<0.005	
Mid Escp	05/17/94	NNL		5	6.69			6.3				0.009	0.857	0.011	
Mid Escp	05/31/94	NNL		11	6.69			11.2				0.003	1.150	<0.005	
Mid Escp	06/14/94	NNL		11	7.00			12.3				0.014	2.200	0.015	
Mid Escp	06/28/94	NNL												<0.005	

Chippewa Creek Water Quality Data Base 1985 - present
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Site	Date	Source	Rain	Alk	pH	Ammonia	Temp	Cl	Dis. O2	Tot P.	Turbid	Copper	Iron	Lead	Nickel
			mm	mg/L		mg/L	oC	mg/L	mg/L	mg/L	NTU	mg/L	mg/L	mg/L	mg/L
Mid Escp	07/12/94	NNL		17	7.20			15.9				0.005	2.000	<0.005	
Mid Escp	07/27/94	NNL		21	7.35			15.5					2.010	<0.005	
Mid Escp	08/10/94	NNL												<0.005	
Golf Trib	05/17/94	NNL		28	7.46			39.8				0.003	0.952	0.005	
Golf Trib	05/31/94	NNL		34	7.21			50.1				0.003	3.390	<0.005	
Golf Trib	06/14/94	NNL		40	7.59			56.2				0.005	2.030	0.014	
Golf Trib	06/28/94	NNL		37	7.11			25.7				0.005	1.420	0.020	
Golf Trib	07/12/94	NNL		34	7.70			38.0				0.008	1.410	<0.005	
Golf Trib	07/27/94	NNL		40	7.57			53.7					1.840	<0.005	
Golf Trib	08/10/94	NNL												<0.005	
Top Escp	05/17/94	NNL		3	6.28			12.3				<0.001	0.519	0.011	
Top Escp	05/31/94	NNL		6	4.55			36.3				<0.001	1.040	<0.005	
Top Escp	06/14/94	NNL		8	6.58			26.9				0.010	1.930	0.009	
Top Escp	06/28/94	NNL		8	6.45			12.6				0.005	2.270	0.019	
Top Escp	07/12/94	NNL		8	6.67			17.0				0.004	2.370	<0.005	
Top Escp	07/27/94	NNL		14	6.88			28.8					2.570	<0.005	
Top Escp	08/10/94	NNL												<0.005	
L.F. Trib	05/17/94	NNL		8	6.79			1.3				0.016	1.480	0.010	
L.F. Trib	05/31/94	NNL		15	6.76			2.8				0.014	7.210	<0.005	
L.F. Trib	06/14/94	NNL		13	6.88			2.3				0.014	3.200	0.005	
L.F. Trib	06/28/94	NNL		17	6.95			2.7				0.007	1.420	0.019	
L.F. Trib	07/12/94	NNL		19	7.20			4.4				0.007	1.540	0.005	
L.F. Trib	07/27/94	NNL		29	7.36			8.3					1.980	<0.005	
L.F. Trib	08/10/94	NNL												<0.005	
Pre L.F.	05/31/94	NNL		17	6.79			3.0				0.015	8.290	<0.005	
Pre L.F.	06/14/94	NNL		18	6.64			1.9				0.014	2.970	<0.005	
Pre L.F.	06/28/94	NNL		12	6.50			1.8				0.015	3.250	0.022	
Pre L.F.	07/12/94	NNL		5	6.90			4.4				0.008	1.670	<0.005	
Pre L.F.	07/27/94	NNL		23	6.95			5.1					2.660	<0.005	
Pre L.F.	08/10/94	NNL												<0.005	
Wetland	05/31/94	NNL		3	6.07			32.4				<0.001	1.770	<0.005	
Wetland	06/14/94	NNL										0.014	0.600	<0.005	
Wetland	06/28/94	NNL		7	6.59			19.1				<0.001	4.690	0.009	
Wetland	07/12/94	NNL		6	6.55			30.2				0.003	4.760	<0.005	
Wetland	07/27/94	NNL		13	6.90			55.0					5.810	<0.005	
Wetland	08/10/94	NNL												<0.005	
Psyc Trib	05/05/94	NNL												<0.005	
Psyc Trib	05/31/94	NNL												<0.005	
Psyc Trib	06/14/94	NNL												<0.005	
Psyc Trib	06/28/94	NNL		6	6.28			2.6				0.002	0.830	0.010	
Psyc Trib	07/12/94	NNL		5	6.43			3.6				0.003	0.930	<0.005	
Psyc Trib	07/27/94	NNL		12	6.83			17.8					1.370	<0.005	
Psyc Trib	08/10/94	NNL													

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Site	Date	Source	Zinc mg/L	Al mg/L	Mg mg/L	Ca mg/L	Cond. uS/cm	Hard. mg/L	S. Solid mg/L	D. Solid mg/L	Nitrate mg/L	Phenol mg/L	COD mg/L	Oil & Grease mg/L
S30	05/01/85	GarLee					708			378		0.006		
S30	06/01/85	GarLee					432			268		UI		
S30	07/01/85	GarLee					462			274		0.001		
S30	08/01/85	GarLee					552			298		0.003		
S30	09/01/85	GarLee					516			390		0.002		
S30	10/01/85	GarLee					431			240		0.002		
S30	11/01/85	GarLee					440			233		0.002		
S30	12/01/85	GarLee					496			253		0.003		
S30	01/01/86	GarLee					429			231		0.003		
S30	02/01/86	GarLee					663			329		0.003		
S30	03/01/86	GarLee					306			168		0.004		
S30	04/01/86	GarLee					165			112		0.003		
S30	06/01/86	GarLee					213			142		0.003		
S30	07/01/86	GarLee					402			224		0.002		
S30	09/01/86	GarLee					410			-		0.002		
S30	05/01/87	GarLee					333			188		0.001		
S30	06/01/87	GarLee					200			149		0.001		
S30	09/01/87	GarLee					564			302				
S30	12/01/87	GarLee					261			162		0.000		
S30	04/01/88	GarLee					327			166		(0.0008		
S30	06/01/88	GarLee					762			416		0.006		
S30	09/01/88	GarLee					589			277		0.007		
S30	11/01/88	GarLee					491			TU		0.007		
S30	05/01/89	GarLee					355			188		0.004		
S30	07/01/89	GarLee					693			345		0.022		
S30	09/01/89	GarLee					686			330		0.008		
S30	11/01/89	GarLee										0.003		
S30	05/01/90	GarLee					119			80		0.002		
S30	07/01/90	GarLee					280			229		(0.0002		
S30	09/01/90	GarLee					238			152		(0.0008		
S30	11/01/90	GarLee					202			122		(0.0006		
S30	05/01/91	GarLee					261			166		(0.0004		
S30	06/01/91	GarLee					452			230		(0.0004		
S30	09/01/91	GarLee					383			200		(0.001		
S30	11/01/91	GarLee					114			92		(0.0008		
S30	05/01/92	GarLee					368			191		(0.0004		
S30	07/01/92	GarLee					371			218		(0.0006		
S30	09/01/92	GarLee					361			189		(0.0002		
S30	11/01/92	GarLee					362			188		(0.0006		
S30	07/01/93	CNB					320							
S10	05/01/85	GarLee					29			19		0.004		
S10	06/01/85	GarLee					35			22		UI		
S10	07/01/85	GarLee					30			20		0.001		
S10	08/01/85	GarLee					46			30		0.320		
S10	09/01/85	GarLee					39			26		0.002		
S10	10/01/85	GarLee					40			26		(0.0008		
S10	11/01/85	GarLee					46			30		(0.0008		
S10	12/01/85	GarLee					44			29		0.001		
S10	01/01/86	GarLee					52			34		0.003		
S10	02/01/86	GarLee					53			34		0.002		
S10	03/01/86	GarLee					49			68		0.003		
S10	04/01/86	GarLee					34			40		0.002		
S10	06/01/86	GarLee					30			61		0.002		
S10	07/01/86	GarLee					30			76		0.002		
S10	09/01/86	GarLee					35					0.002		

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Site	Date	Source	Zinc	Al	Mg	Ca	Cond.	Hard.	S. Solid	D. Solid	Nitrate	Phenol	COD	Oil & Grease
			mg/L	mg/L	mg/L	mg/L	uS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
S10	05/01/87	GarLee					42			46		0.005		
S10	06/01/87	GarLee					37			76		0.001		
S10	09/01/87	GarLee					45			72				
S10	12/01/87	GarLee					46			65		0.000		
S10	04/01/88	GarLee					112			34		(0.0006		
S10	06/01/88	GarLee					47			66		0.006		
S10	09/01/88	GarLee					36			68		0.008		
S10	11/01/88	GarLee					33					0.005		
S10	05/01/89	GarLee					33			25		0.008		
S10	07/01/89	GarLee					37			88		0.011		
S10	09/01/89	GarLee					56			68		0.007		
S10	11/01/89	GarLee					116			66		0.003		
S10	05/01/90	GarLee					43			45		(0.0002		
S10	07/01/90	GarLee					34			82		(0.0002		
S10	09/01/90	GarLee					61			97		(0.0008		
S10	11/01/90	GarLee					35			55		(0.0002		
S10	05/01/91	GarLee					30			52		(0.0004		
S10	06/01/91	GarLee					38			85		(0.0004		
S10	09/01/91	GarLee					83			101		0.001		
S10	11/01/91	GarLee					46			68		(0.0006		
S10	05/01/92	GarLee					35			61		(0.0006		
S10	07/01/92	GarLee					42			95		0.004		
S10	09/01/92	GarLee					47			98		0.001		
S10	11/01/92	GarLee					39			66		0.004		
S10	07/01/93	CNB					320							
S20	05/01/85	GarLee					132			86		0.004		
S20	06/01/85	GarLee					150			98		UI		
S20	07/01/85	GarLee					151			98		0.001		
S20	08/01/85	GarLee					214			139		0.004		
S20	09/01/85	GarLee					211			137		0.002		
S20	10/01/85	GarLee					151			99		0.002		
S20	11/01/85	GarLee					113			13		0.001		
S20	12/01/85	GarLee					132			86		0.002		
S20	01/01/86	GarLee					211			137		0.003		
S20	02/01/86	GarLee					302			196		0.002		
S20	03/01/86	GarLee					187			115		0.003		
S20	04/01/86	GarLee					87			64		0.003		
S20	06/01/86	GarLee					92			92		0.002		
S20	07/01/86	GarLee					150			148		0.002		
S20	09/01/86	GarLee					185					0.001		
S20	05/01/87	GarLee					125			103		0.001		
S20	06/01/87	GarLee					99			105		0.001		
S20	09/01/87	GarLee					152			121				
S20	12/01/87	GarLee					92			86		0.001		
S20	04/01/88	GarLee					86			26		(0.0004		
S20	06/01/88	GarLee					138			109		0.004		
S20	09/01/88	GarLee					92			90		0.005		
S20	11/01/88	GarLee					104			T.U.		0.004		
S20	05/01/89	GarLee					65			42		0.005		
S20	07/01/89	GarLee					170			140		0.008		
S20	09/01/89	GarLee					233			152		0.008		
S20	11/01/89	GarLee										0.002		
S20	05/01/90	GarLee					93			62		(0.0002		
S20	07/01/90	GarLee					102			106		(0.0002		
S20	09/01/90	GarLee					100			105		(0.0006		

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Site	Date	Source	Zinc mg/L	Al mg/L	Mg mg/L	Ca mg/L	Cond. uS/cm	Hard. mg/L	S. Solid mg/L	D. Solid mg/L	Nitrate mg/L	Phenol mg/L	COD mg/L	Oil & Grease mg/L
S20	11/01/90	GarLee					82			72		(0.0006		
S20	05/01/91	GarLee					75			83		(0.0004		
S20	06/01/91	GarLee					151			127		0.001		
S20	09/01/91	GarLee					170			142		0.001		
S20	11/01/91	GarLee					89			80		0.001		
S20	05/01/92	GarLee					80			65		(0.0002		
S20	07/01/92	GarLee					177			178		0.001		
S20	09/01/92	GarLee					69			91		(0.0002		
S20	11/01/92	GarLee					76			78		(0.0002		
S20	07/01/93	CNB					129							
S50	05/01/85	GarLee					828			424		0.021		
S50	06/01/85	GarLee					272			177		0.013		
S50	07/01/85	GarLee					247			161		0.015		
S50	08/01/85	GarLee					343			223		0.009		
S50	09/01/85	GarLee					329			214		0.009		
S50	10/01/85	GarLee					233			151		0.012		
S50	11/01/85	GarLee					181			118		0.012		
S50	12/01/85	GarLee					261			170		0.008		
S50	01/01/86	GarLee					260			169		0.019		
S50	02/01/86	GarLee					351			228		0.009		
S50	03/01/86	GarLee					214			127		D1		
S50	04/01/86	GarLee					101			73		0.003		
S50	06/01/86	GarLee					122			104		0.003		
S50	07/01/86	GarLee					272			128		0.002		
S50	09/01/86	GarLee					270					0.002		
S50	05/01/87	GarLee					228			140		0.000		
S50	06/01/87	GarLee					144			125		0.001		
S50	09/01/87	GarLee					342			187		NR		
S50	12/01/87	GarLee					164			122		0.001		
S50	04/01/88	GarLee					151			88		(0.0008		
S50	06/01/88	GarLee					306			184		0.003		
S50	09/01/88	GarLee					191			124		0.005		
S50	11/01/88	GarLee					192			TU		0.004		
S50	05/01/89	GarLee					123			78		0.004		
S50	07/01/89	GarLee					384			225		0.011		
S50	09/01/89	GarLee					346			183		0.004		
S50	11/01/89	GarLee										0.002		
S50	05/01/90	GarLee					50			55		(0.0004		
S50	07/01/90	GarLee					203			170		(0.0002		
S50	09/01/90	GarLee					132			106		0.001		
S50	11/01/90	GarLee					132			91		(0.0002		
S50	05/01/91	GarLee					120			104		(0.0004		
S50	06/01/91	GarLee					243			137		(0.0004		
S50	09/01/91	GarLee					196			132		0.001		
S50	11/01/91	GarLee					72			69		(0.0006		
S50	05/01/92	GarLee					108			89		(0.0006		
S50	07/01/92	GarLee					196			148		(0.0006		
S50	09/01/92	GarLee					80			101		(0.0004		
S50	11/01/92	GarLee					94			85		0.002		
S50	07/01/93	CNB					194							
S60	04/01/88	GarLee					148			82		(0.00021		
S60	06/01/88	GarLee					298			186		0.003		
S60	09/01/88	GarLee					182			122		0.006		
S60	11/01/88	GarLee					213			T.U.		0.004		
S60	05/01/89	GarLee					127			74		0.002		

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Site	Date	Source	Zinc mg/L	Al mg/L	Mg mg/L	Ca mg/L	Cond. uS/cm	Hard. mg/L	S. Solid mg/L	D. Solid mg/L	Nitrate mg/L	Phenol mg/L	COD mg/L	Oil & Grease mg/L
S60	07/01/89	GarLee					116			94		0.009		
S60	09/01/89	GarLee					322			171		0.005		
S60	11/01/89	GarLee										0.003		
S60	05/01/90	GarLee					83			79		<0.0002		
S60	07/01/90	GarLee					191			132		<0.0002		
S60	09/01/90	GarLee					144					<0.0002		
S60	11/01/90	GarLee					6730					<0.0002		
S60	05/01/91	GarLee					130			100		<0.0004		
S60	06/01/91	GarLee					229			131		<0.0004		
S60	09/01/91	GarLee					187			130		<0.001		
S60	11/01/91	GarLee					90			82		<0.0006		
S60	05/01/92	GarLee					105			87		<0.0006		
S60	07/01/92	GarLee					181			140		<0.0008		
S60	09/01/92	GarLee					84			97		<0.0004		
S60	11/01/92	GarLee					92			78		<0.001		
S60	07/01/93	CNB					150							
S80	04/01/88	GarLee												
S80	06/01/88	GarLee					134			95		0.002		
S80	09/01/88	GarLee					101			79		0.006		
S80	11/01/88	GarLee					83			T.U.		0.005		
S80	05/01/89	GarLee					88			54		0.005		
S80	07/01/89	GarLee					387			223		0.013		
S80	09/01/89	GarLee					148			97		0.006		
S80	11/01/89	GarLee										0.002		
S80	05/01/90	GarLee					87			68		<0.0002		
S80	07/01/90	GarLee					110			93		<0.0002		
S80	09/01/90	GarLee					100			77		<0.0008		
S80	11/01/90	GarLee					102			72		<0.0006		
S80	05/01/91	GarLee					122			88		<0.0006		
S80	06/01/91	GarLee					136			94		<0.0006		
S80	09/01/91	GarLee					168			115		0.001		
S80	11/01/91	GarLee					100			83		<0.0006		
S80	05/01/92	GarLee					118			84		<0.0006		
S80	07/01/92	GarLee					155			124		<0.0006		
S80	09/01/92	GarLee					99			96		<0.0002		
S80	11/01/92	GarLee					90			79		<0.0002		
S70	04/01/88	GarLee												
S70	06/01/88	GarLee					229			137		0.002		
S70	09/01/88	GarLee					139			104		0.006		
S70	11/01/88	GarLee					112			T.U.		0.004		
S70	05/01/89	GarLee					105			64		0.003		
S70	07/01/89	GarLee					118			94		0.009		
S70	09/01/89	GarLee					200			123		0.007		
S70	11/01/89	GarLee										0.002		
S70	05/01/90	GarLee					83			76		<0.0002		
S70	07/01/90	GarLee					146			120		<0.0002		
S70	09/01/90	GarLee					116			91		0.001		
S70	11/01/90	GarLee					114			78		<0.0006		
S70	05/01/91	GarLee					127			95		<0.0004		
S70	06/01/91	GarLee					156			108		<0.0006		
S70	09/01/91	GarLee					171			116		0.001		
S70	11/01/91	GarLee					95			83		<0.0006		
S70	05/01/92	GarLee					111			86		<0.0006		
S70	07/01/92	GarLee					165			140		0.001		
S70	09/01/92	GarLee					92			99		<0.0002		

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Site	Date	Source	Zinc mg/L	Al mg/L	Mg mg/L	Ca mg/L	Cond. uS/cm	Hard. mg/L	S. Solid mg/L	D. Solid mg/L	Nitrate mg/L	Phenol mg/L	COD mg/L	Oil & Grease mg/L
S70	11/01/92	GarLee					90			80		(0.0004		
Golf club	03/17/85	MOEE	0.025	0.230			149		8			0.007		
Golf club	05/06/85	MOEE					88		69			0.004		
Golf club	05/29/85	MOEE	0.019	0.150			178		22			(0.0008		
Golf club	06/26/85	MOEE	0.034	0.322			162		(3			0.004		
Golf club	07/25/85	MOEE	0.016	0.120			172		(3			0.001		
Golf club	08/22/85	MOEE	0.012	0.056					(3			0.002		
Golf club	09/09/85	MOEE	0.025	0.110			196		(3			0.001		
Golf club	10/17/85	MOEE	0.032	0.240			151		(3			(0.0006		
Golf club	10/21/85	MOEE	0.022	0.130			165		3			0.001		
Golf club	10/31/85	MOEE	0.018	0.160			160		(3			0.001		
Golf club	12/06/85	MOEE	0.027	0.570			144		25			0.001		
Golf club	01/01/86	MOEE	0.009	0.190			171		19			(0.0002		
Golf club	05/01/86	MOEE	0.014	0.320			161		12			0.005		
Golf club	06/16/86	MOEE	0.014	0.400			141		27					
Golf club	07/21/86	MOEE					202	4	11			0.003	27	
Golf club	08/04/86	MOEE	0.013	0.210			153		8					
Golf club	09/03/86	MOEE	(0.001	0.088			191		3					
Golf club	10/02/86	MOEE	0.008	0.240			133		5			0.002		
Golf club	11/03/86	MOEE	0.012	0.280			116		13			(0.0004		
Golf club	01/03/87	MOEE	0.026	1.400			185		7			(0.0004		
Golf club	03/05/87	MOEE	0.009	0.041			220		(3			(0.0006		
Golf club	05/25/87	MOEE	0.009	0.170			143		4			(0.0008		
Golf club	07/19/87	MOEE	0.008	0.110			209		4			(0.0006		
Golf club	08/10/87	MOEE	0.030	0.088			225		(3			(0.0004		
Golf club	09/28/87	MOEE	0.006	0.097			222		(3			(0.0004		
Golf club	10/15/87	MOEE	0.009	0.100			179		(3			0.001		
Golf club	10/25/87	MOEE	0.005	0.098			191		4					
Golf club	11/02/87	MOEE	0.015	0.290			122		9			(0.0002		
Golf club	01/02/88	MOEE	0.011	0.150			177		(3					
Golf club	04/28/88	MOEE	0.010	0.330			153		15			0.001		
Golf club	05/31/88	MOEE					199		5			0.004		
Golf club	06/13/88	MOEE	(0.004	0.059			229		2			0.005		
Golf club	07/25/88	MOEE	0.006	0.080			241		9			(0.0002		
Golf club	08/17/88	MOEE	0.010	0.150			205		2					
Golf club	10/03/88	MOEE	0.011	0.530			102		30					
Golf club	10/31/88	MOEE	0.012	0.160			142		2			0.005		
Golf club	07/12/89	MOEE	(0.004	0.110			232		2			0.007		
Golf club	08/08/89	MOEE	(0.003	0.051			215					0.002		
Golf club	09/04/89	MOEE	(0.003	(0.044			226		(3			0.003		
Golf club	09/28/89	MOEE	(0.005	0.068			222		(3			0.003		
Golf club	10/23/89	MOEE	0.011	0.110			180		(3					
Golf club	10/31/89	MOEE	0.006	0.078			198		3					
Golf club	11/07/89	MOEE	0.011									0.002		
Golf club	11/13/89	MOEE	0.012	0.190			145		3					
Golf club	12/05/89	MOEE	0.006	0.270			169		15			0.003		
Golf club	01/02/90	MOEE	(0.024	0.068			205		3			0.002		
Golf club	03/18/90	MOEE	0.010	0.330			118		30			0.002		
Golf club	04/23/90	MOEE	0.011	0.240			115		10			(0.0004		
Golf club	05/21/91	MOEE	0.008	0.470			146		50			(0.0002		
Golf club	06/11/91	MOEE	0.008	0.084			165		(3.0			(0.0004		
Golf club	07/09/91	MOEE	(0.0042	0.120			186		6			(0.0004		
Golf club	08/06/91	MOEE	0.005	0.140					7			(0.0006		
Golf club	09/15/91	MOEE	0.011	0.530			186		30			(0.0004		
Golf club	10/29/91	MOEE	0.015	0.520			91		55			(0.0006		

Chippewa Creek Water Qualit
Compiled: 94/08/23 by Near

Site	Date	Source	Zinc	Al	Mg	Ca	Cond.	Hard.	S. Solid	D. Solid	Nitrate	Phenol	COD	Oil & Grease
			mg/L	mg/L	mg/L	mg/L	uS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Golf club	11/11/91	MOEE	0.013	0.370			112		10			0.001		
Golf club	08/11/93	MOEE	0.015	0.180			163	40	7			(0.0002		
Golf club	12/19/93	MOEE	0.009	0.180			136	34	7					
Mouth	03/17/85	MOEE	0.033	0.200			373		5			0.002		
Mouth	05/06/85	MOEE					218		69			0.003		
Mouth	05/29/85	MOEE	0.034	0.170			401		27			0.001		
Mouth	06/26/85	MOEE	0.197	0.260			352		8			0.003		
Mouth	07/25/85	MOEE	0.035	0.150			398		10					
Mouth	08/22/85	MOEE	0.046				344							
Mouth	09/09/85	MOEE	0.035	0.050			869		(1.56			0.001		
Mouth	10/17/85	MOEE	0.026	0.180			398		(1.07			(0.006		
Mouth	10/21/85	MOEE	0.028	0.120			429		4			0.001		
Mouth	10/31/85	MOEE					384		5			0.001		
Mouth	12/06/85	MOEE	0.046	1.100			413		50			0.001		
Mouth	01/01/86	MOEE	0.015	0.130			318		5			(0.0002		
Mouth	05/01/86	MOEE	0.022	0.330			320		10			0.005		
Mouth	06/16/86	MOEE					318		7			0.002		
Mouth	08/04/86	MOEE	0.017	0.210			283		8					
Mouth	09/03/86	MOEE	0.014	0.097			336		4					
Mouth	10/02/86	MOEE					244		(2.0			0.001		
Mouth	11/03/86	MOEE	0.017	0.290			239		13			(0.0004		
Mouth	01/03/87	MOEE	0.052	0.150			414		7			0.000		
Mouth	03/05/87	MOEE	0.024	0.380			566		35			0.002		
Mouth	05/25/87	MOEE	0.022	0.140			314		6			(0.0008		
Mouth	07/19/87	MOEE	0.016	0.110			670		4			(0.0008		
Mouth	08/10/87	MOEE	0.026	0.083			431		3			(0.0002		
Mouth	09/28/87	MOEE	0.013	0.083			371		3			(0.0006		
Mouth	10/15/87	MOEE	0.018	0.110			309		4			0.001		
Mouth	10/25/87	MOEE	0.005	0.120			312		7			(0.0004		
Mouth	11/02/87	MOEE	0.015	0.350			217		12			(0.0004		
Mouth	01/02/88	MOEE	0.014	0.120			348		3					
Mouth	04/28/88	MOEE	0.019	0.370			440		15			0.002		
Mouth	05/31/88	MOEE	0.037	0.120			372		7			0.005		
Mouth	06/13/88	MOEE	0.010	0.094			309		7			0.006		
Mouth	07/25/88	MOEE	0.012	0.150			307		7			0.004		
Mouth	08/17/88	MOEE	0.010	0.072			190		3			0.002		
Mouth	10/03/88	MOEE	0.011	0.420			196		20					
Mouth	10/31/88	MOEE	0.013	0.160			264		1			0.006		
Mouth	07/12/89	MOEE	(0.004	0.043			125		2			0.003		
Mouth	08/08/89	MOEE	0.008	0.099			138		8			0.003		
Mouth	09/04/89	MOEE	(0.0014	0.038			126		1			0.002		
Mouth	09/28/89	MOEE	(0.004	0.098			357		20			0.008		
Mouth	10/23/89	MOEE	0.019	0.310			374		35					
Mouth	10/31/89	MOEE	0.008	0.100			345		2					
Mouth	11/13/89	MOEE	(0.049	(0.17			251		4			0.003		
Mouth	12/05/89	MOEE	0.013	0.210			398		6			0.003		
Mouth	01/02/90	MOEE	0.008	0.079			424		2			0.004		
Mouth	03/19/90	MOEE	(0.0026	0.620			281		60			0.002		
Mouth	04/23/90	MOEE					262		15					
Mouth	05/21/91	MOEE	0.013	0.130			350		5			(0.0004		

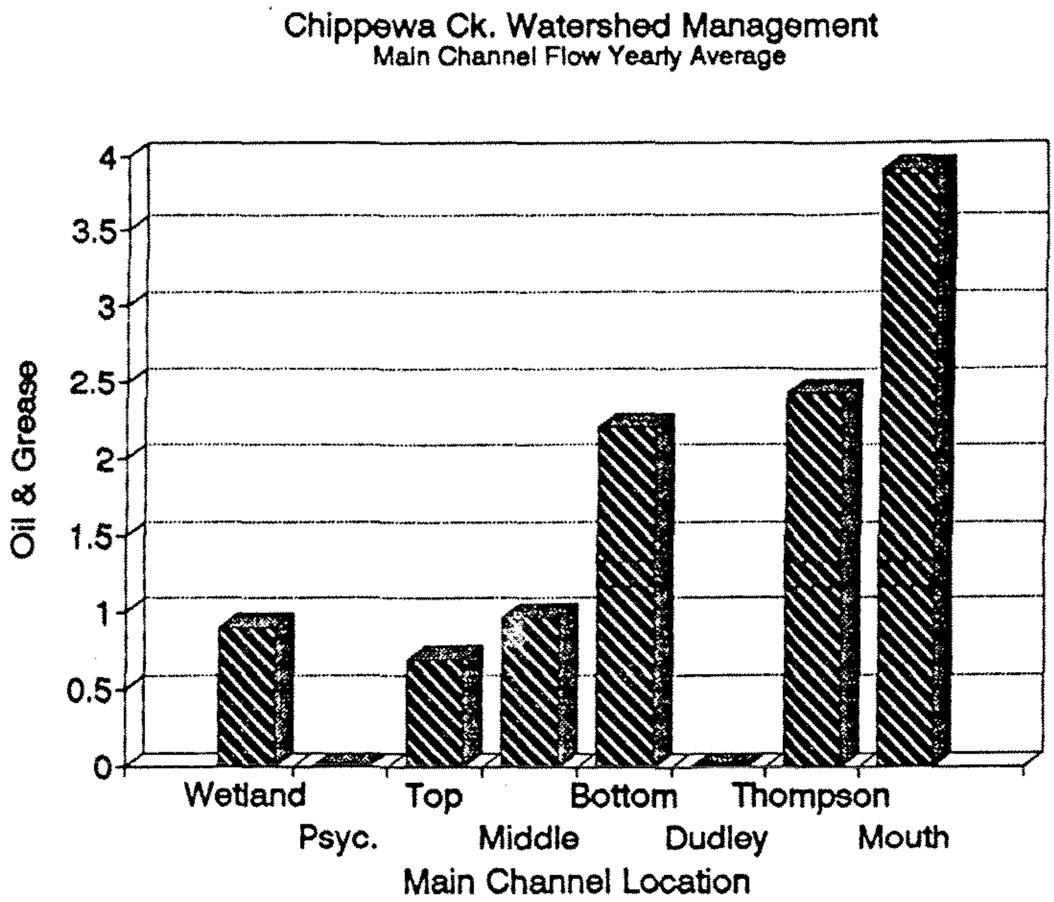
Chippewa Creek Water Qualit
Compiled: 94/08/23 by Near

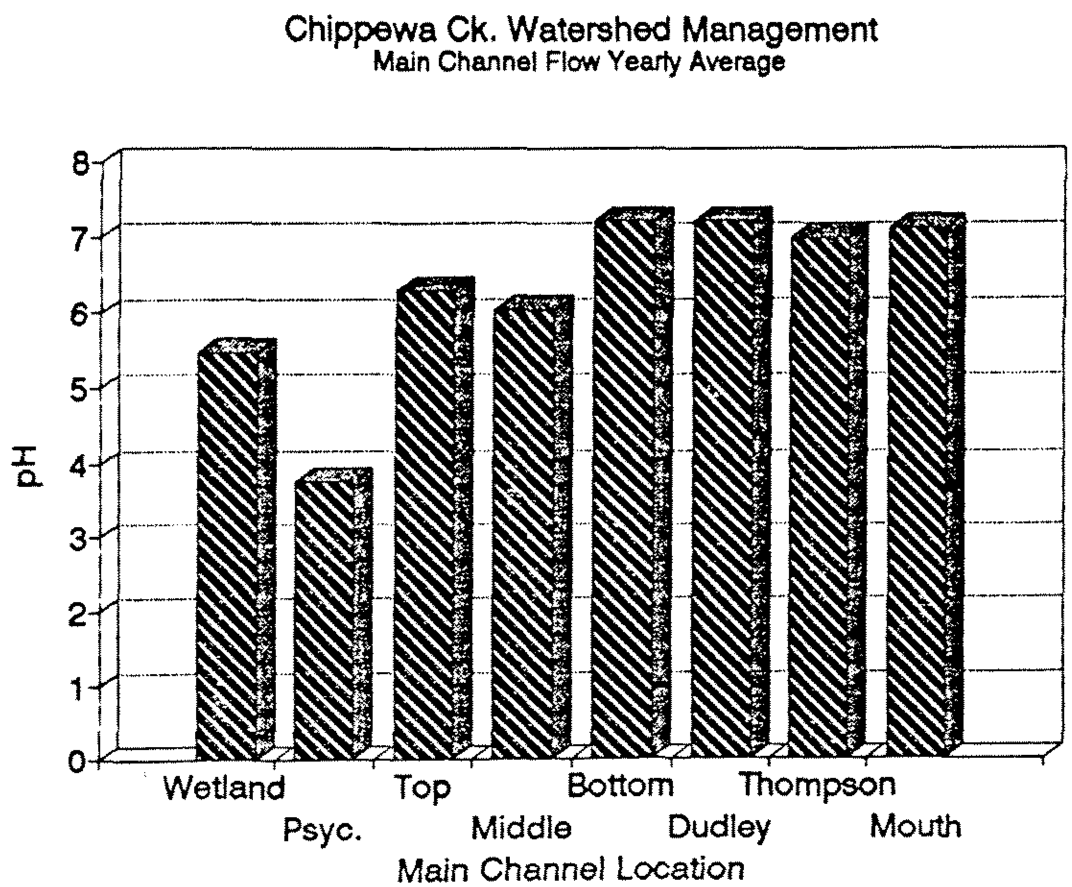
Site	Date	Source	Zinc mg/L	Al mg/L	Mg mg/L	Ca mg/L	Cond. uS/cm	Hard. mg/L	S. Solid mg/L	D. Solid mg/L	Nitrate mg/L	Phenol mg/L	COD mg/L	Oil & Grease mg/L
Mouth	06/11/91	MOEE	0.019	0.210			343		9			<0.0002		
Mouth	07/09/91	MOEE	0.009	0.099			247		<4					
Mouth	08/06/91	MOEE	0.010	0.110					<4			<0.0006		
Mouth	09/15/91	MOEE	0.024	0.810			268		35			0.001		
Mouth	10/29/91	MOEE	0.019	0.540			240		20			<0.008		
Mouth	11/11/91	MOEE	0.019	0.310			269		<4					
Mouth	08/11/93	MOEE	0.016	0.160			422	72	10					
Mouth	12/19/93	MOEE	0.044	0.410			1710	71	30					
Mouth	05/05/94	NNL	0.018		2.550	6.560	211	27	8					
Mouth	05/31/94	NNL	0.019		2.600	11.200	222	39	11		0.73			
Mouth	06/14/94	NNL	0.045		1.700	11.400	175	35	123					12
Mouth	06/28/94	NNL	0.020		2.500	12.700	216	42	8					
Mouth	07/12/94	NNL	0.033		2.440	11.500	260	39	20					<1
Mouth	07/27/94	NNL	0.045		3.090	10.800	352	40	5					
Mouth	08/10/94	NNL						0						
Laurier	05/05/94	NNL	0.021		5.480	18.100	795	68	7					
Laurier	05/31/94	NNL	0.031		2.600	27.200	1070	79	69		0.09		52	
Laurier	06/14/94	NNL	0.021		5.980	34.400	1248	111	13					6
Laurier	06/28/94	NNL	0.019		6.200	37.400	1269	119	15					
Laurier	07/12/94	NNL	0.017		6.222	41.200	1342	128	14					<1
Laurier	07/27/94	NNL	0.027		7.140	38.000	2320	124	31					
Laurier	08/10/94	NNL						0						
Thompson	05/05/94	NNL	0.014		2.090	4.060	154	19	8					
Thompson	05/31/94	NNL	0.062		2.880	9.800	150	36	151		0.78		20	
Thompson	06/14/94	NNL	0.042		2.200	9.100	131	32	108					7
Thompson	06/28/94	NNL	0.042		1.900	9.300	134	31	29					
Thompson	07/12/94	NNL	0.024		1.680	8.850	213	29	10					<1
Thompson	07/27/94	NNL	0.043		2.940	9.300	268	35	12					
Thompson	08/10/94	NNL						0						
Johnston	05/05/94	NNL	0.038		3.960	13.300	529	50	4					
Johnston	05/31/94	NNL	0.161		3.740	15.200	340	53	129		0.91		162	
Johnston	06/14/94	NNL	0.040		3.440	15.600	308	53	12					7
Johnston	06/28/94	NNL	0.030		3.200	16.300	321	54	4					
Johnston	07/12/94	NNL	0.018		3.060	15.200	370	51	4					<1
Johnston	07/27/94	NNL	0.030		3.340	12.200	437	44	4					
Johnston	08/10/94	NNL						0						
Dudley	05/05/94	NNL	0.019		1.890	8.400	136	29	11					
Dudley	05/31/94	NNL	0.102		3.800	10.300	156	41	268		0.68		163	
Dudley	06/14/94	NNL	0.030		2.100	9.200	127	32	90					
Dudley	06/28/94	NNL	0.017		1.900	8.900	119	30	9					
Dudley	07/12/94	NNL	0.025		1.430	7.870	364	26	15					<1
Dudley	07/27/94	NNL	0.047		2.730	8.200	220	32	5					
Dudley	08/10/94	NNL						0						
Bottom Es	05/05/94	NNL	0.020		1.580	6.980	102	24	13					
Bottom Es	05/31/94	NNL	0.033		1.530	7.900	120	26	67		0.76			
Bottom Es	06/14/94	NNL	0.040		1.700	8.200	105	27	85					7
Bottom Es	06/28/94	NNL	0.012		1.500	7.600	89	25	13					
Bottom Es	07/12/94	NNL	0.019		1.290	6.830	73	22	13					<1
Bottom Es	07/27/94	NNL	0.260		2.270	9.030	158	32	5					
Bottom Es	08/10/94	NNL						0						
Mid Escp	05/17/94	NNL	0.045		0.830	4.100	53	14	60					
Mid Escp	05/31/94	NNL	0.024		1.050	6.100	76	20	29		0.32			
Mid Escp	06/14/94	NNL	0.030		1.700	6.700	78	24	84					3
Mid Escp	06/28/94	NNL						0						

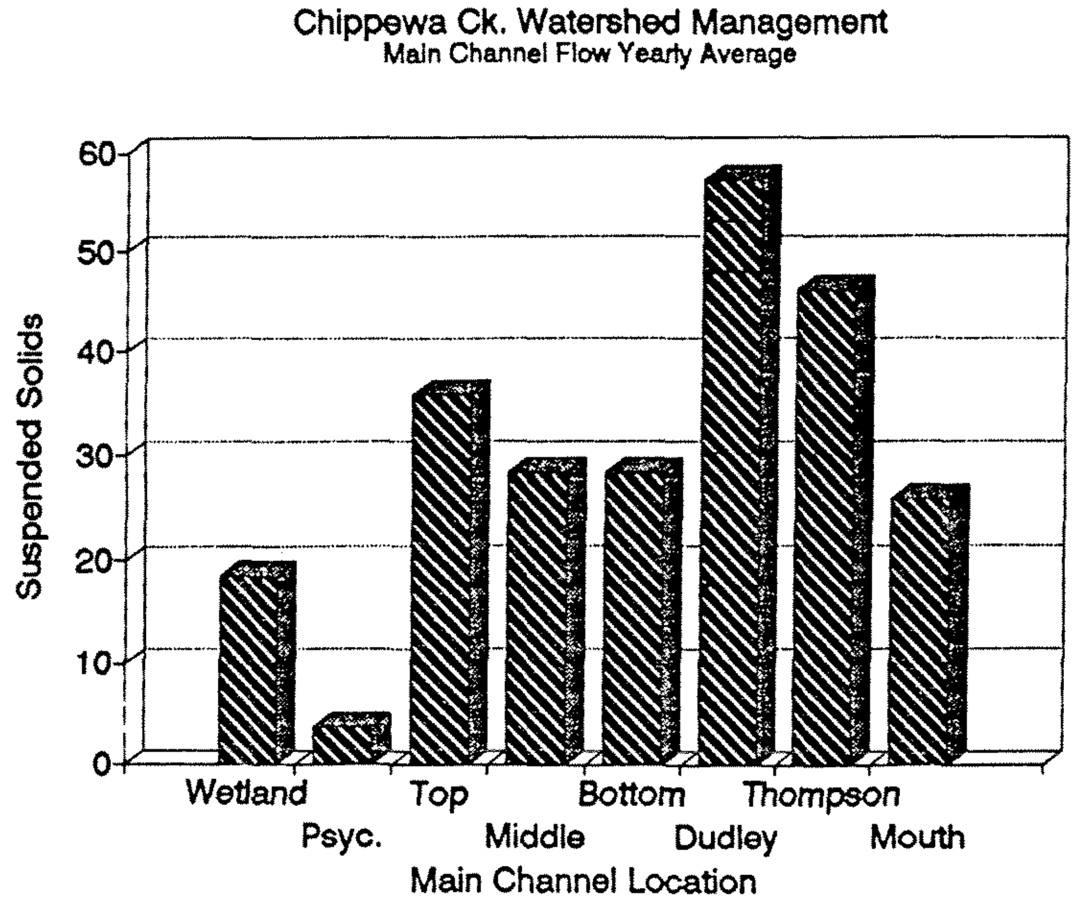
Chippewa Creek Water Qualit
Compiled: 94/08/23 by Near

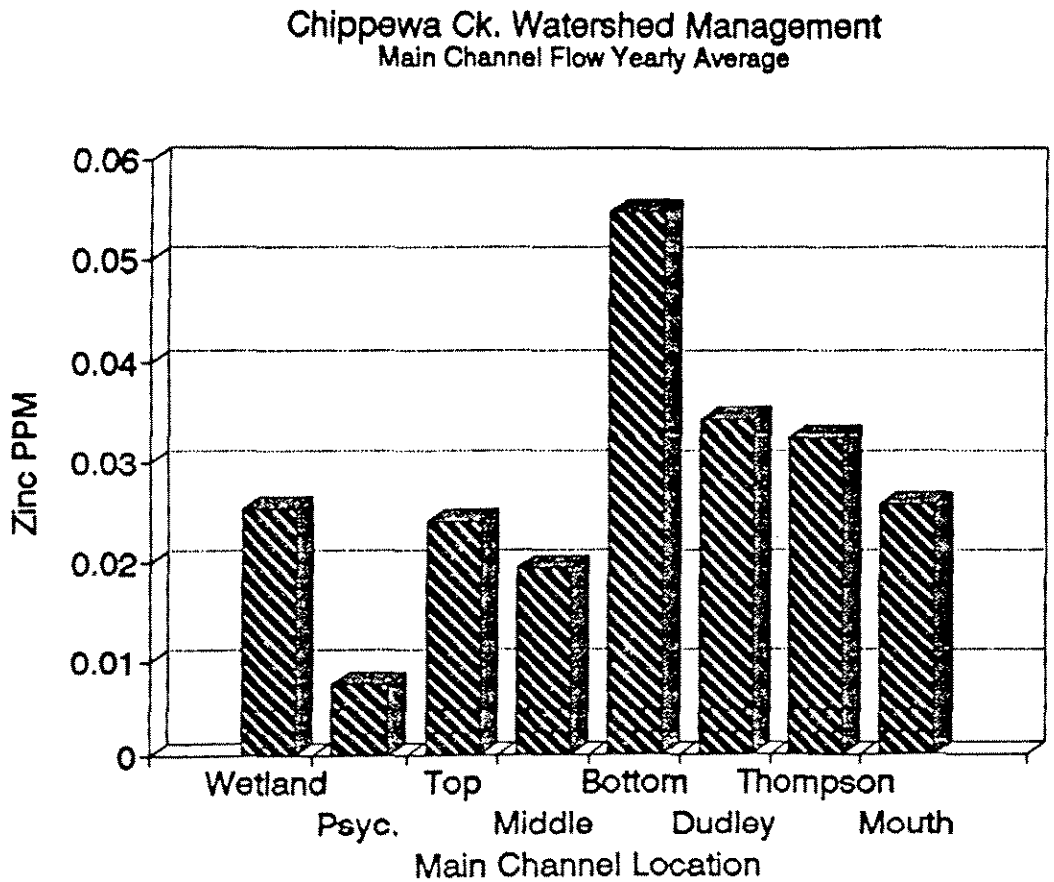
Site	Date	Source	Zinc	Al	Mg	Ca	Cond.	Hard.	S. Solid	D. Solid	Nitrate	Phenol	COD	Oil & Grease
			mg/L	mg/L	mg/L	mg/L	uS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Mid Escp	07/12/94	NNL	0.015		1.230	4.770	61	17	15					<1
Mid Escp	07/27/94	NNL	0.022		1.940	6.650	104	25	5					
Mid Escp	08/10/94	NNL						0						
Golf Trib	05/17/94	NNL	0.033		2.200	13.800	215	44	3					
Golf Trib	05/31/94	NNL	0.048		3.600	16.000	242	55	44		3.01			
Golf Trib	06/14/94	NNL	0.109		3.400	18.500	258	60	6					<1
Golf Trib	06/28/94	NNL	0.022		2.900	16.500	187	53	2					
Golf Trib	07/12/94	NNL	0.029		2.800	14.700	217	48	2					<1
Golf Trib	07/27/94	NNL	0.032		3.200	11.600	273	42	4					
Golf Trib	08/10/94	NNL						0						
Top Escp	05/17/94	NNL	0.052		0.900	0.606	66	5	7					
Top Escp	05/31/94	NNL	0.024		1.210	5.300	148	18	85					
Top Escp	06/14/94	NNL	0.031		1.200	5.600	111	19	10					1
Top Escp	06/28/94	NNL	0.027		1.000	4.700	75	16	9					
Top Escp	07/12/94	NNL	0.014		0.840	3.840	86	13	4					<1
Top Escp	07/27/94	NNL	0.021		1.490	5.340	129	19	5					
Top Escp	08/10/94	NNL						0						
L.F. Trib	05/17/94	NNL	0.031		0.910	5.400	42	17	72					
L.F. Trib	05/31/94	NNL	0.044		3.800	10.200	63	41	597					
L.F. Trib	06/14/94	NNL	0.047		2.100	7.700	54	28	164					2
L.F. Trib	06/28/94	NNL	0.032		1.700	7.500	57	26	19					
L.F. Trib	07/12/94	NNL	0.020		1.440	5.950	76	21	9					<1
L.F. Trib	07/27/94	NNL	0.022		2.520	8.660	106	32	16					
L.F. Trib	08/10/94	NNL						0						
Pre L.F.	05/31/94	NNL	0.049		4.600	12.300	65	50	912		0.54			
Pre L.F.	06/14/94	NNL	0.028		1.700	7.500	50	26	156					6
Pre L.F.	06/28/94	NNL	0.029		1.700	7.800	52	26	55					
Pre L.F.	07/12/94	NNL	0.026		1.490	5.300	64	19	24					<1
Pre L.F.	07/27/94	NNL	0.027		2.310	7.870	87	29	28					
Pre L.F.	08/10/94	NNL						0						
Wetland	05/31/94	NNL	0.022		1.070	4.300	120	15	9		0.05			
Wetland	06/14/94	NNL	0.027		1.000	3.800		14						3
Wetland	06/28/94	NNL	0.045		0.970	5.400	121	17	9					
Wetland	07/12/94	NNL	0.019		0.850	4.190	98	14	59					<1
Wetland	07/27/94	NNL	0.039		1.600	6.360	190	22	9					
Wetland	08/10/94	NNL						0						
Psyc Trib	05/05/94	NNL						0						
Psyc Trib	05/31/94	NNL						0						
Psyc Trib	06/14/94	NNL						0						
Psyc Trib	06/28/94	NNL	0.020		0.790	3.700	33	12	5					
Psyc Trib	07/12/94	NNL	0.014		1.030	3.070	40	12	18					<1
Psyc Trib	07/27/94	NNL	0.020		1.450	4.470	76	17	3					
Psyc Trib	08/10/94	NNL												

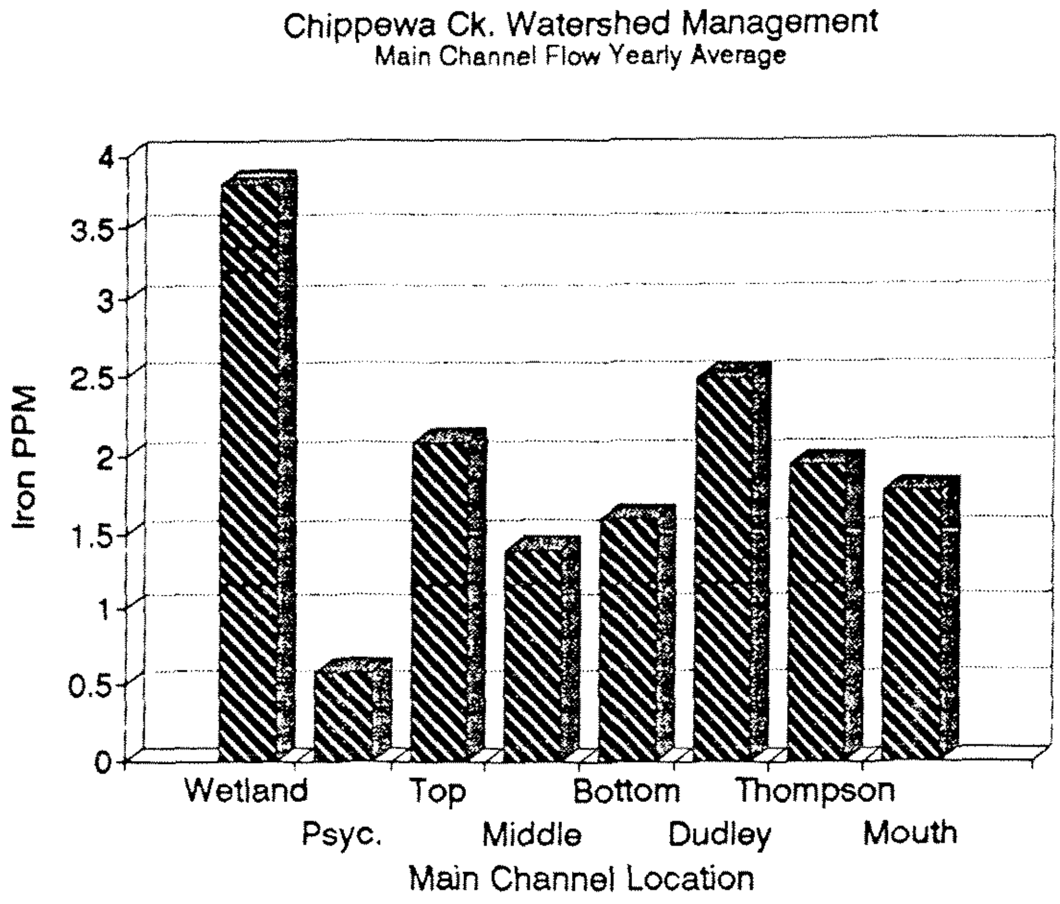
Appendix E-3
Graphic Summary of 1994 Data by
Individual Parameter

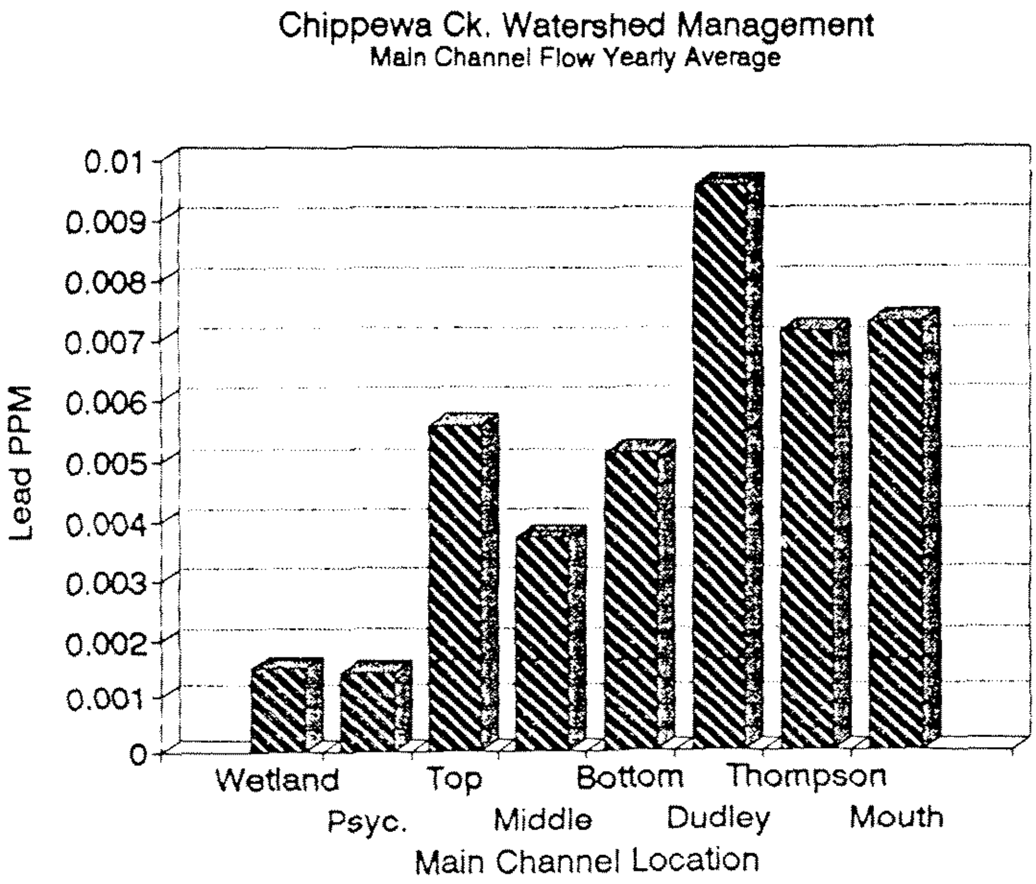

Chippewa Ck. Watershed Management
Main Channel Flow Yearly Average
Oil & Grease
0
0.5
1
1.5
2
2.5
3
3.5
4
Wetland
Psyc.
Top
Middle
Bottom
Dudley
Thompson
Mouth
Main Channel Location

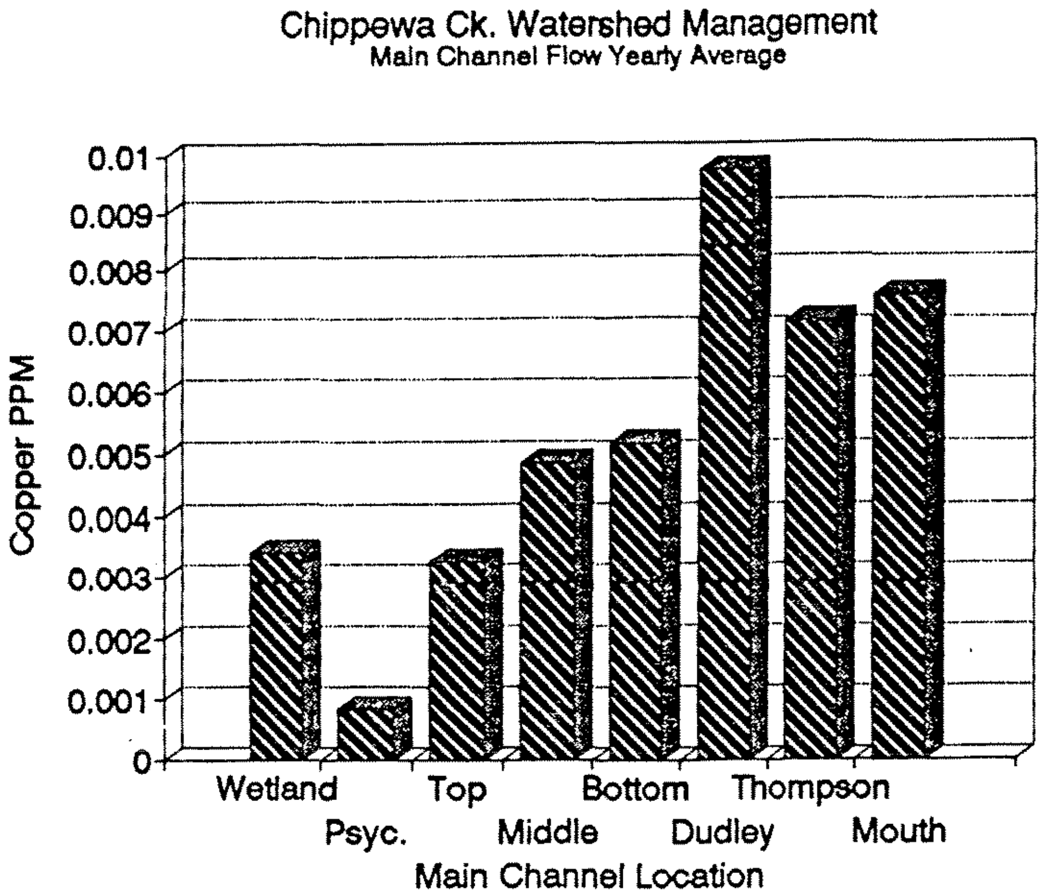

Chippewa Ck. Watershed Management
Main Channel Flow Yearly Average
pH
0
1
2
3
4
5
6
7
8
Wetland
Psyc.
Top
Middle
Bottom
Dudley
Thompson
Mouth
Main Channel Location

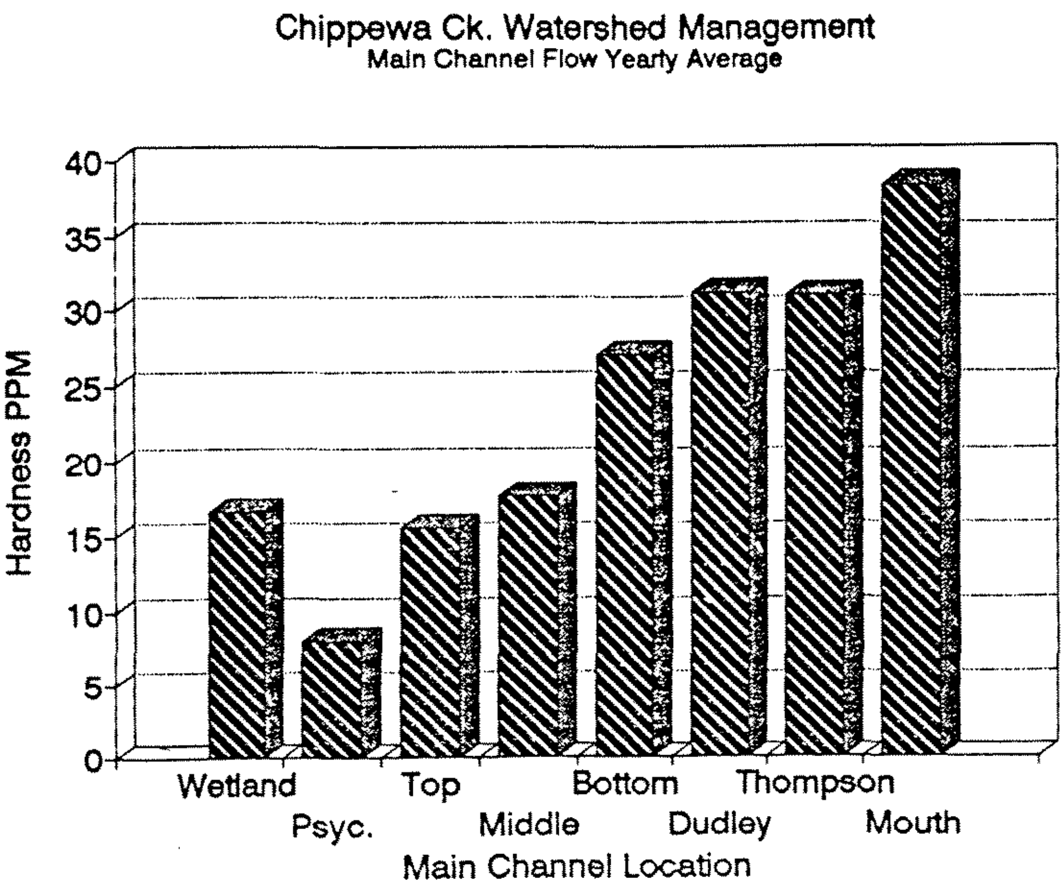

Chippewa Ck. Watershed Management
Main Channel Flow Yearly Average
Suspended Solids
0
10
20
30
40
50
60
Wetland
Psyc.
Top
Middle
Bottom
Dudley
Thompson
Mouth
Main Channel Location

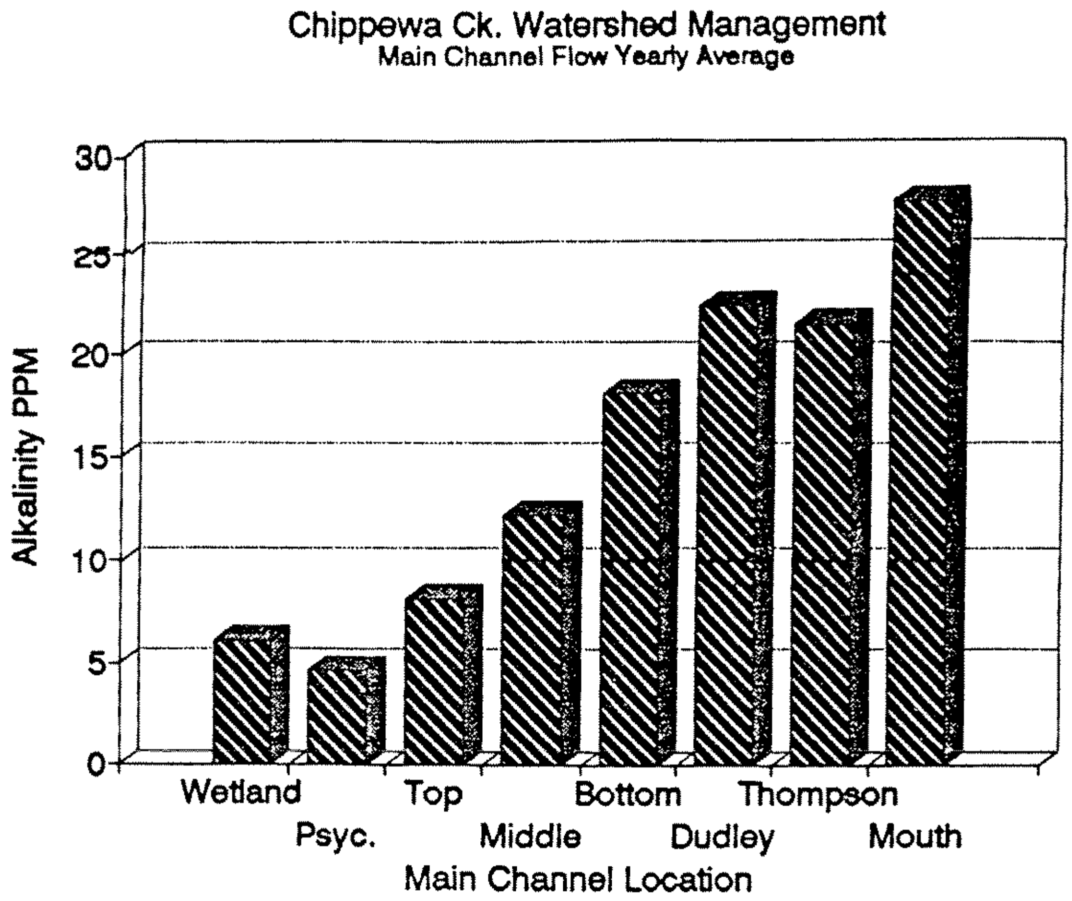

Chippewa Ck. Watershed Management
Main Channel Flow Yearly Average
Zinc PPM
0
0.01
0.02
0.03
0.04
0.05
0.06
Wetland
Psyc.
Top
Middle
Bottom
Dudley
Thompson
Mouth
Main Channel Location

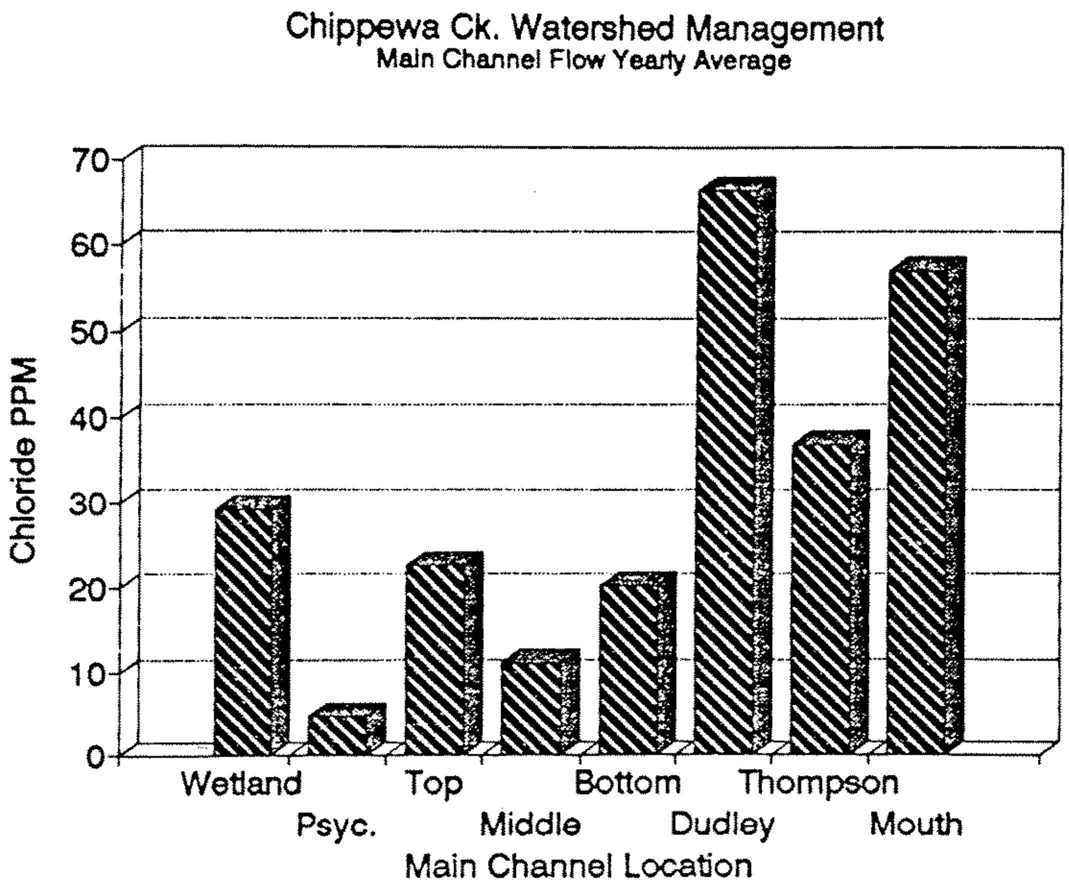

Chippewa Ck. Watershed Management
Main Channel Flow Yearly Average
Iron PPM
4
3.5
3
2.5
2
1.5
1
0.5
0
Wetland
Psyc.
Top
Middle
Bottom
Dudley
Thompson
Mouth
Main Channel Location


Chippewa Ck. Watershed Management
Main Channel Flow Yearly Average
Lead PPM
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Wetland
Psyc.
Top
Middle
Bottom
Dudley
Thompson
Mouth
Main Channel Location

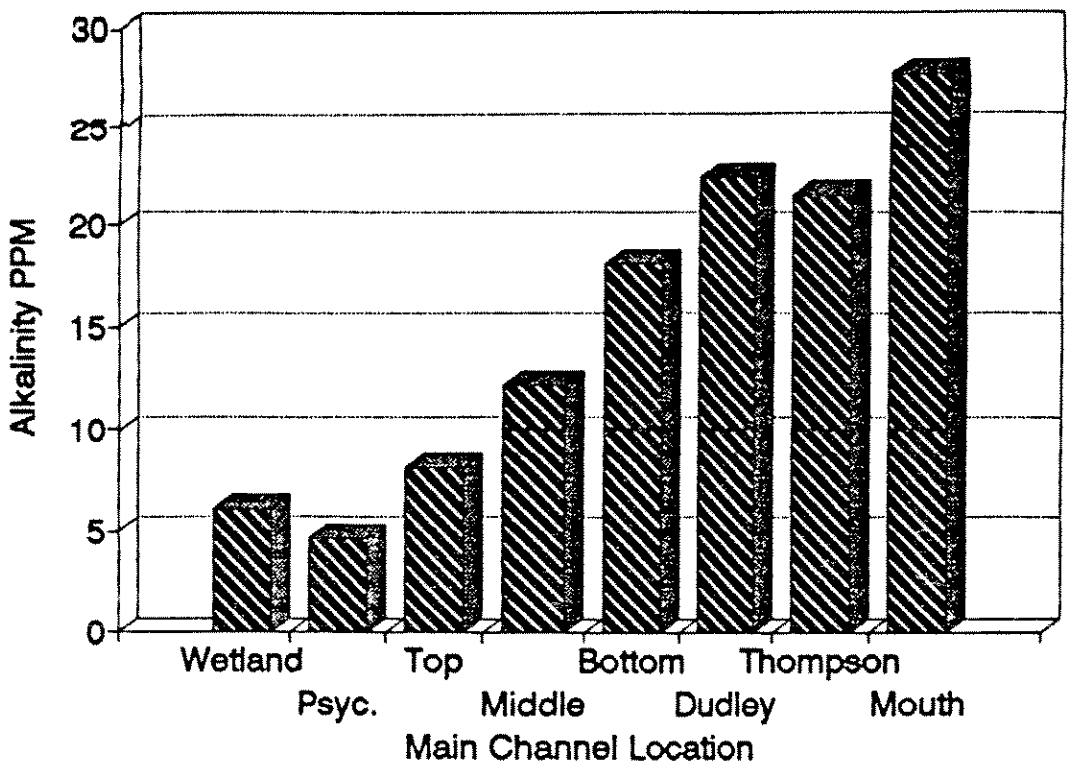

Chippewa Ck. Watershed Management
Main Channel Flow Yearly Average
Copper PPM
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Wetland
Psyc.
Top
Middle
Bottom
Dudley
Thompson
Mouth
Main Channel Location


Chippewa Ck. Watershed Management
Main Channel Flow Yearly Average
Hardness PPM
40
35
30
25
20
15
10
5
0
Wetland
Psyc.
Top
Middle
Bottom
Dudley
Thompson
Mouth
Main Channel Location

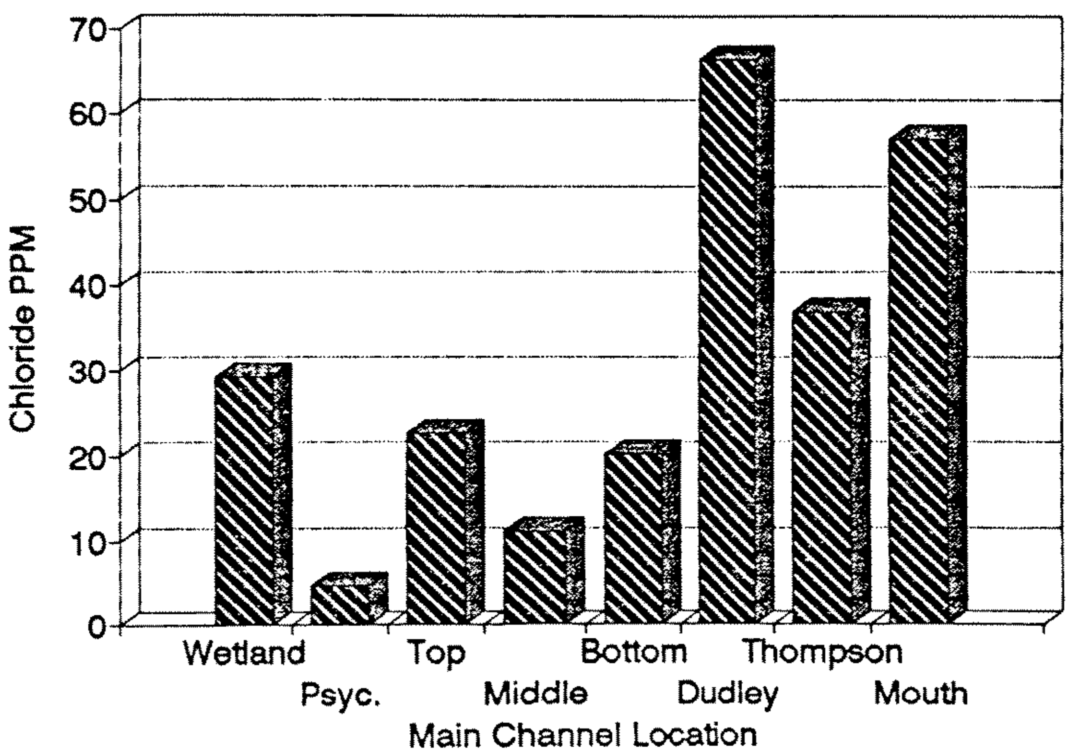

Chippewa Ck. Watershed Management
Main Channel Flow Yearly Average
30
25
20
15
10
5
0
Alkalinity PPM
Wetland
Psyc.
Top
Middle
Bottom
Dudley
Thompson
Mouth
Main Channel Location


Chippewa Ck. Watershed Management
Main Channel Flow Yearly Average
70
60
50
40
30
20
10
0
Chloride PPM
Wetland
Psyc.
Top
Middle
Bottom
Dudley
Thompson
Mouth
Main Channel Location

Chippewa Ck. Watershed Management
Main Channel Flow Yearly Average

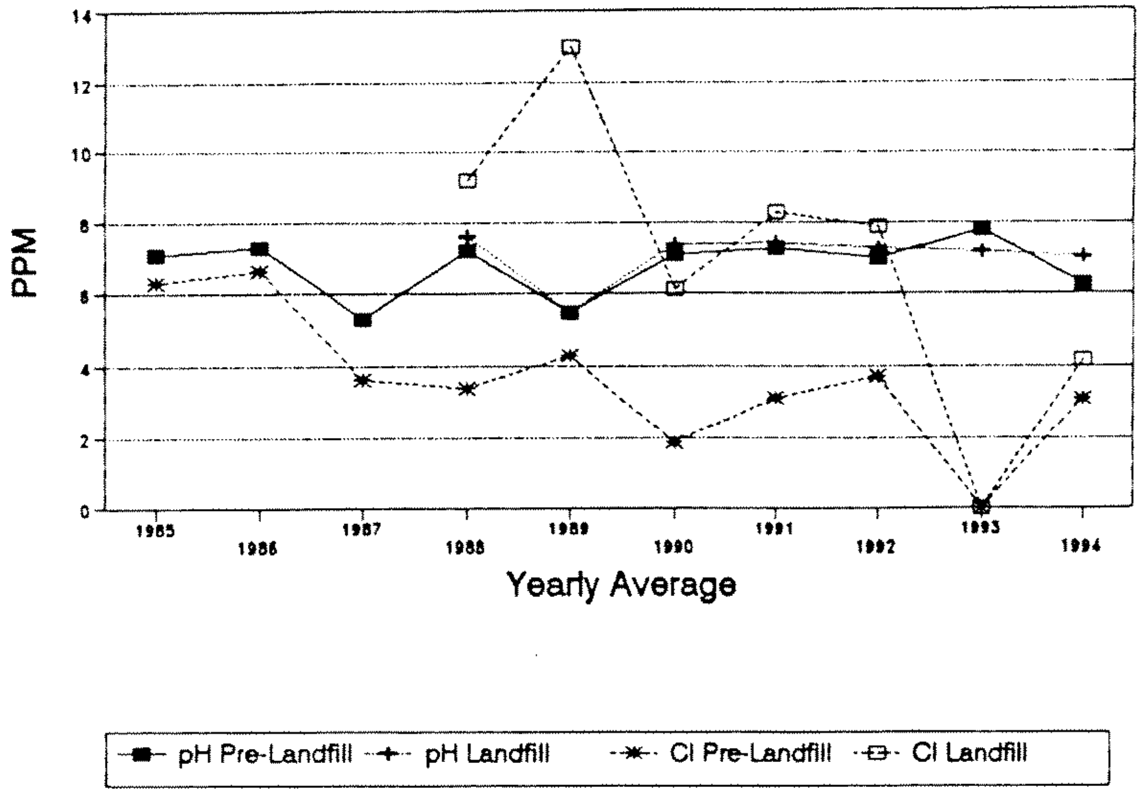


Chippewa Ck. Watershed Management
Main Channel Flow Yearly Average

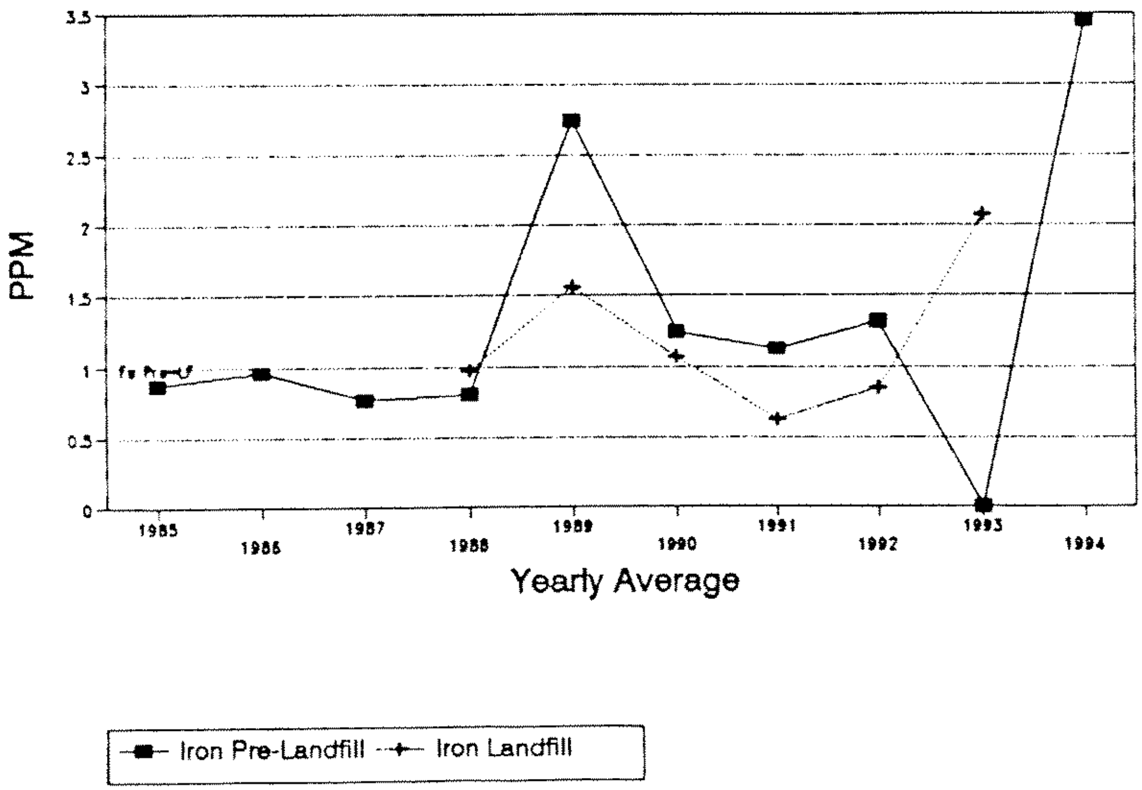


Appendix E-4
Historical Dry Flow Graphs

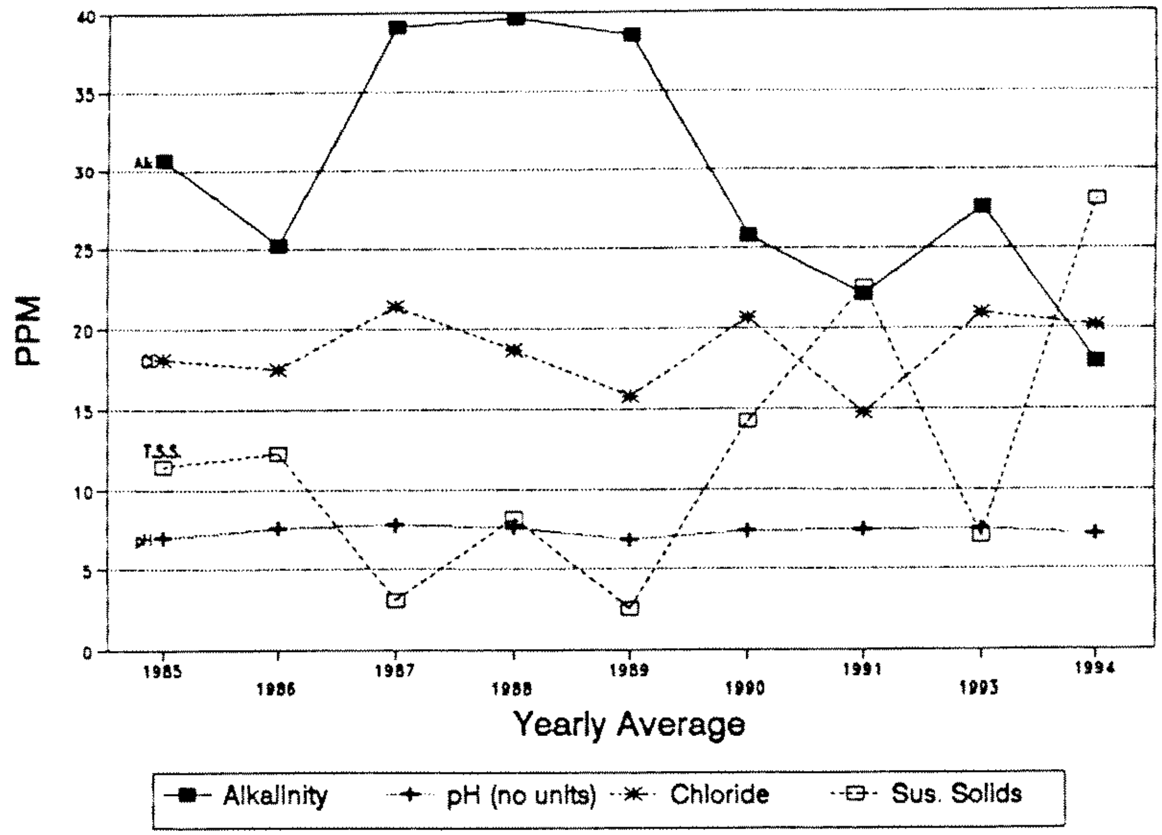
Chippewa Creek
Landfill Contribution 1985-1994



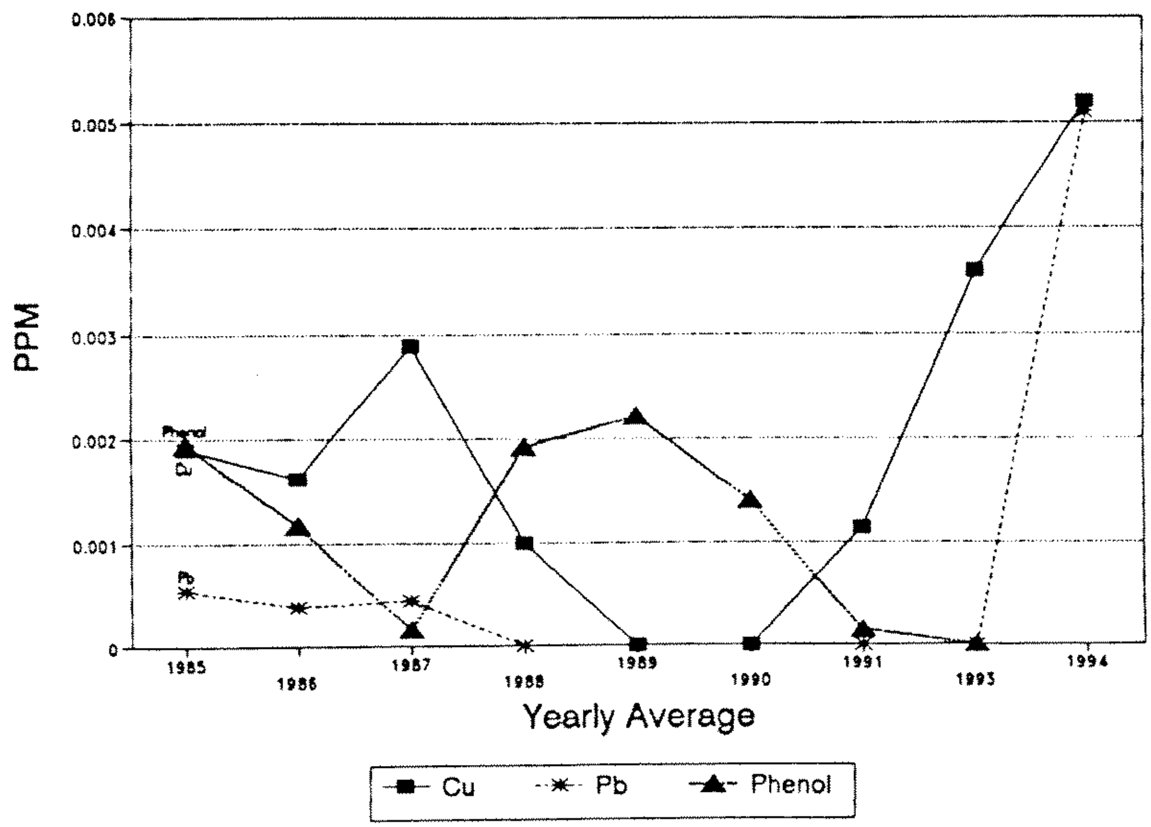
Chippewa Creek
Landfill Contribution 1985-1994

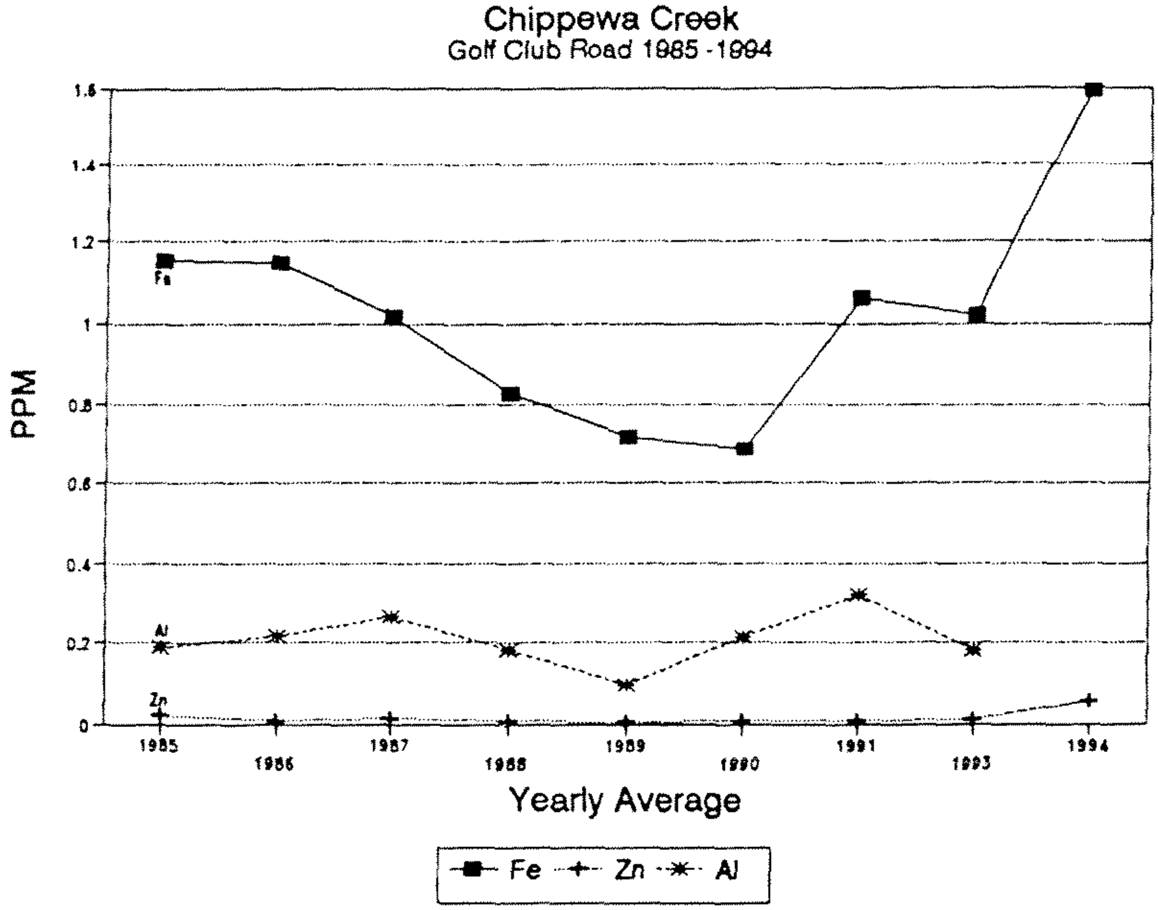


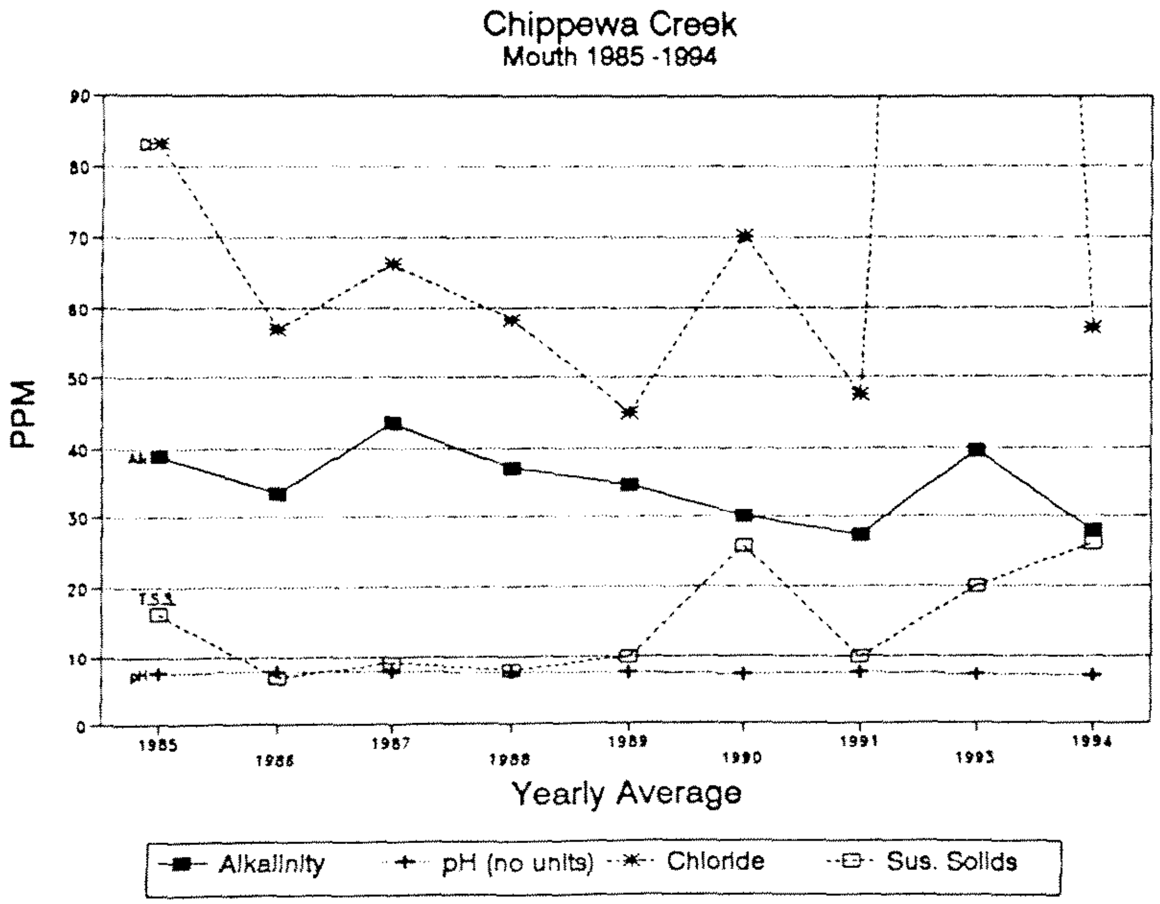
Chippewa Creek
Golf Club Road 1985 -1994

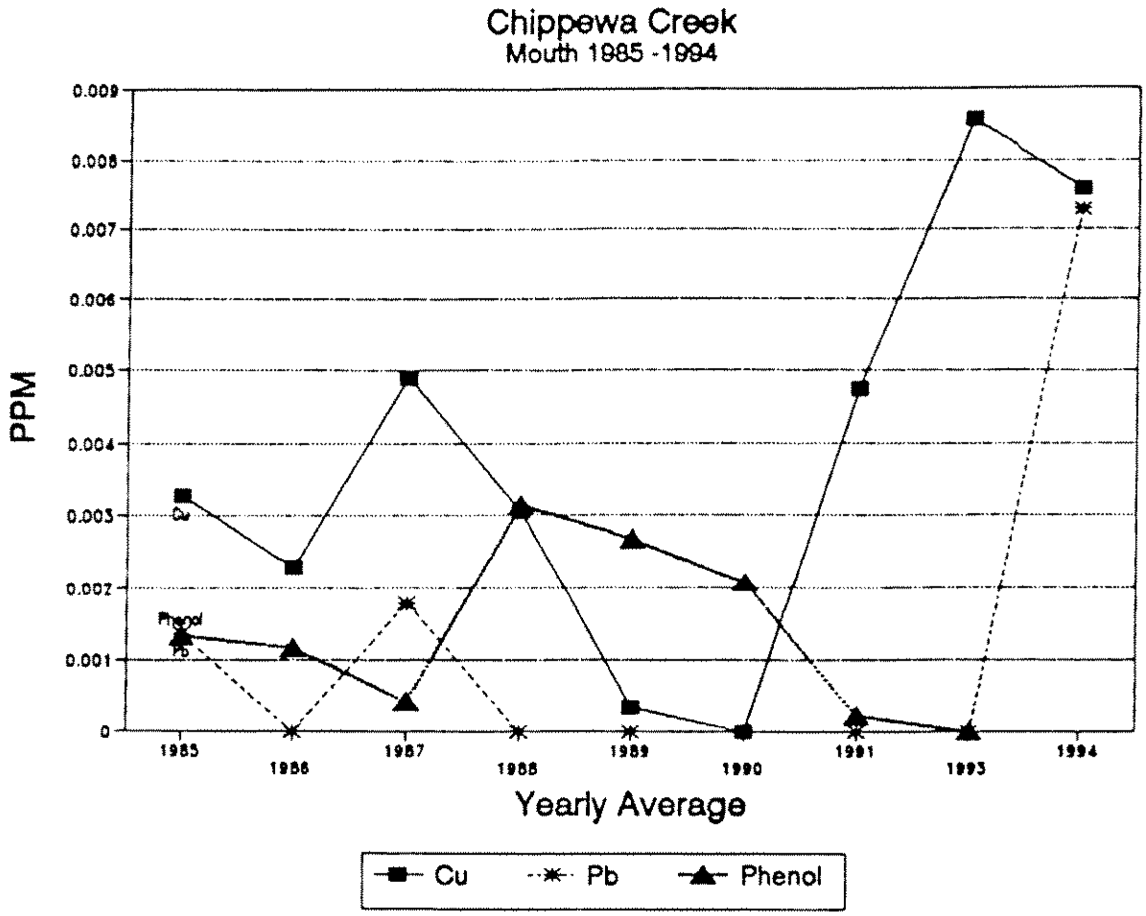


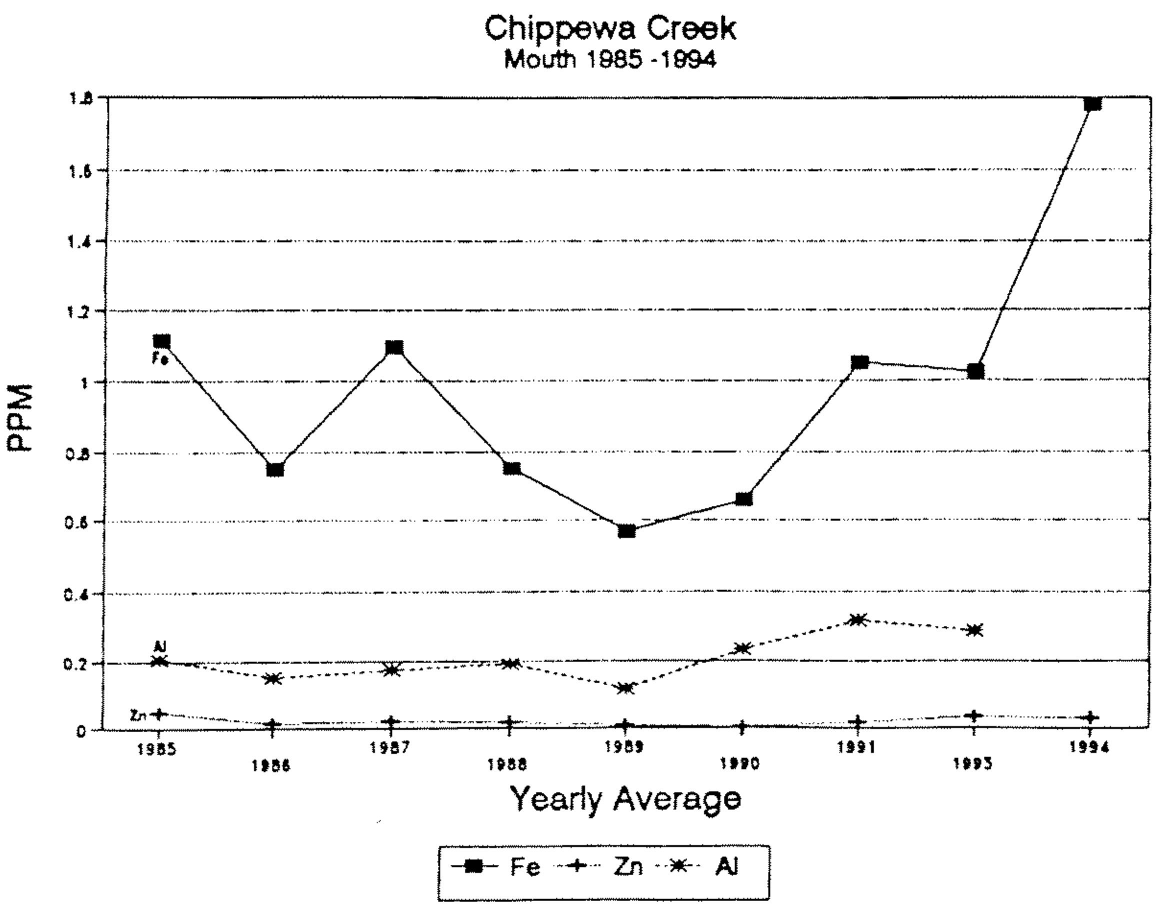
Chippewa Creek
Golf Club Road 1985 -1994



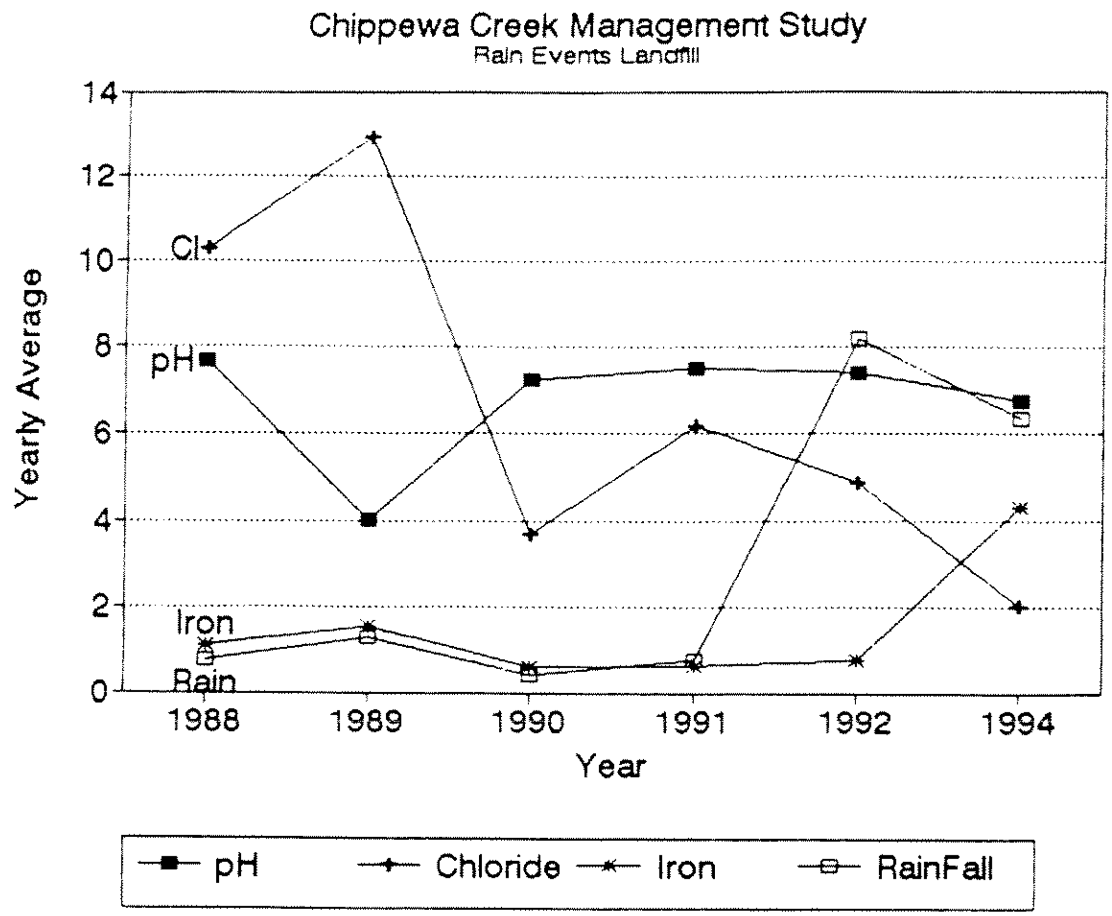

Chippewa Creek
Golf Club Road 1985 -1994
PPM
Fe
Al
Zn
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1985
1986
1987
1988
1989
1990
1991
1993
1994
Yearly Average
Fe
Zn
Al

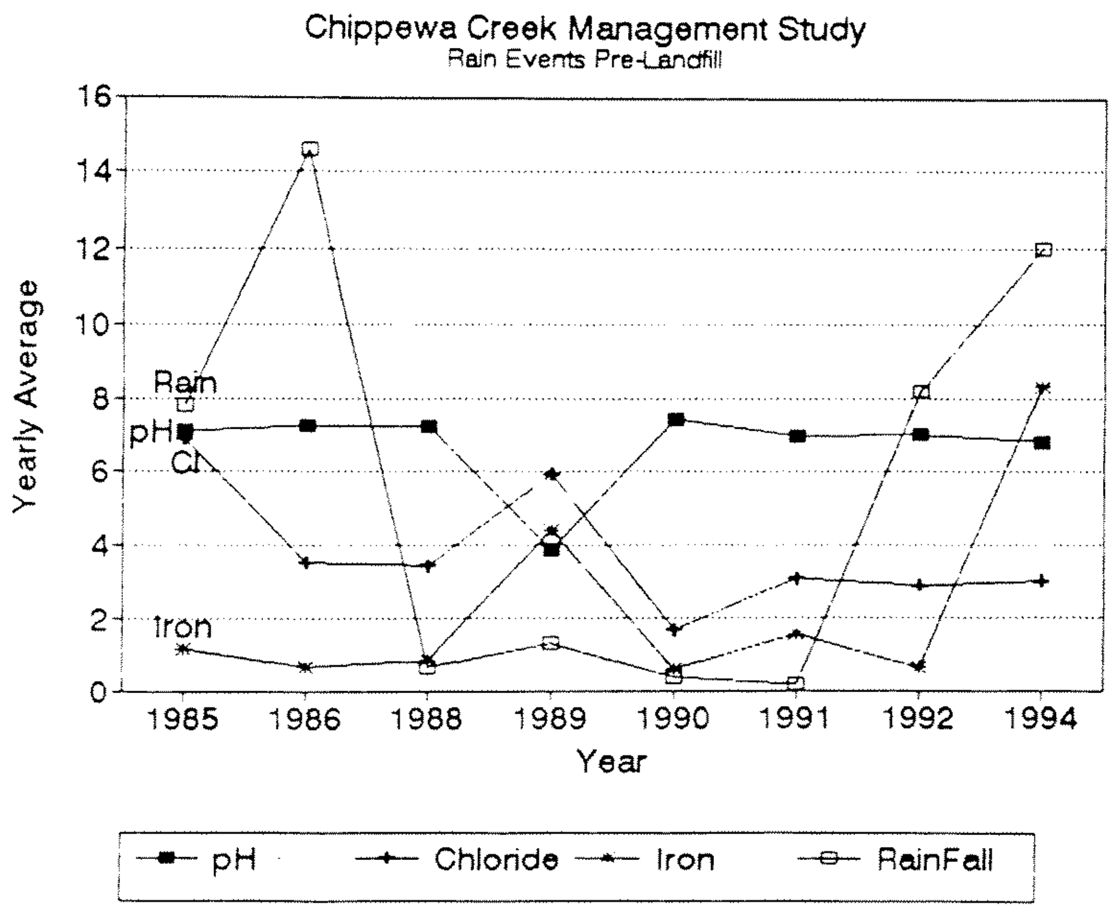

Chippewa Creek
Mouth 1985 -1994
PPM
Cl
Alk
T.S.S.
pH
90
80
70
60
50
40
30
20
10
0
1985
1986
1987
1988
1989
1990
1991
1993
1994
Yearly Average
Alkalinity
pH (no units)
Chloride
Sus. Solids

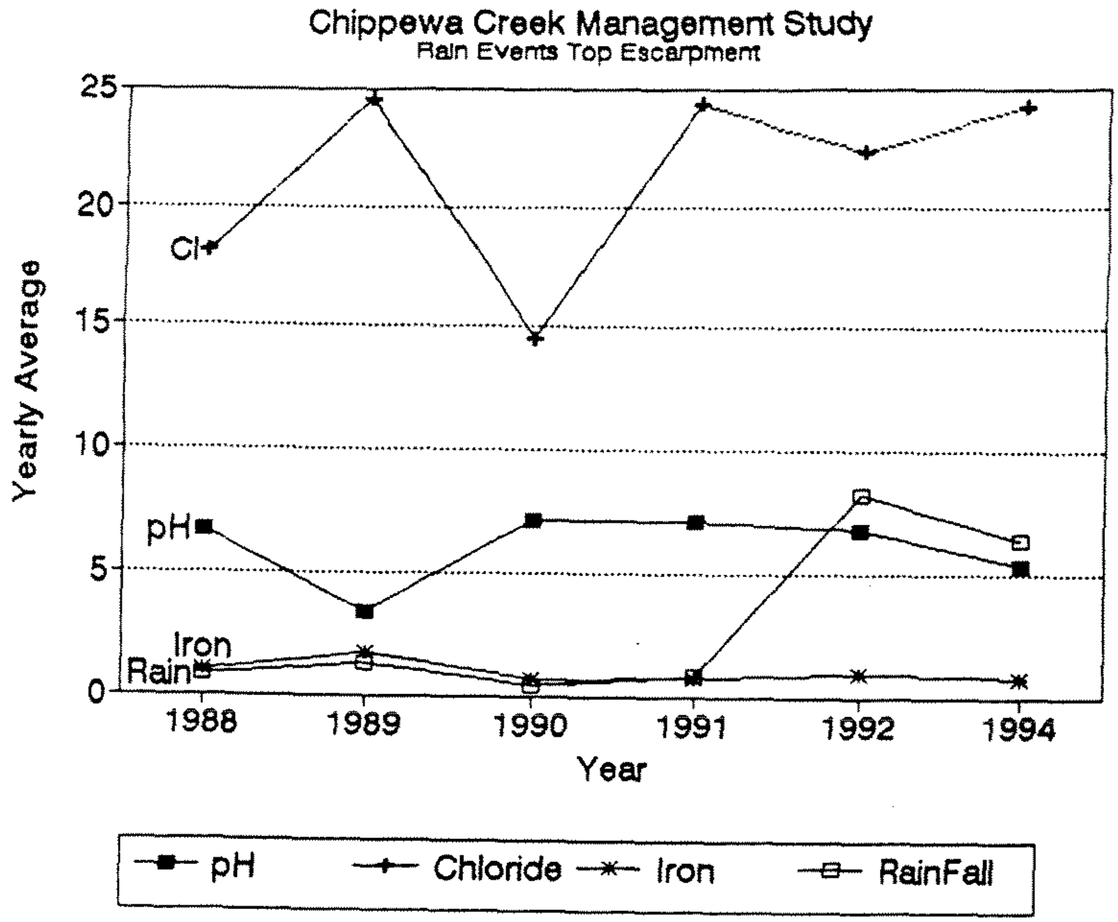

Chippewa Creek
Mouth 1985 -1994
PPM
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Cu
Phenol
Pb
1985
1986
1987
1988
1989
1990
1991
1993
1994
Yearly Average
Cu
Pb
Phenol

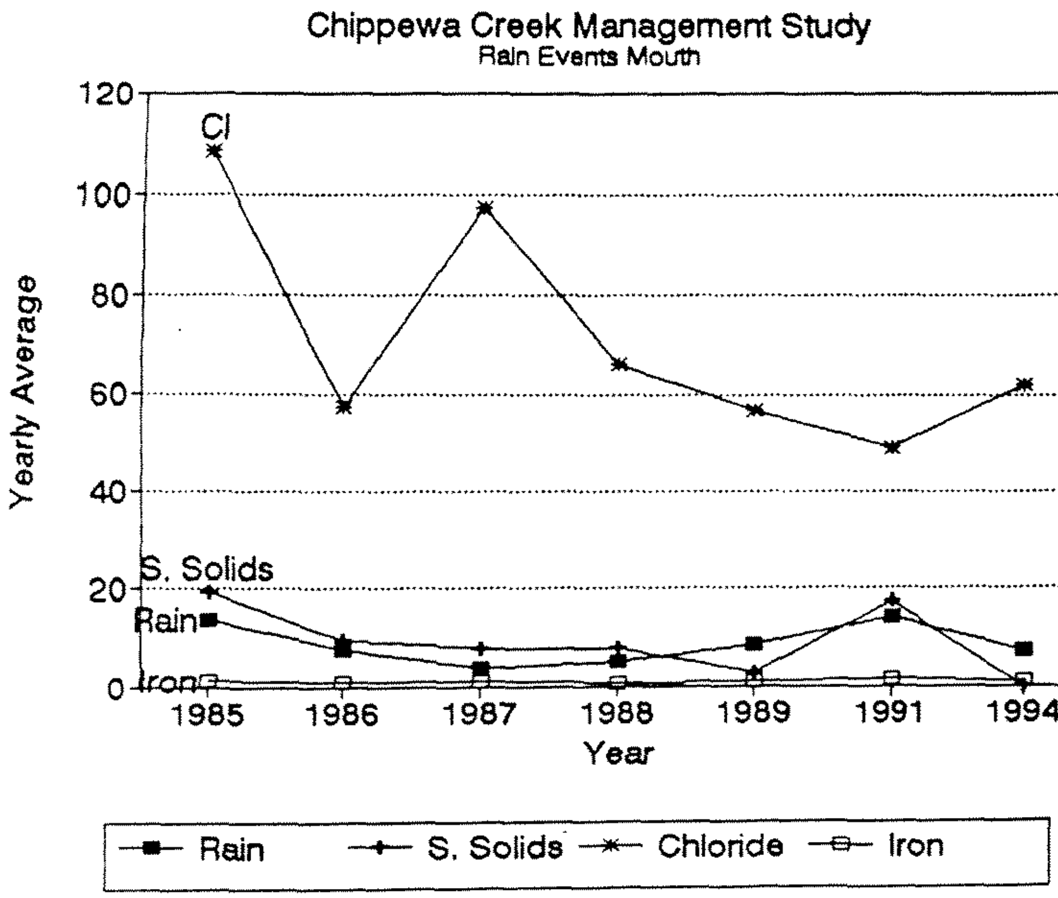

Chippewa Creek
Mouth 1985 -1994
PPM
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Fe
Al
Zn
1985
1986
1987
1988
1989
1990
1991
1993
1994
Yearly Average
Fe
Zn
Al

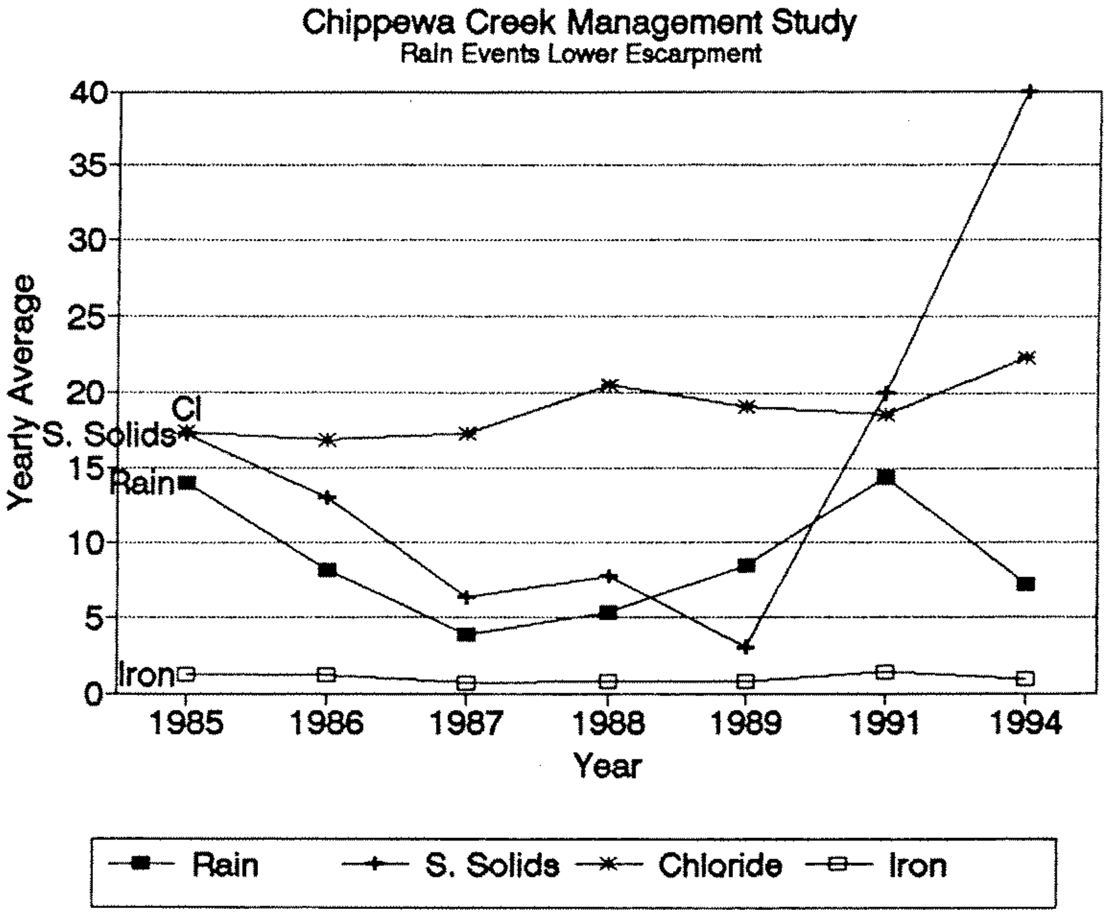
Appendix E-5
Historical Rain Event Graphs


Chippewa Creek Management Study
Rain Events Landfill
14
12
10
8
6
4
2
0
Yearly Average
Cl
pH
Iron
Rain
1988
1989
1990
1991
1992
1994
Year
pH
Chloride
Iron
RainFall

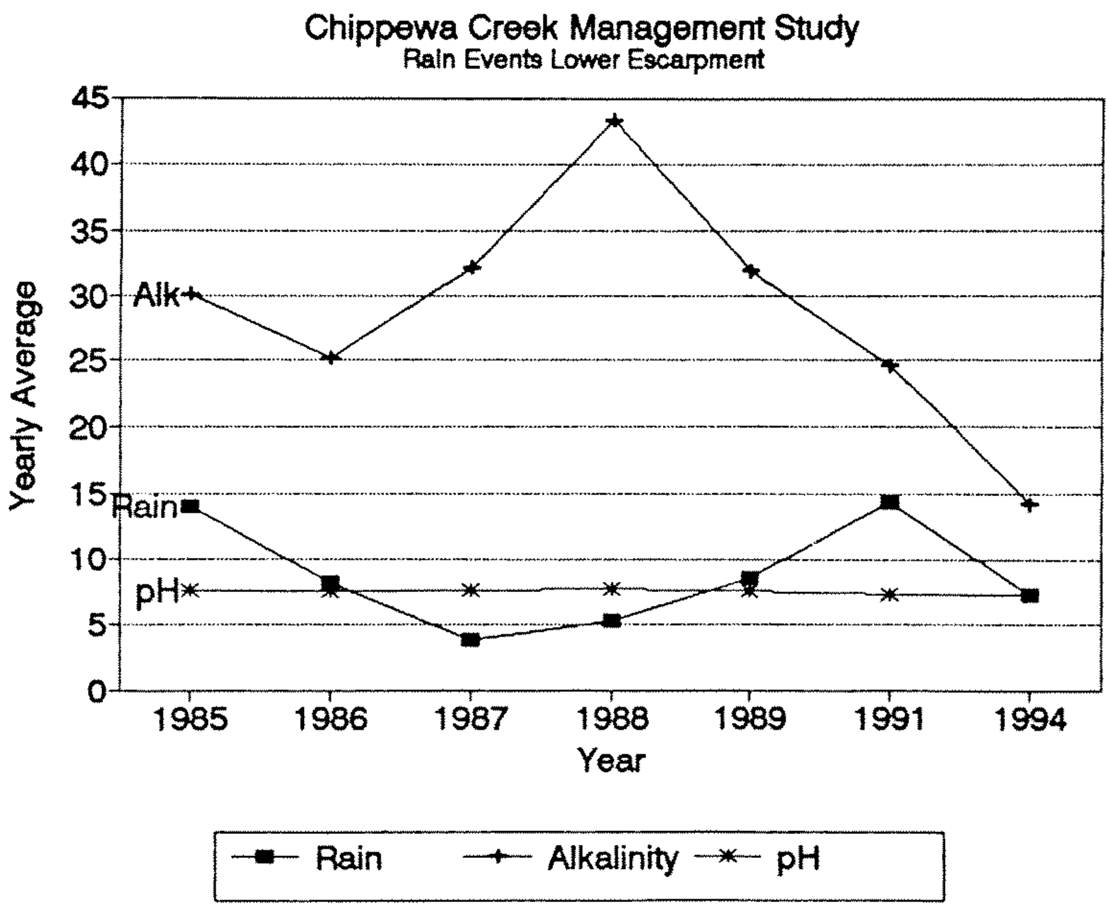

Chippewa Creek Management Study
Rain Events Pre-Landfill
16
14
12
10
8
6
4
2
0
Yearly Average
Rain
pH
Cl
Iron
1985
1986
1988
1989
1990
1991
1992
1994
Year
pH
Chloride
Iron
RainFall


Chippewa Creek Management Study
Rain Events Top Escarpment
Yearly Average
Year
25
20
15
10
5
0
1988
1989
1990
1991
1992
1994
Cl
pH
Iron
Rain
pH
Chloride
Iron
RainFall

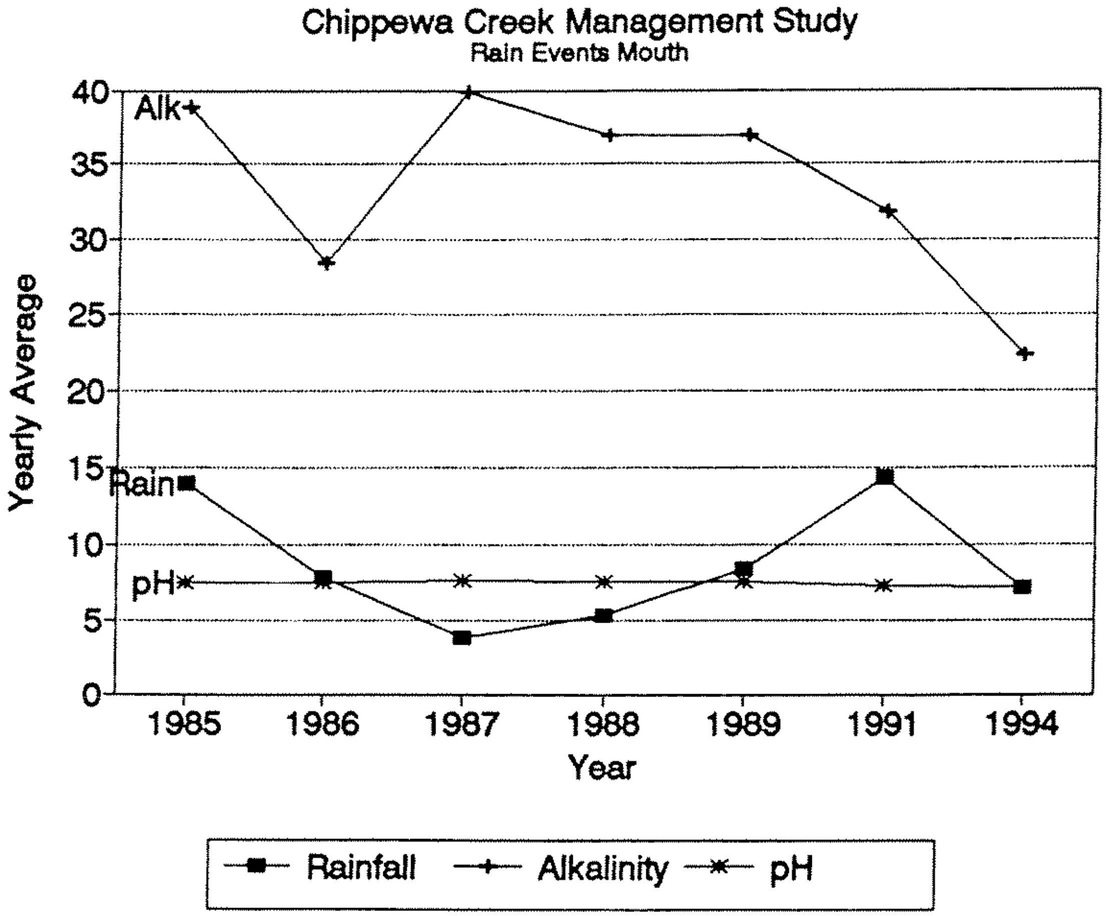

Chippewa Creek Management Study
Rain Events Mouth
Yearly Average
Year
120
100
80
60
40
20
0
1985
1986
1987
1988
1989
1991
1994
Cl
S. Solids
Rain
Iron
Rain
S. Solids
Chloride
Iron



Chippewa Creek Management Study
Rain Events Lower Escarpment
Yearly Average
40
35
30
25
20
15
10
5
0
Cl
S. Solids
Rain
Iron
1985
1986
1987
1988
1989
1991
1994
Year
Rain
S. Solids
Chloride
Iron



Chippewa Creek Management Study
Rain Events Lower Escarpment
Yearly Average
45
40
35
30
25
20
15
10
5
0
Alk
Rain
pH
1985
1986
1987
1988
1989
1991
1994
Year
Rain
Alkalinity
pH



Chippewa Creek Management Study
Rain Events Mouth
Alk
Rain
pH
40
35
30
25
20
15
10
5
0
Yearly Average
1985
1986
1987
1988
1989
1991
1994
Year
Rainfall
Alkalinity
pH

APPENDIX F

ECOLOGICAL RESOURCES

APPENDIX F-1

CHIPPEWA CREEK INVENTORY ASSESSMENT

Prepared by:

North Bay-Mattawa Conservation Authority

Chippewa Creek
Inventory Assessment

By : Todd King
Shawn Nelson

Table of Contents

Purpose:

The major goal for this Chippewa Creek project is to take inventory of all stream and bank features outlined to be pertinent by Proctor and Redfern.

Introduction:

The Chippewa Creek inventory officially began for the North Bay-Mattawa Conservation Authority on July 27, 1994. The initial guidelines for the project were stipulated by Mike Roy of Proctor & Redfern. The results from this study will assist Proctor & Redfern in the Chippewa Creek work they are undertaking now and in the future.

The Chippewa Creek headwaters originate at the wetland complex north on highway 11. Major tributaries to Chippewa Creek include Johnson Creek, Eastview tributary and the Airport tributary. The main creek channel flows southerly through the city of North Bay and finally empties into Lake Nipissing just before the sewage treatment plant on Memorial Drive.

Methodology:

The Chippewa Creek research can be split into three separate sections. These sections are stream inventory, water testing and mapping. Prior to starting any field work the proper maps had to be obtained from Proctor & Redfern and the City of North Bay. These maps were then separated into individual sections for ease of use in the field. All field notes were made on these maps in order to transfer them to a final map at the end of the project.

The first and largest portion of this study is devoted to stream inventory. The necessary information was obtained by walking the creek starting at the mouth and continuing as far as we could up stream. The key components we looked for and noted were unidentified pipe inlets, storm sewer inlets, ground water sources (ie. springs, run off sites), erosion sites, canopy cover, potential fish spawning beds, bank vegetation, fish barriers and aeration sites. In addition to noting these features, pictures were taken to substantiate some of our more significant findings.

The second objective accomplished during this project was water quality data collection. Five sites were selected by Mike Roy at the end of July and monitored for the month of August. The site locations are Stanley St. (up from the mouth), behind NB Hydro, Thompson park, O'Brien St. and beside highway 11. Data for each creek site was collected weekly. Measurements consisted of maximum/minimum water temperature readings, PH values, conductivity and total dissolved solids. The later three readings were obtained using a hand held water quality meter. All the quantitative site readings are summarized in a final chart for ease of weekly comparison. (Appendix I)

The final requirement for this study is a finished map and report. The final mapping was accomplished using the information gathered and noted on the field maps. This field information was transferred to five large maps and is the final mapping for the project. The accompanying report enhances the mapping by giving a description of procedures, findings and significant areas which may merit immediate attention.

__Discussion__:

The overall objective for this project was to get as much information about Chippewa Creek mapped in the stipulated time frame. The total number of working days spent on this assessment was twenty three. Three of these days were spent collecting and dissecting the required city mapping of Chippewa Creek. Due to the age of the mapping (1964) it was difficult to attain the correct path of the creek presently. Six days were spent collecting water quality data from our five sites around the city. Ten days were accumulated actually walking the creek to conduct the stream inventory. The remaining four days were used to develop final maps and complete this report.

In total we have completed the main channel of the creek to roughly one kilometre before its intersection with highway 11. In addition to this all the main tributaries are completed, except for Johnson Creek which is finished up to where it crosses under highway 63. This translates into approximately sixteen kilometres of Chippewa Creek completed and mapped. The daily yield averages out to be 1.6 kilometres of walked stream. This figure betters our original goal of one kilometre per day creek walking. This success is due in part to the areas along the creek which have been developed. Surveying these areas was easier then expected but some of the segments upstream were more tedious then imagined which evened out our productivity. Overall we are pleased with the success in surpassing our initial distance goals.

The analysis of our research will begin with water quality data. All that can really be said about the water quality numbers is consistency. With a few exceptions all the data from week to week remained uniform. We encountered some problems with the thermometers at a couple of sites. The maximum/minimum temperature indicators had strayed grossly from the normal range. We have no idea how or why this may have happened. On the summary chart these readings are indicated as n/a. Aside from that flaw all other temperature readings were consistent. The one element of water quality that did consistently vary was the conductivity readings. The meter jumped from milli siemens to micro siemens quite frequently leaving us wondering if the readings were always accurate. The other readings taken from the water quality meter seemed to stay consistent so we are assuming that the conductivity is correct as well. Calibrating the meter was challenging at times but it was determined later that the calibration solutions were askew. The rest of the site readings went smoothly and hopefully will contribute valuable information to the study.

The focus of our project was the creek inventory. Although we did not get as many days "in" the creek as we would have liked, a lot of valuable information was collected. The majority of information is attributed to inlets. An inlet can be a creek confluence, unidentified pipe, storm sewer drain pipe and/or a ground water source (ie. springs). In many cases the only inlets, other then adjoining streams, were storm sewer drains. These inlets are prevalent throughout the creek concentrated mainly within the core of the city. Unidentified pipe inlets also showed up in various places around the city. These pipes look as if the water they are contributing to the creek is dirty. One example of this is the car wash on the corner of Fisher St. and Chippewa St.. We actually observed brown water exiting this pipe. Every unidentified pipe along the creek merits consideration. All unidentified pipes are indicated on the final maps. Ground water sources, such as springs, tended to be less prevalent within the core of the city. They started to show up at the bottom of Airport hill and were sparsely scattered upstream. Pictures of some ground water locations were taken (slide #7). Springs were harder to find then ground water seepage but we tried to locate as many springs as possible. Due to the low water levels ground water seepage was very evident on surface bedrock. Please consult the maps to obtain the exact location of all inlets.

Arguably the second most important reason for this study was the location of erosion sites. Chippewa Creek, as with most other creeks, has its share of erosion in the form of bank undercutting. Slope and bank failure was the real problem we were searching for. A lot of the bad bank erosion has already been dealt with by the city. The two worst slope erosion sites we discovered along the creek need immediate attention. The first has already been addressed because it is located beside Chippewa High School (slide 9 & 10). Presently construction is taking place and this erosion site is scheduled to be repaired. The second site is located between Golf Course Rd. and Thibeault Hill. It is not quite as large as the first site but it is collapsing quickly. It could be a major silt loader for the creek now and in the future. Both sites have been photographed and are clearly marked on our final maps.

Potential fish spawning beds require three features in order to merit some consideration. A potential fish spawning area will have a clean gravel bottom, some canopy cover and an aeration producer. The aeration site has to produce this oxygen element without forming a barrier for fish movement. Unfortunately we found no sites during our research that met all three requirements totally. There were a few areas that had a somewhat clean gravel bottom, but lacked the other two features. Canopy cover is present in many areas along the stream but lacks the suitable bottom for fish spawning. There were quite a few fish barriers scattered along the creek. These barriers were formed by such things as steel pipes, deadfall debris and waterfalls. All of these individual elements are shown on the final maps. As for fish spawning beds the areas with the most potential are shown on the final maps. No one spot stood out as being better or more suitable than another for fish spawning. Every potential fish spawning area marked on the maps will need some constructive work to make it ideal for fish development.

The stream bank vegetation is the final element depicted in this inventory assessment. Bank vegetation varied greatly throughout the creek. The most common communities we observed tended to be grasses, ferns, shrubs, deciduous trees, coniferous trees and mixed forest. These groups were rarely observed by themselves with nothing else present. For this reason many community groups had to be lumped together. On the completed maps sixty five separate groupings were developed. These communities are described fully in appendix II. The one thing that did stand out in various areas of the creek was grass that is cut right up to the stream bank edge (pic. #9, slide #2). These areas were mainly observed within the core of the city and could be contributing to various problems in the creek.

An element that was not really a prime focus of this study but is worth mentioning is aesthetics. While walking the stream it was hard not to be impressed with the natural beauty of Chippewa Creek. Closer to the mouth pollution and development over shadow the creeks aesthetic features. As you move farther upstream the water begins to speed up and with the surrounding vegetation it is really quite picturesque. To our surprise Chippewa Creek has a couple of substantial waterfalls (slide #3,4,5). Both are worth accessing to show to the public, preferably by trails only. Construction is presently under way beside Chippewa High School. This has caused extreme silt loading downstream and has prompted many resident complaints. The construction is definitely a positive step and in addition a large erosion site is scheduled to be mended. Once completed these steps should add to the aesthetic value of the creek. All and all Chippewa Creek is worth seeing for yourself.

Summary / Conclusion:

The overall goals and objectives for this project have been met. The three main components being water quality data, stream inventory and a final map and report have all been completed. Water quality data was basically uniform with the exception of the conductivity readings. Conductivity seemed to vary considerably but due to the accuracy of the other readings we will assume they are all correct. The stream inventory is complete almost to the junction of highway 11. A total of 16 kilometres of Chippewa Creek has been surveyed. The inventory comprises all aspects required in the original specifications. Many unidentified inlet pipes appear sporadically throughout the creek which should be addressed. Two large erosion sites were discovered in addition to severe bank undercutting which is scattered throughout the creek. No true fish spawning beds were located, although many areas along the creek have good potential. Stream bank vegetation is plentiful and diverse. Sixty five separate communities have been developed to accurately depict bank vegetation. Aesthetically, Chippewa Creek offers some picturesque scenery notably its two waterfalls. Near the mouth pollution and development dominate the creek banks. Work on Chippewa Creek is continuously ongoing. Presently creek enhancement work is taking place beside Chippewa High School. Hopefully this study, and others of its kind, will ensure the betterment and continued value of Chippewa Creek.

SITE VALUES

APPENDIX I

SITE LOCATIONS:

SITE 1	- Top of Thibeault Hill (HWY 11)
SITE 2	- Bridge before O'Brien St. and Golf Course Rd.
SITE 3	- Inlet to Chippewa Creek by the Hydro Building
SITE 4	- Chippewa Creek in Thomson Park
SITE 5	- Two streets up from the mouth of Chippewa Creek

Head

STATION	DATE	MAX TEMP	MIN TEMP	PH	CONDUCTIVITY	TDS
1	JULY 26	27	19	5.90	174.6 uS	75.6
1	AUG. 5	26	13	5.28	1048 mS	526
1	AUG. 11	24	13	5.70	1473mS	739
1	AUG. 19	23	13.5	5.45	176.9 uS	87.2
1	AUG. 26	23	15	6.86	175.8 uS	89.3
2	JULY 26	24	11	6.21	163.8 uS	83.8
2	AUG. 5	n/a	n/a	5.68	118.6 uS	60.4
2	AUG. 11	20.5	10.5	6.58	1633 mS	795
2	AUG. 19	21	12	6.43	152.4 uS	76.6
2	AUG. 26	21	11	5.96	156.2 uS	76.8
3	JULY 26	28	19	6.40	481 uS	242
3	AUG. 5	29	11	6.17	402 uS	202
3	AUG. 11	25	15	6.17	5.61 mS	2.88
3	AUG. 19	25	13	6.46	566 uS	282
3	AUG. 26	26	15	6.31	566 uS	283
4	JULY 26	n/a	n/a	6.52	319 uS	1.58
4	AUG. 5	23	11	6.05	185.4 uS	93.2
4	AUG. 11	24	11	6.28	3.3 mS	1.64
4	AUG. 19	23	12	6.74	347 uS	177
4	AUG. 26	23.5	13	6.33	330 uS	166
5	JULY 26	34	16	6.44	439 uS	211
5	AUG. 5	26	13	6.43	285 uS	144
5	AUG. 11	22	12.5	6.51	4.47 mS	2.09
5	AUG. 19	21.5	13	6.28	423 uS	212
5	AUG. 26	22	15	6.41	388 uS	192

mouth

* n/a - The thermometer guages were awry and no max/min reading was available.

APPENDIX II

LEGEND

G1 - Grasses mixed, rock bank or gabion basket
a - Few deciduous shrubs
b - Rock slope

G2 - Grasses mixed, with a few deciduous shrubs
b - Shrubs speckled alder and willow, 1m back from bank
c - Deciduous and coniferous trees also

G3 - Timothy, clover, goldenrod and few other species

G4 - Foxtail, horse tail and few other species

G5 - Goldenrod, some clover, and few deciduous shrubs

G6 - Grass cut to the edge
a - Few cedars
b - Few deciduous trees and shrubs, and a few cedars
c - Rock bank

G7 - Grasses mixed with ferns
a - Few deciduous shrubs also

G8 - Grass cut to edge with a few willow and manitoba maple shrubs

G9 - Bare bank with very little grass

G10- Steep clover bank with a few other grasses

G11- Mixed grasses with small uncut buffer zone

G12- Mixed grasses, cat tails, ferns
a - Purple loosestrife and shrubs

S1 - Elm, manitoba maple, choke cherry with a few grasses

S2 - Elm, manitoba maple, choke cherry, few grasses, rock bank

S3 - Elm, manitoba maple, with a few grasses

S4 - Manitoba maple, goldenrod, with a few other grasses

S5 - Mixed shrubs, deciduous, also some mixed grasses
b - Rock bank
c - Ferns

S6 - Shrubs mixed, deciduous, with a few ferns

S7 - Maple, elm, with a few ferns and grasses

S8 - Willow, elm. with a few ferns and grasses

S9 - Speckled alder, silver maple, with a few ferns and grasses

S10- Speckled alder, willow, with a few grasses
a - Few coniferous trees also

S11- Speckled alder, cedar, with fern understorey with rock bank
a - no rock bank
b - no rock bank, spruce and maple also

S12- Speckled alder with a few grasses
a - A few willow, spruce and ash
b - Poplar, spruce, birch, ferns and a few maple
c - Same as b, cedar also
d - Few manitoba maple
e - Few cedar and spruce
f - Mixed grasses, raspberry, a few cedar
g - Few cedar, spruce, maple,birch,with ferns and grasses

T1 - Manitoba maple, a few deciduous shrubs, some ferns and grasses

T2 - White birch, elm, and manitoba maple
a - No elm, but yellow birch

T3 - Deciduous tree and shrub mix, a few grasses, raspberry's and ferns
a - No raspberry
b - Construction

T4 - Elm
a - Ferns also, a few deciduous shrubs, rock bank
b - Few coniferous trees, rock bank

T5 - Willow, with some mixed grasses and ferns

T6 - Willow/Elm few grasses and other deciduous shrubs, rock bank

T7 - Willow, manitoba maple, choke cherry, few grasses and deciduous shrubs

T8 - Manitoba maple, white birch, elm, a few shrubs and ferns

T9 - Maple, yellow birch, spruce, a few grasses and ferns

T10- Deciduous trees with a few coniferous
a - No coniferous
b - A few deciduous shrubs

W - Barren rock bank

W2 - Barren sandy slope

LEGEND

AERATION	
BANK UNDERCUT	bu
CANOPY COVER	
DEBRIS	d
EROSION SITE	E
FISH BARRIER	
GABION BASKET	
INLET	
PIPE-	
Storm sewer	⊕
Other	●
POLLUTION	p
POTENTIAL SPAWNING BED	
SPRING	■

Chippewa Creek Assessment

The Chippewa Creek survey began for us on the twenty seventh of July. To date the total number of working days on this project has been sixteen. Two days were spent collecting and dissecting the required city mapping of Chippewa Creek. Four days were spent collecting maximum /minimum temperatures, PH values, total dissolved solids and conductivity for five separate sites along the creek. These findings are summarized in a chart for ease of site comparison. The readings are taken every Friday, and a note of prior weather is always completed.

The actual Chippewa Creek assessment began at the mouth of the creek (Lake Nipissing). We focused on several key stream components and noted each on our field maps. These components included unidentified pipe inlets, storm sewer inlets, ground water sources (springs), erosion sites, canopy cover, potential fish spawning beds, bank vegetation, fish barriers and aeration sites. All of our field notes will be transferred to a final map at the end of the project. Along with field notes, pictures were taken to substantiate our major findings. Although recently the camera was damaged so no more pictures will be taken. At this time we have completed the main channel of the Creek to roughly one and a half kilometres before its intersection with highway 11. In addition to this all the main tributaries are completed, except for all of Johnson creek which is completed up to where it crosses under Highway 63. In total, 15.16 kilometres of creek has been completed. This averages out to roughly 1.5 kilometres per creek working day.

There are seven working days left in our contract. With this time we hope to spend one day on site readings, two days on finalizing the creek assessment and four days completing the final Chippewa Creek map and report.

APPENDIX F-2

AQUATIC BENTHIC INVERTEBRATE PROGRAM

CHIPPEWA CREEK

AQUATIC BENTHIC INVERTEBRATE PROGRAM
CHIPPEWA CREEK

1.0 Introduction

The composition and diversity of aquatic invertebrate communities in a watercourse often provides an indication of the quality of habitat for aquatic organisms. The quality of habitat is based on a number of factors including water quality parameters, substrate type and composition, aquatic vegetation, seasonality of water flow, etc. Studies on the composition of aquatic invertebrate communities can in fact be used to monitor long-term water quality when other factors are accounted for.

In the case of Chippewa Creek, a study of aquatic invertebrate communities was conducted to provide information regarding long-term water quality and the interactions between water quality and biological communities in the creek.

2.0 Sampling Methodology

Aquatic benthic invertebrates were sampled from seven (7) locations within the Chippewa Creek watershed on May 12, 1994. The locations were determined based on representation of the various portions of the watershed and selection of similar substrate type. Sampling locations (BS1-BS7) are indicated on the attached figure.

Due to the seasonal nature of aquatic benthos presence in freshwater streams, it is necessary that any sampling program be designed to capture the aquatic benthic invertebrates at a time of maximum diversity. This period is from late fall, when certain invertebrate larvae are deposited in the stream substrates, to early spring, prior to the emergence of aquatic insects and other invertebrates from the substrates.

The following describes the aquatic benthic invertebrate sampling locations:

Sample Station	Location
BS 1	Chippewa Creek headwaters - Hwy 11 crossing
BS 2	Upper-watershed downstream of Marsh Drive tributary confluence
BS 3	O'Brien St. bridge at Golf Club Rd - riffle area downstream of bridge
BS 4	Memorial Park - upstream of Johnson Creek confluence - riffle area
BS 5	Memorial Park - Johnson Creek tributary at foot bridge
BS 6	Memorial Park - downstream of Johnson Creek tributary, riffle area behind North Bay Hydro
BS 7	Creek mouth area - upstream of Memorial Drive.

At each of the above locations samples were collected using the "kick-method" with a D-frame net. At each station, substrate was agitated within the sampler for a period of 5 minutes. Invertebrates on rocks were hand-picked and placed in the sample container. After collection, samples were coarsely screened, placed in 2 L plastic jars and preserved in 37% formalin solution Three (3) replicate samples were composited to obtain one (1) sample for each station. Samples were sent to Richard Bland Associates for invertebrate identification and enumeration.

Invertebrate data for each of the stations was compared for four (4) community metrics:

Total Invertebrates - the total number of invertebrates within a sample,

Species Richness - the number of different species within a sample,

EPT value - the total number of species of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) in a sample. These groups of invertebrates are considered to be mostly clean-water organisms, and their presence generally indicates good water quality.

Hilsenhoff Biotic Index - the biotic index is a measure that indicates the impact of water quality on biological communities. The index is calculated by multiplying the number of individuals of each species by a pollution tolerance value, summing these products, and dividing by the total number of invertebrates in the sample. Tolerance values are obtained from Hilsenhoff (1987). Tolerance values range from 0 to 10, where higher values indicate higher tolerance. The biotic index ranges for water quality are: 0-2.5 excellent, 2.51-4.5 very good, 4.51-5.5 good, 5.51-6.5 fair, 6.51-7.5 fairly poor, 7.51-8.5 poor, 8.6-10 very poor.

The results of the benthic invertebrate sampling and the community metrics are presented below.

3.0 Results and Discussion

The results of benthic invertebrate sampling in Chippewa Creek are presented in Table F-2.1. A total of forty-three (43) species representing twenty-six (26) different inveretbrate families were identified for the seven (7) sample locations.

Table F-2.1

CHIPPEWA CREEK

RESULTS OF AQUATIC BENTHIC INVERTEBRATE SURVEY -1994

CLASS/ORDER	FAMILY	TAXON	BS1	BS2	BS3	BS4	BS5	BS6	BS7
OLIGOCHAETA	Lumbricidae	*Lumbricidae*			2	12		4	2
	Lumbriculidae	*Lumbriculus variegatus*					4		
	Tubificidae	*Tubificidae immatures*				1	34	4	2
		Tubifex tubifex					2		
AMPHIPODA	Crangoncytidae	*Crangonyx gracilis cplx.*					1		
	Talitridae	*Hyalella azteca*					3		
ISOPODA	Asellidae	*Asellus racovitzai*					50	1	9
DECAPODA	Cambaridae	*Cambaras sp. juvenile*							1
		Orconectes virilis					2		3
COLEOPTERA	Elmidae	*Promoresia tardella*			1				

CLASS/ORDER	FAMILY	TAXON	BS1	BS2	BS3	BS4	BS5	BS6	BS7
		larva							
DIPTERA	Tipulidae	*Tipulidae, damaged*			1				
		Hexatoma sp.						1	
		Molophilus sp.			1			1	
		Tipula sp. type I			1				
		Tipula sp. type II				1		1	2
	Chironomidae	*Chironomus sp.*							1
		Dicrotendipes sp.					1		
		Stictochironomus sp.					1		
		Orthocladius sp.					3		
		Psectrocladius sp.					1		
		Conchapelopia sp.			1		7	1	2
EPHEMEROPTERA	Baetudae	*Baetis brunneicolor*			2		1		1
	Caenidae	*Caenis sp.*			1				
HEMIPTERA	Gerridae	*Gerris comatus*	1						
		Gerris remigis	1						
ODONATA	Cordulegastrdae	*Cordulegaster maculatus*	2						
	Corduliidae	*Somatochlora minor*	1						
		Tetragoneuria canis	2						
PLECOPTERA	Leuctridae	*Leuctra sp. juvenile*			1				
	Perlodidae	*Isoperla transmarina*			9				
TRICHOPTERA	Hydropsychidae	*Diplectrona modesta*			1				
		Hydropsyche alhedra	14				10	1	4
		Hydropshyche sparna			9				
	Leptoceridae	*Oecetis sp.*					1		
	Limnephilidae	*Limnephilidae, v. damaged*			1				
		Platycentropus sp							1
	Philipotamidae	*Dolophilodes distinctus*			1				
	Psychomyiidae	*Psychomyia flava*							1
	Rhyacophilidae	*Rhyacophila fuscula*		3					
GASTROPODA	Physidae	*Physella gyrina*					1		
	Planorbidae	*Planorbella pilsbryi*	1						
PELECYPODA	Sphaeriidae	*Sphaerium sp. immatures*					4		
VERTEBRATA		*Fish eggs*			(7)		(14)	(7)	(1)
	Cottidae	*Cottus bairdi*							(1)
		TOTALS	20	3	32	14	126	14	29

At the time of sampling, water flows in Chippewa Creek were very high. For this reason, a complete sample could not be obtained from BS-2. BS-2 is, therefore, not considered in the following asessment.

Table F-2.2 presents the community metrics for stations sampled in Chippewa Creek.

Table F-2.2

Chippewa Creek

Aquatic Benthic Invertebrate Community Metrics

Parameter	BS-1	BS-3	BS-4	BS-5	BS-6	BS-7
Total Invertebrates	20	32	14	126	14	29
Species Richness	7	9	3	17	8	12
EPT value	1	8	0	3	1	4
Biotic Index	4.5	4.0	7.9	8.0	7.1	6.5
Water Quality	very good	very good	poor	poor	fairly poor	fair

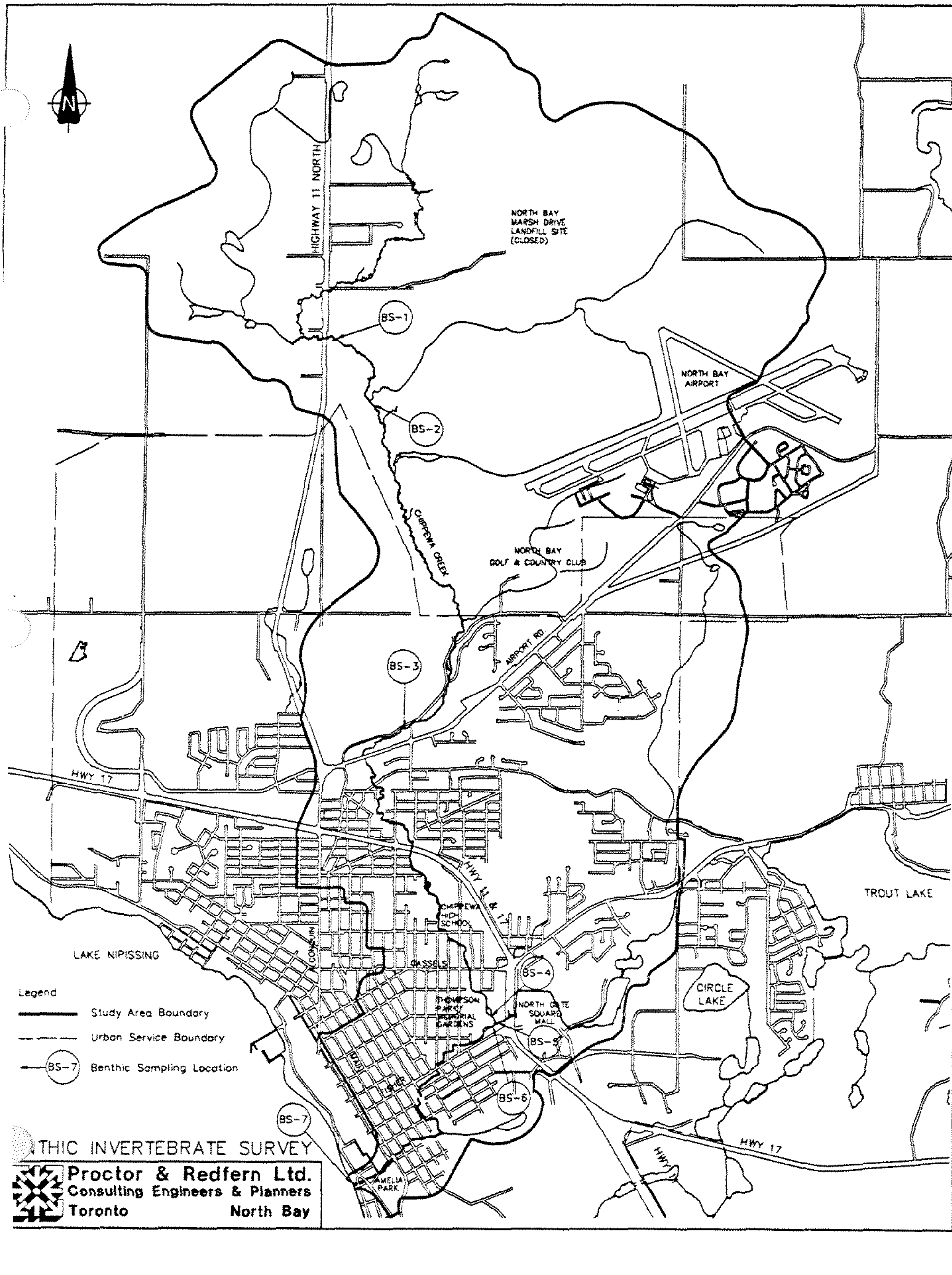
With the exception of BS-5 at Johnson's Creek, the total invertebrates at each sampling location were relatively low, ranging from 14 to 29 per sample. The higher number of invertebrates at BS-5 may be accounted for by the greater accumulation of detritus at this station.

Species richness (number of species) ranged from 3 to 17 species. While BS-5 contained the greatest number of species many of these were "pollution-tolerant" species.

Biotic index values indicate water quality at the two upper watershed stations, BS-1 and BS-3, to be very good based on the presence of indicator invertebrates. Species composition at BS-3 was dominated by a number of species indicative of clean water environments. Conversely, the biotic indices for BS-4 to BS-7 indicate more degraded water quality in the lower watershed. Johnson's Creek and Memorial Park area appear to be the most degraded portions of the watercourse. At the outlet of Chippewa Creek, the biotic index value, 6.5, indicates only fair water quality.

4.0 Conclusions

The aquatic benthic invertebrate survey results obtained for Chippewa Creek indicate water quality in the upper-watershed to be very good based on the presence of indicator organisms. The greatest impact of water quality on invertebrate communities appears to be in the lower-watershed in Johnson's Creek and the Memorial Park area.


N
HIGHWAY 11 NORTH
NORTH BAY
MARSH DRIVE
LANDFILL SITE
(CLOSED)
BS-1
NORTH BAY
AIRPORT
BS-2
CHIPPEWA CREEK
NORTH BAY
GOLF & COUNTRY CLUB
AIRPORT RD
BS-3
HWY 17
HWY 11 & 17
CHIPPEWA
HIGH
SCHOOL
TROUT LAKE
LAKE NIPISSING
ALGONQUIN
CASSELS
BS-4
THOMPSON
PARK
MEMORIAL
GARDENS
NORTH GATE
SQUARE
MALL
BS-5
CIRCLE
LAKE
MAIN
FISHER
BS-6
BS-7
AMELIA
PARK
HWY 17
HWY
Legend
Study Area Boundary
Urban Service Boundary
BS-7 Benthic Sampling Location
NTHIC INVERTEBRATE SURVEY
Proctor & Redfern Ltd.
Consulting Engineers & Planners
Toronto North Bay

APPENDIX F-3

CHIPPEWA CREEK WETLAND EVALUATION

SCORING SUMMARIES

3.0 HYDROLOGICAL COMPONENT

3.1 FLOOD ATTENUATION	80	
3.2 GROUNDWATER RECHARGE		
3.2.1 Site Type	20	
3.2.2 Soils	2	
Total for Groundwater Recharge		107
3.3 WATER QUALITY IMPROVEMENT		
3.3.1 Watershed Improvement Factor	30	
3.2.2 Adjacent and Watershed Land Use	19	
3.2.3 Vegetation Form	8	
Total for Water Quality Improvement		57
3.4 CARBON SINK		0
3.5 SHORELINE EROSION CONTROL		0
3.6 GROUNDWATER DISCHARGE (maximum 30)		21
TOTAL FOR HYDROLOGICAL COMPONENT (not to exceed 250)		185

4.0 SPECIAL FEATURES

4.1 RARITY

4.1.1 Wetlands		
4.1.1.1 Rarity of Wetland Type (maximum 80)	10	
Total for Wetland Rarity		10
4.1.2 Species		
4.1.2.1 Breeding Habitat for Endangered Species	0	
4.1.2.2 Traditional Migration or Feeding Habitat	0	
4.1.2.3 Provincially Significant Animal Species	0	
4.1.2.4 Provincially Significant Plant Species	0	
4.1.2.5 Regionally Significant Species (Site Region)	0	
4.1.2.6 Locally Significant Species (Site District)	20	
4.1.2.7 Species of Special Status		
Total for Species Rarity		20

4.2 SIGNIFICANT FEATURES AND HABITATS

4.2.1 Nesting of Colonial Waterbirds	0	
4.2.2 Winter Cover for Wildlife	0	
4.2.3 Waterfowl Staging and/or Moulting	0	
4.2.4 Waterfowl Breeding	10	
4.2.5 Migratory Passerine, Shorebird or Raptor Stopover	0	
4.2.6 Ungulate Habitat	0	
4.2.7 Fish Habitat		
4.2.7.1 Spawning and Nursery Habitat	~~35~~ 4	
4.2.7.2 Migration and Staging Habitat	0	
Total for Significant Features and Habitat		34

4.3 ECOSYSTEM AGE

2

TOTAL FOR SPECIAL FEATURES (not to exceed 250) 36

WETLAND EVALUATION SCORING RECORD

WETLAND NAME Johnston Road

1.0 BIOLOGICAL COMPONENT

1.1 PRODUCTIVITY

1.1.1 Growing Degree-Days/Soils	15	
1.1.2 Wetland Type	11	
1.1.3 Site Type	2	
Total for Productivity		28

1.2 BIODIVERSITY

1.2.1 Number of Wetland Types	13	
1.2.2 Vegetation Communities (maxixmum 45)	4	
1.2.3 Diversity of Surrounding Habitat (maximum 7)	5	
1.2.4 Proximity to Other Wetlands	8	
1.2.5 Interspersion	12	
1.2.6 Open Water Types	14	
Total for Biodiversity		56

1.3 SIZE (Biological Component) 7

TOTAL FOR BIOLOGICAL COMPONENT (not to exceed 250) 91

2.0 SOCIAL COMPONENT

2.1 ECONOMICALLY VALUABLE PRODUCTS

2.1.1 Wood Products	0	
2.1.2 Lowbush Cranberry	0	
2.1.3 Wild Rice	0	
2.1.4 Commercial Fish	0	
2.1.5 Furbearers	6	
Total for Economically Valuable Products		6

2.2 RECREATIONAL ACTIVITIES (maximum 80)

0

2.3 LANDSCAPE AESTHETICS

2.3.1 Distinctness	3	
2.3.2 Absence of Human Disturbance	1	
Total for Landscape Aesthetics		4

2.4 EDUCATION AND PUBLIC AWARENESS

2.4.1 Educational Uses	12	
2.4.2 Facilities and Programs	0	
2.4.3 Research and Studies (maximum 12)	0	
Total for Education and Public Awareness		12

2.5 PROXIMITY TO AREAS OF HUMAN SETTLEMENT

40

2.6 OWNERSHIP

4~~2~~

2.7 SIZE (Social Component)

5

2.8 ABORIGINAL AND CULTURAL VALUES (maximum 30)

0

TOTAL FOR SOCIAL COMPONENT (not to exceed 250) 71

WETLAND DATA RECORD

i) **WETLAND NAME AND OR NUMBER:** Johnston Road Wetland

ii) **ADMINISTRATIVE REGION:** Central **, DISTRICT:** North Bay
AREA: Nipissing **(MINISTRY OF NATURAL RESOURCES)**

iii) **CONSERVATION AUTHORITY JURISDICTION:** North Bay - Mattawa

(If not within a designated CA, check here:________

iv) **COUNTY OR REGIONAL MUNICIPALITY:** City of North Bay

v) **TOWNSHIP:** Widdifield **UNDESIGNATED (CHECK):**

vi) **LOTS & CONCESSIONS:** Lot 16, Concession "C"
(attach separate sheet if necessary)

vii) MAP AND AIR PHOTO REFERENCES

a) Latitude: 46°20' Longitude: 79°25'

b) U.T.M. grid ref.: Zone 17 ; Two-letter code PB
6 digit Grid 215315

c) National Topographic Series
Name: North Bay Edition: 5
Number: 31 L/6 Scale: 1:50,000

d) Air photos: Date photo taken: 1989 Scale: 1:20,000

Flight & plate numbers: 4612 - 244

____
(attach separate sheet if necessary)

e) Ontario Base Map Scale: 1:20,000
Numbers: 20 17 6200 51300

viii) WETLAND SIZE AND BOUNDARIES

a) Single contiguous wetland area: 5.9 hectares

SUMMARY OF EVALUATION RESULT

Wetland Johnston Road

TOTAL FOR 1.0 BIOLOGICAL COMPONENT	91
TOTAL FOR 2.0 SOCIAL COMPONENT	71
TOTAL FOR 3.0 HYDROLOGICAL COMPONENT	185
TOTAL FOR 4.0 SPECIAL FEATURES COMPONENT	36
WETLAND TOTAL	383

INVESTIGATORS

AFFILIATION

DATE

3.0 HYDROLOGICAL COMPONENT

3.1 FLOOD ATTENUATION	60	60
3.2 GROUNDWATER RECHARGE		
3.2.1 Site Type	20	
3.2.2 Soils	7	
Total for Groundwater Recharge		27
3.3 WATER QUALITY IMPROVEMENT		
3.3.1 Watershed Improvement Factor	30	
3.2.2 Adjacent and Watershed Land Use	15	
3.2.3 Vegetation Form	10	
Total for Water Quality Improvement		55
3.4 CARBON SINK		6
3.5 SHORELINE EROSION CONTROL		0
3.6 GROUNDWATER DISCHARGE (maximum 30)		18
TOTAL FOR HYDROLOGICAL COMPONENT (not to exceed 250)		166

4.0 SPECIAL FEATURES

4.1 RARITY

4.1.1 Wetlands

4.1.1.1 Rarity of Wetland Type (maximum 80)	10	
Total for Wetland Rarity		10

4.1.2 Species

4.1.2.1 Breeding Habitat for Endangered Species	___	
4.1.2.2 Traditional Migration or Feeding Habitat	___	
4.1.2.3 Provincially Significant Animal Species	___	
4.1.2.4 Provincially Significant Plant Species	___	
4.1.2.5 Regionally Significant Species (Site Region)	___	
4.1.2.6 Locally Significant Species (Site District)	___	
4.1.2.7 Species of Special Status	20	
Total for Species Rarity		20

4.2 SIGNIFICANT FEATURES AND HABITATS

4.2.1 Nesting of Colonial Waterbirds	0	
4.2.2 Winter Cover for Wildlife	0	
4.2.3 Waterfowl Staging and/or Moulting	20	
4.2.4 Waterfowl Breeding	10	
4.2.5 Migratory Passerine, Shorebird or Raptor Stopover	0	
4.2.6 Ungulate Habitat	0	
4.2.7 Fish Habitat		
4.2.7.1 Spawning and Nursery Habitat	3	
4.2.7.2 Migration and Staging Habitat	0	
Total for Significant Features and Habitat		33

4.3 ECOSYSTEM AGE

4.3 ECOSYSTEM AGE	1
TOTAL FOR SPECIAL FEATURES (not to exceed 250)	64

WETLAND EVALUATION SCORING RECORD

WETLAND NAME Ski Club Wetland

1.0 BIOLOGICAL COMPONENT

1.1 PRODUCTIVITY

1.1.1 Growing Degree-Days/Soils	15	
1.1.2 Wetland Type	13	
1.1.3 Site Type	2	
Total for Productivity		30

1.2 BIODIVERSITY

1.2.1 Number of Wetland Types	13	
1.2.2 Vegetation Communities (maxixmum 45)	4	
1.2.3 Diversity of Surrounding Habitat (maximum 7)	5	
1.2.4 Proximity to Other Wetlands	8	
1.2.5 Interspersion	12	
1.2.6 Open Water Types	14	
Total for Biodiversity		56

1.3 SIZE (Biological Component) 7

TOTAL FOR BIOLOGICAL COMPONENT (not to exceed 250) 93

2.0 SOCIAL COMPONENT

2.1 ECONOMICALLY VALUABLE PRODUCTS		
2.1.1 Wood Products	0	
2.1.2 Lowbush Cranberry	0	
2.1.3 Wild Rice	0	
2.1.4 Commercial Fish	0	
2.1.5 Furbearers	12	
Total for Economically Valuable Products		12
2.2 RECREATIONAL ACTIVITIES (maximum 80)		20
2.3 LANDSCAPE AESTHETICS		
2.3.1 Distinctness	3	
2.3.2 Absence of Human Disturbance	2	
Total for Landscape Aesthetics		5
2.4 EDUCATION AND PUBLIC AWARENESS		
2.4.1 Educational Uses	12	
2.4.2 Facilities and Programs	0	
2.4.3 Research and Studies (maximum 12)	5	
Total for Education and Public Awareness		17
2.5 PROXIMITY TO AREAS OF HUMAN SETTLEMENT		40
2.6 OWNERSHIP		4
2.7 SIZE (Social Component)		10
2.8 ABORIGINAL AND CULTURAL VALUES (maximum 30)		0
TOTAL FOR SOCIAL COMPONENT (not to exceed 250)		108

WETLAND DATA AND SCORING RECORD

i) WETLAND NAME: Ski Club Wetland

ii) MNR ADMINISTRATIVE REGION: Central DISTRICT: North Bay

AREA OFFICE (if different from District): Nipissing

iii) CONSERVATION AUTHORITY JURISDICTION: North Bay - Mattawa

(If not within a designated CA, check here:____

iv) COUNTY OR REGIONAL MUNICIPALITY: City of North Bay

v) TOWNSHIP: Widdifield

vi) LOTS & CONCESSIONS: Lot 18, Con C
(attach separate sheet if necessary)

vii) MAP AND AIR PHOTO REFERENCES

a) Latitude 79° 10' 45" Longitude: 79° 26' 30"

b) UTM grid reference: Zone: 17T Block: PB
Grid: E 2 0 2 N 3 1 8

c) National Topographic Series:

map name(s) North Bay

map number(s) 31 L/6 edition 5th

scale 1:50,000

d) Aerial photographs: Date photo taken: 1989 Scale: 1:10,000

Flight & plate numbers: 89 4612 3 244

(attach separate sheet if necessary)

e) Ontario Base Map numbers & scale 1:20,000

20·17·6100·51300 & 20·17·6200·51300
(attach separate sheets if necessary)

SUMMARY OF EVALUATION RESULT

Wetland Ski Club Wetland

TOTAL FOR 1.0 BIOLOGICAL COMPONENT	93
TOTAL FOR 2.0 SOCIAL COMPONENT	108
TOTAL FOR 3.0 HYDROLOGICAL COMPONENT	166
TOTAL FOR 4.0 SPECIAL FEATURES COMPONENT	64
WETLAND TOTAL	431

INVESTIGATORS

Stephen Spencer, Wade McNiece
Mike Kenzie, Todd King

AFFILIATION

North Bay - Mattawa Conservation Authority

DATE August 3/93

reviewed with revisions Wayne Meil
Area Technician
Nipissing Area
Ministry of Natural Resources

Dec. 7/93

3.0 HYDROLOGICAL COMPONENT

3.1 FLOOD ATTENUATION	55
3.2 GROUNDWATER RECHARGE	
3.2.1 Site Type	20
3.2.2 Soils	7
Total for Groundwater Recharge	27
3.3 WATER QUALITY IMPROVEMENT	
3.3.1 Watershed Improvement Factor	30
3.2.2 Adjacent and Watershed Land Use	14.5
3.2.3 Vegetation Form	10
Total for Water Quality Improvement	54.5
3.4 CARBON SINK	6
3.5 SHORELINE EROSION CONTROL	0
3.6 GROUNDWATER DISCHARGE (maximum 30)	18
TOTAL FOR HYDROLOGICAL COMPONENT (not to exceed 250)	160.5

4.0 SPECIAL FEATURES

4.1 RARITY

4.1.1 Wetlands

4.1.1.1 Rarity of Wetland Type (maximum 80)	10	
Total for Wetland Rarity		10

4.1.2 Species

4.1.2.1 Breeding Habitat for Endangered Species	0	
4.1.2.2 Traditional Migration or Feeding Habitat	0	
4.1.2.3 Provincially Significant Animal Species	0	
4.1.2.4 Provincially Significant Plant Species	0	
4.1.2.5 Regionally Significant Species (Site Region)	0	
4.1.2.6 Locally Significant Species (Site District)	0	
4.1.2.7 Species of Special Status	20	
Total for Species Rarity		20

4.2 SIGNIFICANT FEATURES AND HABITATS

4.2.1 Nesting of Colonial Waterbirds	0	
4.2.2 Winter Cover for Wildlife	10	
4.2.3 Waterfowl Staging and/or Moulting	20	
4.2.4 Waterfowl Breeding	10	
4.2.5 Migratory Passerine, Shorebird or Raptor Stopover	0	
4.2.6 Ungulate Habitat	25	
4.2.7 Fish Habitat		
4.2.7.1 Spawning and Nursery Habitat	2	
4.2.7.2 Migration and Staging Habitat	5	
Total for Significant Features and Habitat		72

4.3 ECOSYSTEM AGE — 1

TOTAL FOR SPECIAL FEATURES (not to exceed 250) — 103

WETLAND EVALUATION SCORING RECORD

WETLAND NAME TOWER DRIVE WETLAND

1.0 BIOLOGICAL COMPONENT

1.1 PRODUCTIVITY

1.1.1 Growing Degree-Days/Soils	15	
1.1.2 Wetland Type	12	
1.1.3 Site Type	2	
Total for Productivity		29

1.2 BIODIVERSITY

1.2.1 Number of Wetland Types	13	
1.2.2 Vegetation Communities (maxixmum 45)	3.5	
1.2.3 Diversity of Surrounding Habitat (maximum 7)	7	
1.2.4 Proximity to Other Wetlands	8	
1.2.5 Interspersion	9	
1.2.6 Open Water Types	8	
Total for Biodiversity		48.5

1.3 SIZE (Biological Component) 7

TOTAL FOR BIOLOGICAL COMPONENT (not to exceed 250) 84.5

2.0 SOCIAL COMPONENT

2.1 ECONOMICALLY VALUABLE PRODUCTS		
2.1.1 Wood Products	0	
2.1.2 Lowbush Cranberry	8	
2.1.3 Wild Rice	0	
2.1.4 Commercial Fish	0	
2.1.5 Furbearers	12	
Total for Economically Valuable Products		12
2.2 RECREATIONAL ACTIVITIES (maximum 80)		20
2.3 LANDSCAPE AESTHETICS		
2.3.1 Distinctness	3	
2.3.2 Absence of Human Disturbance	2	
Total for Landscape Aesthetics		5
2.4 EDUCATION AND PUBLIC AWARENESS		
2.4.1 Educational Uses	0	
2.4.2 Facilities and Programs	0	
2.4.3 Research and Studies (maximum 12)	5	
Total for Education and Public Awareness		5
2.5 PROXIMITY TO AREAS OF HUMAN SETTLEMENT		40
2.6 OWNERSHIP		4
2.7 SIZE (Social Component)		10
2.8 ABORIGINAL AND CULTURAL VALUES (maximum 30)		___ NOT DONE YET.
TOTAL FOR SOCIAL COMPONENT (not to exceed 250)		96 (SO FAR)

WETLAND DATA AND SCORING RECORD

i) WETLAND NAME: TOWER DRIVE

ii) MNR ADMINISTRATIVE REGION: CENTRAL DISTRICT: NORTH BAY

AREA OFFICE (if different from District): NORTH BAY

iii) CONSERVATION AUTHORITY JURISDICTION: NORTH BAY-MATTAWA CONSERVA AUTHORITY.

(If not within a designated CA, check here:_____

iv) COUNTY OR REGIONAL MUNICIPALITY: CITY OF NORTH BAY

v) TOWNSHIP: CITY LIMITS

vi) LOTS & CONCESSIONS: CON A-16&17, CON B-16&17.
(attach separate sheet if necessary)

vii) MAP AND AIR PHOTO REFERENCES

a) Latitude 46°20'45" Longitude: 79°25'30"

b) UTM grid reference: Zone: 17T Block: PL
Grid: E 2 1 5 N 3 3 5

c) National Topographic Series:

map name(s) NORTH BAY (NIPISSING DISTRICT).

map number(s) 31 L/6 edition 5TH

scale 1:50 000

d) Aerial photographs: Date photo taken: 1989 Scale: 1:10 000

Flight & plate numbers: 89 - 4612 - 3 - 244

(attach separate sheet if necessary)

e) Ontario Base Map numbers & scale 20-17-6200-51300
1:20000
(attach separate sheets if necessary)

SUMMARY OF EVALUATION RESULT

Wetland TOWER DRIVE WETLAND.

TOTAL FOR 1.0 BIOLOGICAL COMPONENT	84.5
TOTAL FOR 2.0 SOCIAL COMPONENT	96
TOTAL FOR 3.0 HYDROLOGICAL COMPONENT	160.5
TOTAL FOR 4.0 SPECIAL FEATURES COMPONENT	103
WETLAND TOTAL	444

INVESTIGATORS

STEVE SPENCER

WADE McNEICE

AFFILIATION

N.B.M.C.A.

DATE Aug. 93

reviewed Dec 3/93 [illegible]

3.0 HYDROLOGICAL COMPONENT

3.1 FLOOD ATTENUATION	67	67
3.2 GROUNDWATER RECHARGE		
3.2.1 Site Type	20	
3.2.2 Soils	7	
Total for Groundwater Recharge		27
3.3 WATER QUALITY IMPROVEMENT		
3.3.1 Watershed Improvement Factor	30	
3.2.2 Adjacent and Watershed Land Use	15	
3.2.3 Vegetation Form	0	
Total for Water Quality Improvement		45
3.4 CARBON SINK		6
3.5 SHORELINE EROSION CONTROL		0
3.6 GROUNDWATER DISCHARGE (maximum 30)		16
TOTAL FOR HYDROLOGICAL COMPONENT (not to exceed 250)		161

4.0 SPECIAL FEATURES

4.1 RARITY

4.1.1 Wetlands

4.1.1.1 Rarity of Wetland Type (maximum 80)	0	
Total for Wetland Rarity		0

4.1.2 Species

4.1.2.1 Breeding Habitat for Endangered Species	0	
4.1.2.2 Traditional Migration or Feeding Habitat	0	
4.1.2.3 Provincially Significant Animal Species	0	
4.1.2.4 Provincially Significant Plant Species	0	
4.1.2.5 Regionally Significant Species (Site Region)	0	
4.1.2.6 Locally Significant Species (Site District)	20	
4.1.2.7 Species of Special Status		
Total for Species Rarity		20

4.2 SIGNIFICANT FEATURES AND HABITATS

4.2.1 Nesting of Colonial Waterbirds	0	
4.2.2 Winter Cover for Wildlife	10	
4.2.3 Waterfowl Staging and/or Moulting	20	
4.2.4 Waterfowl Breeding	10	
4.2.5 Migratory Passerine, Shorebird or Raptor Stopover	0	
4.2.6 Ungulate Habitat	15	
4.2.7 Fish Habitat		
4.2.7.1 Spawning and Nursery Habitat	0	
4.2.7.2 Migration and Staging Habitat	0	
Total for Significant Features and Habitat		55

4.3 ECOSYSTEM AGE — 3

TOTAL FOR SPECIAL FEATURES (not to exceed 250) — 78

WETLAND EVALUATION SCORING RECORD

WETLAND NAME Orsy's Wetland

1.0 BIOLOGICAL COMPONENT

1.1 PRODUCTIVITY

1.1.1 Growing Degree-Days/Soils	15	
1.1.2 Wetland Type	8	
1.1.3 Site Type	2	
Total for Productivity		25

1.2 BIODIVERSITY

1.2.1 Number of Wetland Types	9	
1.2.2 Vegetation Communities (maxixmum 45)	4	
1.2.3 Diversity of Surrounding Habitat (maximum 7)	7	
1.2.4 Proximity to Other Wetlands	8	
1.2.5 Interspersion	12	
1.2.6 Open Water Types	8	
Total for Biodiversity		48

1.3 SIZE (Biological Component)	7
TOTAL FOR BIOLOGICAL COMPONENT (not to exceed 250)	80

2.0 SOCIAL COMPONENT

2.1 ECONOMICALLY VALUABLE PRODUCTS

2.1.1 Wood Products	0	
2.1.2 Lowbush Cranberry	0	
2.1.3 Wild Rice	0	
2.1.4 Commercial Fish	0	
2.1.5 Furbearers	9	
Total for Economically Valuable Products		9

2.2 RECREATIONAL ACTIVITIES (maximum 80) — 8

2.3 LANDSCAPE AESTHETICS

2.3.1 Distinctness	3	
2.3.2 Absence of Human Disturbance	4	
Total for Landscape Aesthetics		7

2.4 EDUCATION AND PUBLIC AWARENESS

2.4.1 Educational Uses	0	
2.4.2 Facilities and Programs	0	
2.4.3 Research and Studies (maximum 12)	0	
Total for Education and Public Awareness		0

2.5 PROXIMITY TO AREAS OF HUMAN SETTLEMENT — 40

2.6 OWNERSHIP — 4

2.7 SIZE (Social Component) — 4

2.8 ABORIGINAL AND CULTURAL VALUES (maximum 30) — 0

TOTAL FOR SOCIAL COMPONENT (not to exceed 250) — 72

WETLAND DATA AND SCORING RECORD

i) **WETLAND NAME:** Orsy's Wetland

ii) **MNR ADMINISTRATIVE REGION:** Central **DISTRICT:** North Bay

AREA OFFICE (if different from District): Nipissing

iii) **CONSERVATION AUTHORITY JURISDICTION:** North Bay - Mattawa

(If not within a designated CA, check here:_____

iv) **COUNTY OR REGIONAL MUNICIPALITY:** City of North Bay

v) **TOWNSHIP:** Widdifield

vi) **LOTS & CONCESSIONS:** Lot 20, Con. B
(attach separate sheet if necessary)

vii) **MAP AND AIR PHOTO REFERENCES**

a) Latitude 46° 20' 40" Longitude: 79° 27' 40

b) UTM grid reference: Zone: 17 Block: PB
Grid: E 1 8 5 N 3 3 4

c) National Topographic Series:

map name(s) North Bay

map number(s) 31 L/6 edition 5th

scale 1:50000

d) Aerial photographs: Date photo taken: 1989 Scale: 1:10000

Flight & plate numbers: 4612 242 & 243

(attach separate sheet if necessary)

e) Ontario Base Map numbers & scale 1:20000

20 17 6100 51300

(attach separate sheets if necessary)

SUMMARY OF EVALUATION RESULT

Wetland ____________________

TOTAL FOR 1.0 BIOLOGICAL COMPONENT	80
TOTAL FOR 2.0 SOCIAL COMPONENT	72
TOTAL FOR 3.0 HYDROLOGICAL COMPONENT	161
TOTAL FOR 4.0 SPECIAL FEATURES COMPONENT	78
WETLAND TOTAL	391

INVESTIGATORS

Stephen Spencer, Mike Kenzie
Todd King, Wade McNiece

AFFILIATION

North Bay - Mattawa Conservation Authority

DATE July 7 1993

Reviewed with revisions Wayne Meil
Area Technician
Nipissing Area
Ministry of Natural Resources

Dec. 8, 1993

3.0 HYDROLOGICAL COMPONENT

3.1 FLOOD ATTENUATION	65	65
3.2 GROUNDWATER RECHARGE		
3.2.1 Site Type	13	
3.2.2 Soils	7	
Total for Groundwater Recharge		20
3.3 WATER QUALITY IMPROVEMENT		
3.3.1 Watershed Improvement Factor	29	
3.2.2 Adjacent and Watershed Land Use	34	
3.2.3 Vegetation Form	8	
Total for Water Quality Improvement		71
3.4 CARBON SINK		6
3.5 SHORELINE EROSION CONTROL		8
3.6 GROUNDWATER DISCHARGE (maximum 30)		28
TOTAL FOR HYDROLOGICAL COMPONENT (not to exceed 250)		198

4.0 SPECIAL FEATURES

4.1 RARITY

4.1.1 Wetlands

4.1.1.1 Rarity of Wetland Type (maximum 80)	30	
Total for Wetland Rarity		30

4.1.2 Species

4.1.2.1 Breeding Habitat for Endangered Species	0	
4.1.2.2 Traditional Migration or Feeding Habitat	0	
4.1.2.3 Provincially Significant Animal Species	0	
4.1.2.4 Provincially Significant Plant Species	0	
4.1.2.5 Regionally Significant Species (Site Region)	0	
4.1.2.6 Locally Significant Species (Site District)	0	
4.1.2.7 Species of Special Status	20	
Total for Species Rarity		20

4.2 SIGNIFICANT FEATURES AND HABITATS

4.2.1 Nesting of Colonial Waterbirds	0	
4.2.2 Winter Cover for Wildlife	10	
4.2.3 Waterfowl Staging and/or Moulting	20	
4.2.4 Waterfowl Breeding	10	
4.2.5 Migratory Passerine, Shorebird or Raptor Stopover	0	
4.2.6 Ungulate Habitat	25	
4.2.7 Fish Habitat		
4.2.7.1 Spawning and Nursery Habitat	33	
4.2.7.2 Migration and Staging Habitat	5	
Total for Significant Features and Habitat		103

4.3 ECOSYSTEM AGE — 3

TOTAL FOR SPECIAL FEATURES (not to exceed 250) — 156

WETLAND EVALUATION SCORING RECORD

WETLAND NAME Upper Chippewa Watershed Complex

1.0 BIOLOGICAL COMPONENT

1.1 PRODUCTIVITY

1.1.1 Growing Degree-Days/Soils	15	
1.1.2 Wetland Type	11	
1.1.3 Site Type	3	
Total for Productivity		29

1.2 BIODIVERSITY

1.2.1 Number of Wetland Types	30	
1.2.2 Vegetation Communities (maxixmum 45)	33	
1.2.3 Diversity of Surrounding Habitat (maximum 7)	7	
1.2.4 Proximity to Other Wetlands	8	
1.2.5 Interspersion	27	
1.2.6 Open Water Types	14	
Total for Biodiversity		119

1.3 SIZE (Biological Component)	50
TOTAL FOR BIOLOGICAL COMPONENT (not to exceed 250)	198

2.0 SOCIAL COMPONENT

2.1 ECONOMICALLY VALUABLE PRODUCTS

2.1.1 Wood Products	4	
2.1.2 Lowbush Cranberry	2	
2.1.3 Wild Rice	0	
2.1.4 Commercial Fish	12	
2.1.5 Furbearers	12	
Total for Economically Valuable Products		30

2.2 RECREATIONAL ACTIVITIES (maximum 80) 36

2.3 LANDSCAPE AESTHETICS

2.3.1 Distinctness	3	
2.3.2 Absence of Human Disturbance	1	
Total for Landscape Aesthetics		4

2.4 EDUCATION AND PUBLIC AWARENESS

2.4.1 Educational Uses	0	
2.4.2 Facilities and Programs	0	
2.4.3 Research and Studies (maximum 12)	12	
Total for Education and Public Awareness		12

2.5 PROXIMITY TO AREAS OF HUMAN SETTLEMENT	40
2.6 OWNERSHIP	4
2.7 SIZE (Social Component)	20
2.8 ABORIGINAL AND CULTURAL VALUES (maximum 30)	

TOTAL FOR SOCIAL COMPONENT (not to exceed 250) 146

WETLAND DATA AND SCORING RECORD

i) WETLAND NAME: Upper Chippewa Watershed Complex

ii) MNR ADMINISTRATIVE REGION: Central DISTRICT: North Bay

AREA OFFICE (if different from District):

iii) CONSERVATION AUTHORITY JURISDICTION: North Bay-Mattawa

(If not within a designated CA, check here:____

iv) COUNTY OR REGIONAL MUNICIPALITY: City of North Bay

v) TOWNSHIP: Widdifield

vi) LOTS & CONCESSIONS:
(attach separate sheet if necessary)

Conc. A Lots 19 - 21
Conc. 1 Lots 17 - 22
Conc. 2 Lots 16 - 22
Conc. 3 Lots 19 - 21

vii) MAP AND AIR PHOTO REFERENCES

a) Latitude 79° 33' Longitude: 46° 22'

b) UTM grid reference: Zone: 17T Block: PB
Grid: E 1 8 5 N 3 5 0

c) National Topographic Series:

map name(s) North Bay

map number(s) 31 L/G edition 5

scale 1:50,000

d) Aerial photographs: Date photo taken: 1989 Scale: 1:10,000

Flight & plate numbers: 4612 242,243
4613 216,217

(attach separate sheet if necessary)

e) Ontario Base Map numbers & scale scale 1:20,000

20 17 6200 51300 & 20 17 6100 51300
(attach separate sheets if necessary)

SUMMARY OF EVALUATION RESULT

Wetland Upper Chippewa Watershed Complex

TOTAL FOR 1.0 BIOLOGICAL COMPONENT	198
TOTAL FOR 2.0 SOCIAL COMPONENT	146
TOTAL FOR 3.0 HYDROLOGICAL COMPONENT	198
TOTAL FOR 4.0 SPECIAL FEATURES COMPONENT	156
WETLAND TOTAL	698

INVESTIGATORS

Steve Spencer, Wade McNeice, Mike Kenzie, Todd King - N.B.M.C.A.

AFFILIATION

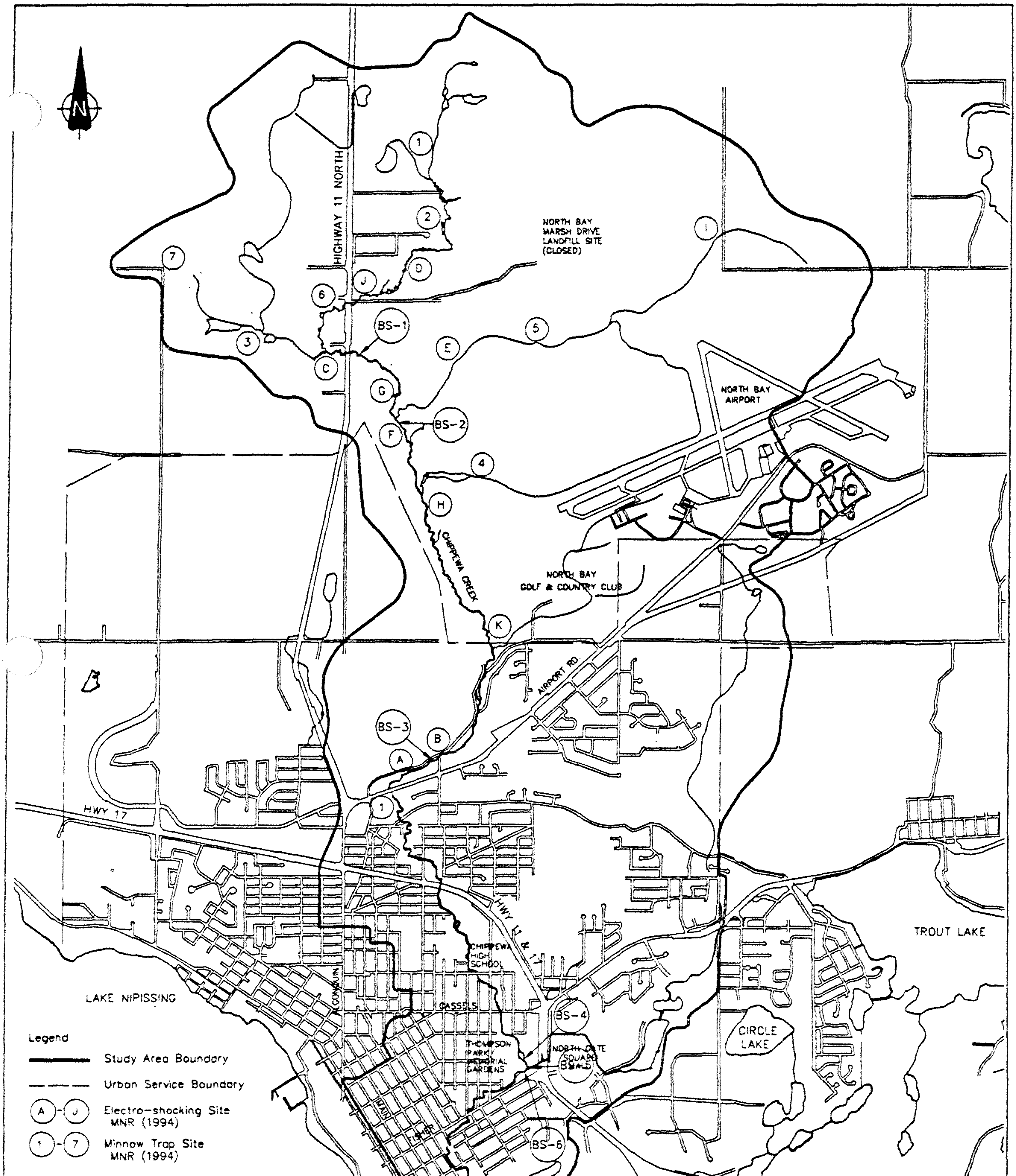
North Bay - Mattawa Conservation Authority

DATE Sept. 14, 1993

reviewed and updated February 11, 1994
Wayne Meil, Area Technician, Nipissing
Ontario Ministry of Natural Reaources.

APPENDIX F-4

ADDITIONAL MAPPING



HERIES SAMPLING LOCATIONS

Proctor & Redfern Ltd
Consulting Engineers & Planners
Toronto North Bay

APPENDIX F-5

TRANS-CANADA PIPELINE REPORT SUMMARY

Natural vegetation is predominantly mixed forest belonging to the Great Lakes - St. Lawrence Forest Region. The forest is characterized by the occurrence of eastern white pine, red pine, eastern hemlock, and yellow birch, in association with a number of dominant hardwood species such as sugar maple, red maple, red oak, basswood and white elm. Other wide-ranging species are eastern white cedar and large tooth aspen, and to a lesser extent beech, white oak, butternut and white ash. Boreal species, such as white spruce, black spruce, balsam fir, jack pine, trembling aspen, balsam poplar and white birch, are intermixed and, in certain areas, red spruce becomes abundant.

Based on information made available by the OMNR (Maraldo, 1991) there are no Woodlot Improvement Act Agreement (WIAA) areas in the project-specific study area.

Along the TransCanada pipeline right-of-way, the vast majority of spontaneous vegetation on either side is mixed wood forest, much of it in diverse composition. Small areas of wetlands are present in the vicinity of stream crossings and in swales. All of the wetland areas seen along the right-of-way are seasonal marshes or wet meadows, and no individual wetland occupies in area greater than 0.3 ha.

The proposed transmission line right-of-way lies west of, and adjacent to, the existing TransCanada right-of-way, and crosses a more low-lying area than the pipeline right-of-way. As a result, nearly all the forested area (7 ha.) along the proposed transmission line is wet conifer forest. The proposed transmission line will also cross about 7 ha. of wetland, mainly swamp thickets dominated by speckled alder.

The **wet conifer forest** on the north half of the property at Compressor Station No. 116 occurs as an irregular ring. The dominant species are balsam fir and white spruce. White birch, yellow birch, black ash and black spruce are scattered throughout the stands. Species are speckled alder and wild raisin. Among the most frequent understory most of the forest is young with trees between 12 cm and 15 cm diameter.

On the proposed transmission line, black spruce and balsam fir are the dominants in the wet conifer forest, and the occurrence of other tree species is quite limited. The understory is sparse with speckled alder and labrador tea being the most frequent species.

The most extensive upland forest community in the study area is mixed woods forest, occurring along most of the existing pipeline right-of-way. The upland forest communities on both sides of the existing TransCanada pipeline right-of-way are similar. Along the proposed transmission line right-of-way, the mixed woods stands differ in species composition and dominance, generally in response to local soil moisture conditions and soil type.

On well-drained soils, sugar maple, white birch and trembling aspen area the dominant species with balsam fir and white spruce present as minor constituents. On lower slopes and swales, balsam fir, black spruce and white cedar are the dominants with minor representation by birch and red maple. Wild raisin is the most abundant understory species.

Near Duchesnay Creek, balsam fir is the principal dominant and trembling aspen is a subdominant.

The proposed transmission line right-of-way will cross three sections of provincially significant wetlands dominated by relatively dense alder thickets. Speckled alder is the dominant species.

Patches of a provincially significant seasonal marsh or wet meadow are present on and along the edges of sections of the pipeline right-of-way where periodic flooding occurs. A couple of small seasonal marshes are also present on the proposed transmission line right-of-way.

The marsh communities in the study area are dominated by a mix of graminoid plants, most notably the grasses, canada blue joint and tall manna grass, sedges and the common cattail.

The largest acreage of open space on the north half of the TransCanada property at Compressor Station No. 116 is occupied by mowed fields. These fields contain a mixture of agricultural species, mostly grasses and legumes, such as red-nap, meadow fescue, timothy and red clover.

APPENDIX G

ARCHAEOLOGY

ARCHAEOLOGY

Archaeological sites are a non-renewable resource requiring proper planning, development, management and protection similar to that afforded to other natural resources and environmental features. Before initiation of fieldwork, Settlement Surveys Ltd. checked relevant files for previously recorded/registered archaeological sites in the North Bay City area. Too, previous archaeological reports were examined to determine if any prehistoric sites had been previously recorded either in or near the Chippewa Creek study area.

Previous archaeological work in the region was undertaken by Wright and Saunders (1980). Burns and Tyyska reported on the North Bay to Mattawa area (1973) as did P. and M. Wright (1975). Also in 1975, A. Tyyska described the Palferman Site in a Canadian Archaeological Association Paper (Tyyska 1975). In 1980, Morris J. Brizinski completed his M.A. thesis at McMaster University (Brizinski 1980). He followed up on earlier work by Frank Ridley at the Frank Bay Site at the west end of Lake Nipissing (Ridley 1954). Also, during the mid 1980's, Beverely Smith undertook a brief survey of the Manitou Islands in Lake Nipissing. However, overall there has been little work within the North Bay City area.

Brief Prehistory of the Study Area

A generalized overview of North Bay's prehistory is presented here for quick review:

<u>Shield Archaic Peoples (5,500 B.C. - 500 B.C.)</u>
The Shield Archaic peoples are represented by the Environmental Frontiersman theme. One of the theme developments is the Abitibi Narrows Phase and Mattawa Archaic (developmental aspects of themes are based on technological and stylistic differences and variations in raw materials as well as the geographic distribution of technology, style, etc...) see Ontario, A Topical Organization of Ontario History 1975: 14,15). The Shield

Archaic peoples (which may involve one or more separate cultural phases or groups) were wide-spread across northern Ontario and may have evolved their culture and technology from the preceding Plano peoples who lived in the Thunder Bay and Manitoulin Island areas.

Laurel peoples (500 B.C. - 500/900 A.D.)

Laurel peoples are represented by the Indigenous Settlers, Traders and Potters Theme (Ontario, A Topical Organization of Ontario History n.d.:22). This phase marks the first appearance of pottery in the North Bay region. Laurel sites tend to be found along major lakes and rivers. Moose and beaver were important food sources as were fish.

Late Prehistoric Peoples (A.D. 500/900 - 1600 A.D.)

These peoples were the groups who lived in Northeastern Ontario just prior to the arrival of Etienne Brule and other Europeans (Father La Caron, Samuel de Champlain, Brother Gabriel Sagard and Alexander MacKenzie) along with European trade goods. Many of these late prehistoric groups are known on the basis of their pottery vessels and distinctive decorations found on them. Some of these pottery traditions found in the area are Blackduck and Ontario Iroquois. These peoples were the ancestors of the present day Anishnabeg (Nipissing and dokis First Nations) peoples who still reside in the area. The Anishnabeg people have shared this area for three hundred and eighty-two years (1610-1992) with European settlers. However, their history in the area goes back a minimum of 6,000 years and perhaps several thousand years earlier to the days of the glacial lake. The entire area was utilized even the very small creeks and lakes (such as Johnson Creek/Delaney or Mud Lake) during this lengthy time period.

Ontario

Ministry of Culture and Communications

Ministère de la Culture et des Communications

Archaeological Site Record

Formule de renseignements - site archéologique

Borden number / Numéro Borden: CLGu-13?

•This form is intended for the field recording of archaeological site in... ...on for sites which have not previously been documented with the ...f Culture and Communications.

•... ...e Archaeological Site Update form to record additional or corrected information concerning sites known to be in the Ministry's files.

•Refer to the instructions when completing the form and contact the Ministry of Culture and Communications for further assistance.

•Return original to the Ministry of Culture and Communications.

•La présente formule sert à consigner sur le terrain même les renseignements archéologiques concernant les sites pour lesquels le ministère de la Culture et des Communications ne dispose pas encore d'une documentation.

•Utiliser la feuille de mise à jour pour noter les renseignements supplémentaires ou révisés sur les sites archéologiques répertoriés dans les dossiers du ministère.

•En remplissant cette formule, se reporter aux instructions et solliciter au besoin l'aide du ministère de la Culture et des Communications.

•Renvoyer l'original au ministère de la Culture et des Communications.

Site Identification / Identification du site

Borden number - Upper case / Numéro Borden - section du haut	Lower case / Section du bas	2. Sequential number / Numéro de série	3. Researcher's site number / Numéro du site fix par l'archéologue
			Site #5

Preferred name / Nom préconisé	5. Other names / identifiers / Autres désignations
Historic Cabin or Cache	

Site Location / Repérage du site

Province	7. County or District / Comté ou district	8. Township / Canton	9. Concession	Lot(s)	10. Municipal Plan Reference No. / Numéro du plan officiel
Ontario	Nipissing	Municipality of North Bay	---	---	---

Street address / Adresse: ---

Elevation / Altitude	13. NTS map / Carte du système national de référence cartographique	14. Copy of map segment / Copie du segment de la carte	15. Sketch map of site / Plan du site
200 ☐ feet / pieds ☑ metres / mètres	1:50,000 31L/6	☑	☐

Grid reference - Grid zone / Référence au quadrillage militaire - zone du quadrillage	100,000 metre square / 100 000 mètres carrés	Easting / Orientation par rapport à l'est	Northing / Orientation par rapport au nord
17T	PB	221	290

Latitude	Longitude
46° 18' 20"	79° 24' 50"

Location and access / Emplacement exact et accès

The site in on the lower east side of the narrows between Twin Lakes

Site Investigation / Exploration du site

Researcher / Archéologue	20. Licence number / Numéro du permis	21. Site observed / Site étudié	Year / année	Month / mois
Dr. John Pollock	94-065		1994	09

Informant(s), Address(es), Nature of information / Informateur(s), adresse(s), nature de l'information

Activities conducted at site / Travaux réalisés sur les lieux

Subsurface testing was done and also photography.

...inued

Borden number
Numéro Borden

ite Investigation
xploration du site

ı. Description of environment
Description de l'environnement

Well treed low area 15 metre back for the shoreline

Nature, density and extent of observed cultural remains
Nature, densité et ampleur des vestiges culturels étudiés

Low earthen mound representing either the remains of a former log cabin or a cache for shoring food and/or supplies.

ɘrences
ɘrences

Dates	Historic
Basis Indices à l'appui	
Site function/type Fonction/nature du site	Cabin or Cache
Basis Indices à l'appui	
Site structure Structure de site	
Basis ndices à l'appui	
Affinities Affinités	Euro-Canadian
Basis ndices à l'appui	

umentation	Location Emplacement	Nature
ırtifact collections :ollection d'artefacts	Settlement Surveys Ltd. New Liskeard, Ont.	
ictorial records locumentation visuelle	Dr. John Pollock, Settlement Surveys Ltd., New Liskeard, Ont.	
ıeld notes ıbservations faites ur le terrain	as above	
npublished material atériel inédit	as above	
ublished material atériel publié	N/A	

nents
nentaires

ncomplete and/or incorrectly completed forms will be eturned to the researcher.
.es formules incomplètes ou incorrectement remplies seront renvoyés a l'archéologue.

Form completed by Formule remplie par	Date
Valerie Boal	May 25, 1995

Ministry of Culture and Communications
Ontario
Ministère de la Culture et des Communications

Archaeological Site Record

Formule de renseignements - site archéologique

Borden number
Numéro Borden
CkGu-17

•This form is intended for the field recording of archaeological site information for sites which have not previously been documented with the Ministry of Culture and Communications.
•Use the Archaeological Site Update form to record additional or corrected information concerning sites known to be in the Ministry's files.
•Refer to the instructions when completing the form and contact the Ministry of Culture and Communications for further assistance.
•Return original to the Ministry of Culture and Communications.

•La présente formule sert à consigner sur le terrain même les renseignements archéologiques concernant les sites pour lesquels le ministère de la Culture et des Communications ne dispose pas encore d'une documentation.
•Utiliser la feuille de mise à jour pour noter les renseignements supplémentaires ou révisés sur les sites archéologiques répertories dans les dossiers du ministère.
•En remplissant cette formule, se reporter aux instructions et solliciter au besoin l'aide du ministère de la Culture et des Communications.
•Renvoyer l'original au ministère de la Culture et des Communications.

Site Identification / Identification du site

1. Borden number - Upper case / Numéro Borden - section du haut:
Lower case / Section du bas:
2. Sequential number / Numéro de série:
3. Researcher's site number / Numéro du site fix par l'archéologue: Site #4

4. Preferred name / Nom préconisé: Delaney Lake Sawmill Foundation
5. Other names / identifiers / Autres désignations:

Site Location / Repérage du site

6. Province	7. County or District / Comte ou district	8. Township / Canton	9. Concession	Lot(s)	10. Municipal Plan Reference No. / Numéro du plan officiel
Ontario	Nipissing	Municipality of North Bay	—	—	—

11. Street address / Adresse: —

12. Elevation / Altitude: 200 ☐ feet / pieds ☐ metres / mètres
13. NTS map / Carte du système national de référence cartographique: 1:50,000 31L/6
☐ 14. Copy of map segment / Copie du segment de la carte
☐ 15. Sketch map of site / Plan du site

Military grid reference - Grid zone / Référence au quadrillage militaire - zone du quadrillage	100,000 metre square / 100 000 mètres carrés	Easting / Orientation par rapport à l'est	Northing / Orientation par rapport au nord
17T	PB	207	301

Latitude: 46° 19'
Longitude: 79° 25' 55"

Location and access / Emplacement exact et accès

Site is on the northwest shore of Delaney Lake in the City of North Bay.

Site Investigation / Exploration du site

Researcher / Archéologue: Dr. John Pollock
20. Licence number / Numéro du permis: 94-065
21. Site observed / Site étudié — Year / année: 1994 Month / mois: 09

Informant(s), Address(es), Nature of information / Informateur(s), adresse(s), nature de l'information

Activities conducted at site / Travaux réalisés sur les lieux

One photo was taken but no test pits were dug.

Continued

Borden number
Numéro Borden

24. Description of environment
Description de l'environnement

Disturbed lakeshore terrace with rock outcrop.

5. *Nature, density and extent of observed cultural remains*
Nature, densité et ampleur des vestiges culturels étudiés

Remnants of an old sawmill plus foundations for a jackladder.

ferences
lérences

Dates	Historic
Basis Indices à l'appui	
Site function/type Fonction/nature du site	Sawmill
Basis Indices à l'appui	
Site structure Structure de site	
Basis Indices à l'appui	
Affinities Affinités	Euro-Canadian
Basis *Indices à l'appui*	

cumentation	Location Emplacement	Nature
Artifact collections Collection d'artefacts	Settlement Surveys Ltd. New Liskeard, Ont.	
Pictorial records Documentation visuelle	Dr. John Pollock, Settlement Surveys Ltd., New Liskeard, Ont.	
Field notes Observations faites sur le terrain	as above	
Unpublished material Matériel inédit	as above	
Published material Matériel publié	N/A	

nments
nmentaires

Incomplete and/or incorrectly completed forms will be returned to the researcher.
Les formules incomplètes ou incorrectement remplies seront renvoyés a l'archéologue.

Form completed by Formule remplie par	Date
Valerie Boal	May 25, 1995

Ministry of Culture and Communications
Ministère de la Culture et des Communications
Ontario

Archaeological Site Record

Formule de renseignements - site archéologique

Borden number / Numéro Borden: CbGu-16

•This form is intended for the field recording of archaeological site information for sites which have not previously been documented with the Ministry of Culture and Communications.
•Use the Archaeological Site Update form to record additional or corrected information concerning sites known to be in the Ministry's files.
•Refer to the instructions when completing the form and contact the Ministry of Culture and Communications for further assistance.
•Return original to the Ministry of Culture and Communications.

•La présente formule sert à consigner sur le terrain même les renseignements archéologiques concernant les sites pour lesquels le ministère de la Culture et des Communications ne dispose pas encore d'une documentation.
•Utiliser la feuille de mise à jour pour noter les renseignements supplémentaires ou révisés sur les sites archéologiques répertories dans les dossiers du ministère.
•En remplissant cette formule, se reporter aux instructions et solliciter au besoin l'aide du ministère de la Culture et des Communications.
•Renvoyer l'original au ministère de la Culture et des Communications.

Site Identification / Identification du site

1. Borden number - Upper case / Numéro Borden - section du haut:
Lower case / Section du bas:
2. Sequential number / Numéro de série:
3. Researcher's site number / Numéro du site fix par l'archéologue: Site #3
4. Preferred name / Nom préconisé: McLean Lake Portage
5. Other names / identifiers / Autres désignations:

Site Location / Repérage du site

6. Province: Ontario
7. County or District / Comte ou district: Nipissing
8. Township / Canton: Municipality of North Bay
9. Concession: —
Lot(s): —
10. Municipal Plan Reference No. / Numéro du plan officiel: —
11. Street address / Adresse: —
12. Elevation / Altitude: 200 feet / pieds / metres / mètres
13. NTS map / Carte du système national de référence cartographique: 1:50,000 31L/6
14. Copy of map segment / Copie du segment de la carte
15. Sketch map of site / Plan du site

Military grid reference - Grid zone / Référence au quadrillage militaire - zone du quadrillage: 17T
100,000 metre square / 100 000 mètres carrés: PB
Easting / Orientation par rapport à l'est: 226
Northing / Orientation par rapport au nord: 298

Latitude: 46° 18' 50"
Longitude: 79° 24' 25"

Location and access / Emplacement exact et accès

Site is located in the City of North bay on the northwest end of McLean Lake at a portage landing area.

Site Investigation / Exploration du site

Researcher / Archeologue: Dr. John Pollock
20. Licence number / Numero du permis: 94-065
21. Site observed / Site etudié — Year / année: 1994 Month / mois: 09

Informant(s), Address(es), Nature of information / Informateur(s), adresse(s), nature de l'information

Activities conducted at site / Travaux réalisés sur les lieux

Test pits dug to a depth of 10 to 15 cm, plus photography.

Continued
Suite

Borden number
Numéro Borden

Site Investigation
Exploration du site

24. Description of environment
Description de l'environnement

Site is in a low sandy subsoil area next to a subdivision at the northwest end of McLean Lake.

25. Nature, density and extent of observed cultural remains
Nature, densité et ampleur des vestiges culturels étudiés

Numerous chert flakes

Inferences
Inférences

26. Dates	Prehistoric
Basis Indices à l'appui	
27. Site function/type Fonction/nature du site	Site and Portage
Basis Indices à l'appui	
28. Site structure Structure de site	
Basis Indices à l'appui	
29. Affinities Affinités	Aboriginal
Basis Indices à l'appui	

Documentation

	Location Emplacement	Nature
30. Artifact collections Collection d'artefacts	Settlement Surveys Ltd. New Liskeard, Ont.	
31. Pictorial records Documentation visuelle	Dr. John Pollock, Settlement Surveys Ltd., New Liskeard, Ont.	
32. Field notes Observations faites sur le terrain	as above	
33. Unpublished material Materiel inedit	as above	
34. Published material Materiel publie	N/A	

Comments
Commentaires

This site warrants further testing.

N.B. Incomplete and/or incorrectly completed forms will be returned to the researcher.
Les formules incomplètes ou incorrectement remplies seront renvoyés a l'archéologue.

Form completed by Formule remplie par	Date
Valerie Boal	May 25, 1995

Ministry of Culture and Communications
Ministère de la Culture et des Communications

Ontario

Archaeological Site Record

Formule de renseignements - site archéologique

Borden number
Numéro Borden
Closure[?]

•This form is intended for the field recording of archaeological site in[...]tion for sites which have not previously been documented with the [...]f Culture and Communications.
•[...]e Archaeological Site Update form to record additional or corrected information concerning sites known to be in the Ministry's files.
•Refer to the instructions when completing the form and contact the Ministry of Culture and Communications for further assistance.
•Return original to the Ministry of Culture and Communications.

•La présente formule sert à consigner sur le terrain même les renseignements archéologiques concernant les sites pour lesquels le ministère de la Culture et des Communications ne dispose pas encore d'une documentation.
•Utiliser la feuille de mise à jour pour noter les renseignements supplémentaires ou révisés sur les sites archéologiques répertories dans les dossiers du ministère.
•En remplissant cette formule, se reporter aux instructions et solliciter au besoin l'aide du ministère de la Culture et des Communications.
•Renvoyer l'original au ministère de la Culture et des Communications.

Site Identification
Identification du site

1. Borden number - Upper case / Numéro Borden - section du haut:
   Lower case / Section du bas:
2. Sequential number / Numéro de série:
3. Researcher's site number / Numéro du site fix par l'archéologue: Site #2
4. Preferred name / Nom préconisé: Prehistoric Delaney (Mud) Lake Site
5. Other names / identifiers / Autres désignations:

Site Location
Repérage du site

Province	7. County or District / Comte ou district	8. Township / Canton	9. Concession	Lot(s)	10. Municipal Plan Reference No. / Numéro du plan officiel
Ontario	Nipissing	Municipality of North Bay	—	—	—

11. Street address / Adresse: —

12. Elevation / Altitude: 200 ☐ feet / pieds ☒ metres / mètres

13. NTS map / Carte du système national de référence cartographique: 1:50,000 31L/6

☐ 14. Copy of map segment / Copie du segment de la carte

☒ 15. Sketch map of site / Plan du site

[...] grid reference - Grid zone / [...]ce au quadrillage militaire - zone du quadrillage	100,000 metre square / 100 000 mètres carrés	Easting / Orientation par rapport à l'est	Northing / Orientation par rapport au nord
17T	PB	205	298

Latitude: 46° 18' 50"
Longitude: 79° 26' 5"

Location and access / Emplacement exact et accès

Site is located at the extreme west end of Delaney Lake in the City of North Bay.

Site Investigation
Exploration du site

Researcher / Archéologue: Dr. John Pollock

20. Licence number / Numéro du permis: 94-065

21. Site observed / Site étudié — Year / année: 1994 — Month / mois: 09

Informant(s), Address(es), Nature of information
Informateur(s), adresse(s), nature de l'information

Activities conducted at site
Travaux realises sur les lieux

Site maps drawn, test pits dug, and photography.

[...]nued
[...]te
[...]30 (04/90)

Borden number
Numéro Borden

Site Investigation
Exploration du site

24. Description of environment
Description de l'environnement

Site is on a flat rock outcrop that forms a small point.

25. Nature, density and extent of observed cultural remains
Nature, densité et ampleur des vestiges culturels étudiés

Artifacts recovered include 2 pieces of fire cracked rock, 2 chert flakes, a rust nail, broken glass pieces, carbonized wood and 2 pieces of white quartz.

nferences
nférences

6. Dates	Prehistoric
Basis / Indices à l'appui	
7. Site function/type / Fonction/nature du site	Landing
Basis / Indices à l'appui	
8. Site structure / Structure de site	
Basis / Indices à l'appui	
9. Affinities / Affinites	Aboriginal
Basis / Indices à l'appui	

ocumentation	Location / Emplacement	Nature
) Artifact collections / Collection d'artefacts	Settlement Surveys Ltd. New Liskeard, Ont.	
1. Pictorial records / Documentation visuelle	Dr. John Pollock, Settlement Surveys Ltd., New Liskeard, Ont.	
2 Field notes / Observations faites sur le terrain	as above	
3. Unpublished material / Matériel inédit	as above	
4. Published material / Matériel publié	N/A	

omments
ommentaires

.B. Incomplete and/or incorrectly completed forms will be returned to the researcher.
Les formules incomplètes ou incorrectement remplies seront renvoyés a l'archéologue.

Form completed by / Formule remplie par	Date
Valerie Boal	May 25, 1995

Ministry of Culture and Communications
Ontario
Ministère de la Culture et des Communications

Archaeological Site Record

Formule de renseignements - site archéologique

Borden number / Numéro Borden: CbGu-14

This form is intended for the field recording of archaeological site ...n for sites which have not previously been documented with the ... Culture and Communications.
... Archaeological Site Update form to record additional or corrected information concerning sites known to be in the Ministry's files.
•Refer to the instructions when completing the form and contact the Ministry of Culture and Communications for further assistance.
•Return original to the Ministry of Culture and Communications.

La présente formule sert à consigner sur le terrain même les renseignements archéologiques concernant les sites pour lesquels le ministère de la Culture et des Communications ne dispose pas encore d'une documentation.
Utiliser la feuille de mise à jour pour noter les renseignements supplémentaires ou révisés sur les sites archéologiques répertories dans les dossiers du ministère.
•En remplissant cette formule, se reporter aux instructions et solliciter au besoin l'aide du ministère de la Culture et des Communications.
•Renvoyer l'original au ministère de la Culture et des Communications.

ite Identification / lentification du site

Borden number - Upper case / Numéro Borden - section du haut:
Lower case / Section du bas:
2. Sequential number / Numéro de série:
3. Researcher's site number / Numéro du site fix par l'archéologue: Site #1

Preferred name / Nom préconisé: Chippewa Creek Campsite and Trail
5. Other names / identifiers / Autres désignations:

ite Location / epérage du site

Province	7. County or District / Comte ou district	8. Township / Canton	9. Concession	Lot(s)	10. Municipal Plan Reference No. / Numéro du plan officiel
Ontario	Nipissing	Municipality of North Bay	---	---	---

Street address / Adresse: ---

Elevation / Altitude: 220 ☐ feet / pieds ☒ metres / mètres
13. NTS map / Carte du système national de référence cartographique: 1:50,000 31L/6
☒ 14. Copy of map segment / Copie du segment de la carte
☒ 15. Sketch map of site / Plan du site

...gnd reference - Grid zone / ...ce au quadrillage militaire - zone du quadrillage	100,000 metre square / 100 000 mètres carrés	Easting / Orientation par rapport à l'est	Northing / Orientation par rapport au nord
17T	PB	195	311

Latitude: 46° 19' 30"
Longitude: 79° 26' 45"

Location and access / Emplacement exact et accès

Site is located in the City of North Bay, on Highway 11 north of Trout Lake Road, on the east side.

e Investigation / ploration du site

Researcher / Archéologue: Dr. John Pollock
20. Licence number / Numéro du permis: 94-065
21. Site observed / Site étudié — Year / année: 1994 — Month / mois: 09

Informant(s), Address(es), Nature of information / Informateur(s), adresse(s), nature de l'information

Activities conducted at site / Travaux réalisés sur les lieux

Site map done, test pits dug, photography.

...inued

Borden number
Numéro Borden

e Investigation
ploration du site

Description of environment
Description de l'environnement

Short remnant (250 meters) remain of ancient "treadway" worn into the ground. Located and surrounded by urban growth.

Nature, density and extent of observed cultural remains
Nature, densité et ampleur des vestiges culturels étudiés

Remains found include broken glass pieces, rusted bottle cap, densely burnt and melted rock pieces.

rences
rences

Dates	Prehistoric
Basis / ndices à l'appui	
Site function/type / Fonction/nature du site	Campsite and trail
Basis / ndices à l'appui	
Site structure / Structure de site	
Basis / ndices à l'appui	
Affinities / Affinités	Aboriginal
Basis / ndices à l'appui	

umentation

	Location / Emplacement	Nature
rtifact collections / ollection d'artefacts	Settlement Surveys Ltd. New Liskeard, Ont.	
ictorial records / ocumentation visuelle	Dr. John Pollock, Settlement Surveys Ltd., New Liskeard, Ont.	
ield notes / bservations faites ur le terrain	as above	
npublished material / atériel inédit	as above	
ublished material / atériel publié	N/A	

ments
mentaires

Incomplete and/or incorrectly completed forms will be returned to the researcher.
Les formules incomplètes ou incorrectement remplies seront renvoyés a l'archéologue.

Form completed by / Formule remplie par: Valerie Boal

Date: May 25, 1995

ARTIFACT CATALOGUE

May 25, 1995

	Borden number	Catalogue #	Description	# Spec.	Site Location\Field #	Date	Project Number	Remarks
1		1	Rusted bottle cap	1	#1, Chippewa Creek	09/22/94	94-2	
2		3	5 pieces of densely burnt and melted rock pieces	5	#1, Chippewa Creek	09/22/94	94-2	
3		4	2 pieces of white soft rock	2	#1, Chippewa Creek	09/22/94	94-2	
4		1	2 pieces fire cracked rock	2	#2 Delaney (Mud) Lake	09/22/94	94-2	
5		2	2 chert flakes	2	#2, Delaney (Mud) Lake	09/22/94	94-2	
6		3	Piece of white broken glass	1	#2, Delaney (Mud) Lake	09/22/95	94-2	
7		4	Piece lilac coloured broken glass	1	#2, Delaney (Mud) Lake	09/22/94	94-2	

ARTIFACT CATALOGUE

May 25, 1995

	Borden number	Catalogue #	Description	# Spec.	Site Location\Field #	Date	Project Number	Remarks
8		5	Large corroded and rusty nail	1	#2, Delaney (Mud) Lake	09/22/94	94-2	
9		6	piece of carbonized wood	1	#2, Delancy (Mud) Lake	09/22/94	94-2	
10		7	2 pieces white quartz	2	#2, Delaney (Mud) Lake	09/22/94	94-2	

APPENDIX H

PUBLIC COMMENTS

1st Steering Committee Meeting - Introduction	November 25/93
Letter of Intent Request for Letters of Interest	December 20, 21, 22, 1993
Reply to letter of interest to be received today	January 7/94
2nd Steering Committee Meeting - Choose firms from letters of interest	January 25/94
Information Session for Consultants NBMCA, MNR, MOEE, City of North Bay	February 16/94
Proposals due from consultants	March 4/94
Interviews - 6 firms Northland Engineering Ltd. Proctor & Redfern Ltd. Totten, Sims, Hubicki Ltd. Paragon Engineering Mc Neely Eng. drops out of competition March 2/94 Fenco Mac Laren drops out March 4/94	March 22/94

As a result of the interviews the firm of **PROCTOR & REDFERN** has been chosen to undertake the Chippewa Creek Watershed Management Study.

Received DRAFT Terms of Reference from P&R	May 27/94
Steering Committee Members to forward comments on draft Terms of Reference before June 29/94	
Final Terms of Reference to be presented to Authority Board Members	June 29/94
Contract "officailly" awarded to P&R	July '94
Steering Committee Meeting study schedule, workplan, progress, tour	August 25/94
1st Public Liaison Committee Meeting same as steering com. mtg.	August 25/94
Watershed tour for PLC	August 31/94
Phase One Report Distributed to committee members	December '94

4th Steering Committee Meeting (Ph. 1 Bkg Review)		January 17/95
2nd Public Liaison Committee Meeting		January 17/95
3rd PLC Meeting		February 15/95
Public Open House - North Bay Public Library		February 21/95
Display -	Northgate Square	February 22-27/95
	Chippewa & Widdefield Secondary Schools	February 27-March 9/95
	North Bay Mall	March 10-13
	North Bay City Hall Foyer	March 13-17
	Northgate Square	March 17-20
5th Steering Committee Meeting (Goals & Objectives)		April 18/95
4th PLC Meeting		April 18/95
Nipissing Rotary Club Boat Show - Display		April 21-23, 1995
Great Northern Snowmobile & Outdoors Show - Display		September 22-24, 1995
6th Steering Com. Meeting (Presentation of Wat. Man. Alter.)		November 1/95
5th PLC Meeting		November 1, 1995
7th Steering Com. Meeting (Phase 3 Report)		October 16, 1996
6th PLC Meeting		October 16, 1996
Notice of Filing of Draft Report		November 1, 1996
Public Meeting - City Hall		November 27, 1996

Jane Agnew
R.R. #3
North Bay, Ont., PIB 8G4

Nov. 26, 1996

NOV 28 1996

Minister of Environment and Energy
135 St. Clair Avenue, W., 15th Floor
Toronto Ont., M4V 1P5

Re: public notice of proposed changes to the Chippewa Creek Watershed Management.

My concern in this matter relates to the Eastern boundary of the Study Area. In particular the Johnston Creek and Delaney Lake watersheds referred to as "Subwatersheds 15-19" on Proctor and Redfern's "Design Flow Rates Comparrison" chart fig. 2.3.5. and later as Area 4 in fig. 7. 2. 1.

This subwatershed lies so close to Trout Lake and therefore the Mattawa/Ottawa watershed that the introduction of a small beaver dam caused Johnston Creek to divert some of its flow into a nearby culvert and then into Trout Lake. This not only alters the water quality of Trout Lake but also destroys the integrity of two of Ontario's largest watershed systems, namely the French River/Great Lakes system and the Mattawa/Ottawa system.

Moreover the vertical elevation between the Delaney Lake area and two small lakes adjacent to the study area namely Circle and Depencier Lake is so small that in the high water conditions, water seeps across from the Delaney Lake marshes to Circle Lake.

Any decrease in the Water Storage Capacity of the lands adjoining Johnston Creek or Deleany Lake systems is unacceptable. Surely these lands can be regarded as landscaping opportunities containing many of the ingredients of some of the world's most famous gardens.

Any increse, re-routing or other changes to the flow of water in these two systems is unacceptable. This small tribtary to the Chippewa Creek System is one of the ones that is working quite well now and everything possible should be done to protect it's natural condition.

If the Minister of Environment and Energy together with the consulting engineers at Proctor and Redfern can give assurances that the plan protects all the Water Storage Capacity mentioned and does not seek to alter the water flow in the area mentioned the this objection will be withdrawn. Until the time that such assurances can be given this letter stands as a formal objection to the Chippewa Creek Watershed Management Study.

Respectfully

Jane Agnew

copy W.F. Beckett, Secretary-Manager, North Bay Mattawa Conservation Authority, 233 Birche's Rd. North Bay.

The Corporation of the City of North Bay
200 McINTYRE STREET EAST, P.O. BOX 360, NORTH BAY, ONTARIO P1B 8H8 (705) 474-0400

Please quote our file no.

November 27, 1996

A01 9400856

Mr. Bill Beckett
North Bay-Mattawa Conservation Authority
R.R. #5, Site 12, Comp 5
233 Birches Road
NORTH BAY, ON P1B 8Z4

Dear Bill:

RE: CHIPPEWA CREEK WATERSHED MANAGEMENT STUDY

Bill, I have reviewed the Chippewa Creek Watershed Management Study and feel that one important element was not given proper consideration and should be seriously reconsidered before the plan is finalized. It would be my opinion that an artificial storage pond/wetland on the west side of Highway 11/17 between Cassells Street and Fisher Street should be re-examined to determine costs and benefits in terms of flood storage and water quality improvement. I would recommend that the Eastview tributary be rerouted near the Trout Lake Road/Highway 11/17 intersection to discharge behind the beer store into a large linear wetland to be created within the highway corridor and perhaps to somewhat encroach into Thompson Park. We have estimated the available space in this area to be roughly 5 acres. A shallow excavation to create shallow pond will provide substantial flood storage and if allowed to grow up with aquatic vegetation, it will provide permanent water quality enhancement.

Other options include rerouting Johnson Creek into this wetland between Fisher and Cassells as well as the main channel of Chippewa which might overflow into this area adjacent to Fraser Street at the end of Shaw. This storage could substantially reduce the area flooded downstream and resizing structure required below Chippewa Street could be averted. There could be extensive water quality benefits as well and perhaps a storage pond somewhere else could be eliminated. I will attach a rough drawing of the concept I propose with my letter. I also point out that MTO is looking at its Highway 11/17 design right now with possible reconstruction in 1998. This concept might be coordinated with their plans at little additional cost!

Yours truly,

Peter Bullock
Manager of Environmental Services
epb936

PROCTOR & REDFERN LIMITED

December 16, 1996

Project EO 94408

Ms. Jane Agnew
R.R.#3
North Bay, Ontario
P1B 8G4

Dear Ms. Agnew

Chippewa Creek Watershed Management Plan

This letter is in response to your letter to the Minister of Environment and Energy dated November 26, 1996. Your letter outlines your concerns that centre around the relationships between the Johnson Creek tributary near Delaney Lake and the lakes in the adjacent watershed, namely Circle Lake and Depencier Lake.

There is no intention in the watershed management plan to modify Delaney Lake or divert water from one watershed to the other. Accordingly, the "water storage capacity" of Delaney Lake should remain unchanged and in its natural condition.

With regards to flow increases, the watershed management plan identifies the potential for very significant flow rate increases in Johnson Creek, due to future upstream urban development proposed south of the airport. In order to address these potential flow rate increases, the watershed management plan recommends the construction of a 47,000 m^3 stormwater management basin, in addition to other stormwater quality best management practices. The intention is to limit flows to existing rates with this facility and to improve the water quality in Johnson Creek. The exact location, size and arrangement of this stormwater management facility is to be determined through a future Stormwater Management Plan, which is to be prepared for Johnson Creek prior to any significant urban development taking place.

We trust this letter addresses your concerns and that you will now be in a position to withdraw your objection to the Chippewa Creek Watershed Management Plan with the MOEE.

Yours truly

Proctor & Redfern Limited

G.K. Strachan, P.Eng
North Bay Regional Manager

c Minister of the Environment and Energy
Bill Beckett, North Bay Mattawa Conservation Authority

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PROCTOR & REDFERN LIMITED

December 17, 1996 | Project EO 94408

Mr. Peter Bullock
Manager of Environmental Services
Corporation of the City of North Bay
200 McIntyre Street East
P.O. Box 380
North Bay, Ontario
P1B 8H8

Dear Peter

Chippewa Creek Watershed Management Study

This letter is in response to your letter to Bill Beckett of the North Bay-Mattawa Conservation Authority dated November 27, 1996. Your letter suggests the study should consider recommending an "...artificial storage pond/wetland on the west side of Highway 11/17 between Cassels and Fisher Street...". You suggest the pond could be made approximately 4.8 acres (1.9 hectares) in size.

Although this is an exciting idea, we do not believe it is a viable watershed management alternative for the following reasons:

1. Size. A facility of this size could not provide any significant flood attenuation for subwatersheds of this size. The facility proposed for the just the developing areas within the upper portions of the Eastview Tributary is 27,000 m^3 and this will require approximately 2.5 to 3 hectares of land.

2. Efficiency. Generally, smaller ponds in series are far less efficient than a single, larger facility. Furthermore, multi-purpose facilities are more efficient than single-purpose facilities. For example, the water quality component of the 27,000 m^3 Eastview Tributary facility might be moved to the site you suggest, however, it might only reduce the size of the Eastview Tributary facility by, say, 20% and the City would still have to construct and maintain two large facilities.

3. Cost. It is doubtful that MTO will allow the City to construct the facility of their property and so close to their highway that it precludes them from future highway widenings. The cost of the land, diversion channels and culverts would be quite significant and, given the small benefits associated with the Highway 11/17 facility, it would not be cost effective.

Professional Consulting Services
34 Commerce Crescent, R.R. 3, North Bay, Ontario, Canada P1B 8G4 Telephone (705) 472-7520 Fax (705) 476-9722

We trust this letter addresses your concerns, however, should you wish to pursue this issue further, this can be done at the time of the Eastview Creek Stormwater Management Plan.

Yours truly

Proctor & Redfern Limited

G.K. Strachan, P.Eng
North Bay Regional Manager

c Bill Beckett, North Bay Mattawa Conservation Authority

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THE CHIPPEWA CREEK WATERSHED MANAGEMENT STUDY

We need your input to assist us in the development of an effective watershed management plan. Please provide us with any concerns or comments you may have, to the address provided below, in regard to the Chippewa Creek Watershed Management Study.

COMMENTS:

NAME: Keith D. Kebaugh
ADDRESS: 32 Oakwood Ave
474-7353

Plant black willow trees or manitoba maples along barren stretches of the Creek, particularity in Thompson Park, where the soils are much more conducive to trees growing. Perhaps sleeves (plastic devices used in tree plantations) could be used to increase the success rate. Maybe the Horticulturalist Society to germinate the seeds for the NBMCA and even help plant the trees.

North Bay-Mattawa Conservation Authority R.R. No.5, Site 12, Comp. 5 233 Birchs Rd.
North Bay, Ontario P1B 8Z4 Tel (705) 474-5420 Fax (705) 474-9793

Proceeding the slide show, Gerry Strachan of Proctor + Redfern presented the plan overview. In summary, the presentation reviewed the 3 phases of the study, & the 7 goals + objectives for the watershed, as well as the recommendations. Mr. Strachan explained that the draft plan is now up for a 30-day public review period, which ends Nov 30th. Following the review + subject to any necessary revisions, the plan will be taken to The Conservation Authority's Board of Directors for approval + then on to City Council for their approval + implementation. Mr. Beckett explained that it could possibly take as long as 12-24 months to implement the plan.

<u>Questions & Answers</u>

1) <u>Peggy Walsh-Craig</u> - she liked the report, however she did notice one inconsistency:
p. 70 refers to "... further subdivisions around Airport Road, without some means of alleviating urban run-off impacts, will further compromise the water quality on the lower portion of the watershed."

be permitted in these areas if it is demonstrated that the key functions of surface water quality protection and sediment trapping are maintained.

Peggy W-C was conserned that ~~fut~~ existing wetlands should be preserved + that future development would not decrease ~~on~~ the quality of H_2O in Chip Cr. due to run-off + sediments. Thinks that this rec. should be strengthened so that runoff + sed. don't occur or are detrimental.

<u>Dave Robinson</u> Mr Robinson questioned the 15% slope as in recom. C.3. He wondered if this was applicable to the entire watershed. Why 15%? Gerry S. explained that this rule applies predominantly to the escarpment. Bill Beckett explained that steeper grades will create grading problems and soil stability or erosion concerns. Proctor + Redfern came up with 15% rule.

<u>Cathy Stackleberg</u> "Describe "Adopt-a-Creek" Program. Gerry S. - similar to "Adopt-a-Highway" program. Public groups would commit to pick up/clean up garbage in creek, it builds community awareness + helps to change public attitudes.

Keith Dullabough: Will the trail system up the creek corridor involve land purchases by the Conservation Authority?

Bill Beckett: Not sure how this will be funded at this time.

Sarah Campbell: Has this study been brought to the public prior to this.

Bill Beckett:

~~[illegible]~~

Dave Robinson: Will this study improve the water quality of Chippewa Creek?

B.B. Some improvements can be made such as tree planting which will eventually provide cover + reduce the water temp. making it more suitable for fish. It is not likely that it will improve to a point where you could safely swim in it, due to the urban setting + influences.

Upon the commencement of questions the meeting was adjourned.