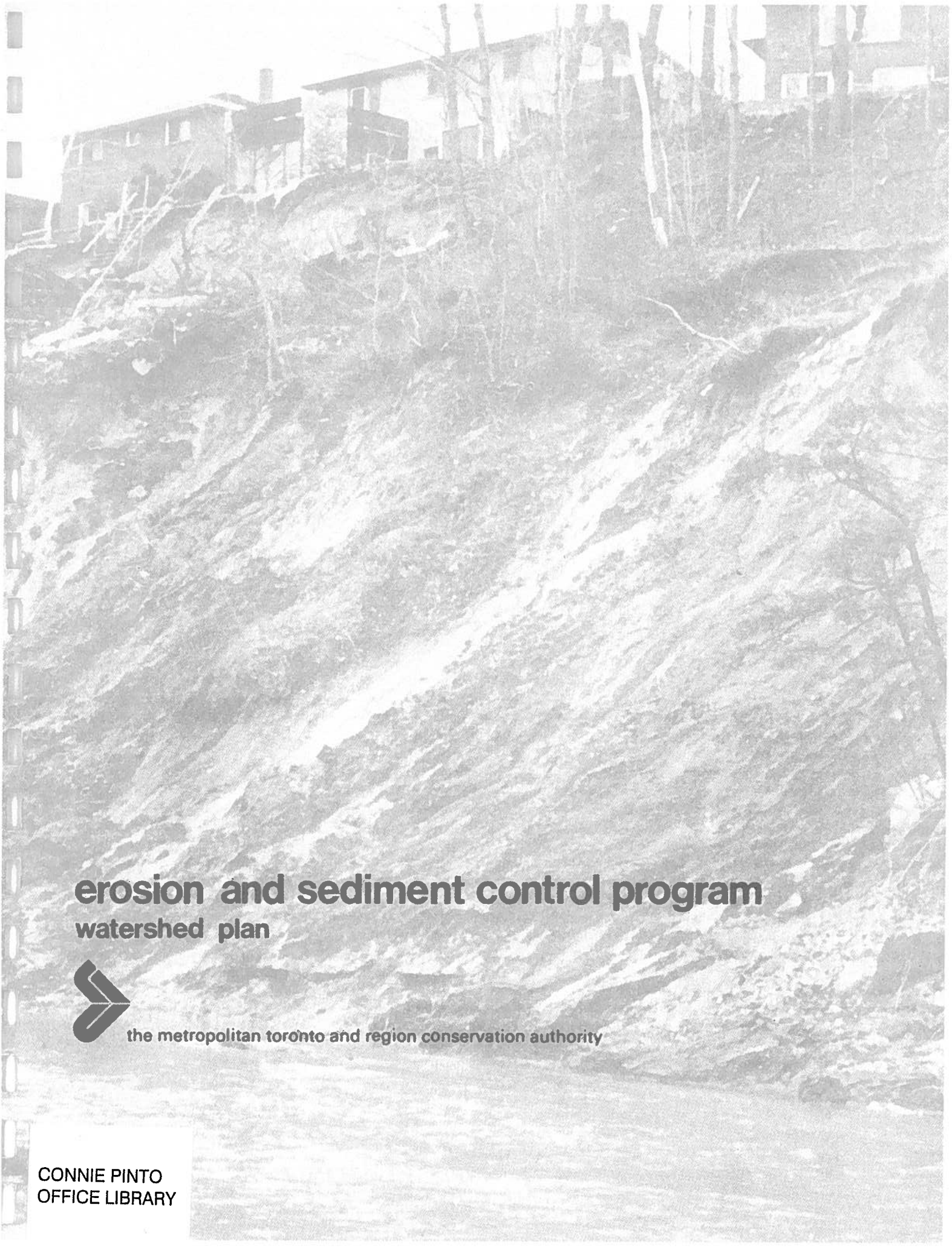

erosion and sediment control program

watershed plan

the metropolitan toronto and region conservation authority

EROSION AND SEDIMENT CONTROL PROGRAM

THE METROPOLITAN TORONTO AND REGION
CONSERVATION AUTHORITY

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1. INTRODUCTION

Soil erosion is a natural process that may be broadly defined as the gradual wearing away of the earth's crust by the principal external dynamic agents of water, wind, gravity and ice.

The erosion process includes both the detachment and transport of soil particles. The kinetic energy generated by raindrop impact on bare or sparsely vegetated soil detaches soil particles. Water running along the ground surface picks up these particles and carries them along as it flows. As runoff gains in velocity and concentration, it detaches more soil particles, cuts rills and gullies into the soil surface and adds to its sediment load. Stream and channel banks and beds are also subject to erosion as a result of increased volume and velocity of runoff (Figure 1).

Sedimentation is the settling out of these soil particles which are transported by water. Sedimentation occurs when the velocity of water in which soil particles are suspended, is slowed to a sufficient degree, and for a sufficient period of time to allow the particles to settle out of suspension. Heavier particles such as sand and gravel, settle out more rapidly than do fine particles such as clay and silt.

Within the unaltered environment, geologic erosion and sedimentation is a natural, recurring element that is a relatively slow process and can be accepted as inevitable. However, the environmental changes emanating from man induced activities have resulted in a significant acceleration and distortion of this process and its associated problems. In the United States natural erosion has been estimated to create about 30% of all sediment; whereas erosion resulting from man's activities, i.e. 'accelerated erosion', has been estimated to generate about 70% of the sediment.

Within the altered environment, the greater imperviousness of the surface tends to produce increased amounts of runoff. Studies have determined that under certain conditions the difference between a 0% and 100% impervious surface will increase peak discharges by approximately 2.5 times; thereby increasing the volume of water in a receiving channel and therefore, the energy available for erosion of that channel.

Sediment, the substance produced by the act of erosion, is in itself a detriment to the environment. Sediments are considered pollutants when they render water unfit for a particular use either by their presence in suspension or as deposits on the bottom; and in addition may carry or contain chemical pollutants. The detrimental effects of sediments may include obstruction of drainage channels and conduits, interference with navigable waterways and harbours, filling of reservoirs, deterioration of aquatic habitat due to turbidity and deposition, clogging of water filters and concentration of pollutants in sewers which result in highly polluted discharges during the 'first flush' of storm runoff events. It has been stated that; "*sediment by volume is our greatest pollutant. In terms of volume, sediment ranks above sewage, industrial wastes and chemical pollution combined*" (Michigan Soil Erosion and Sediment Control Guide Book).

On April 15, 1972, the Canada - United States Agreement on the Great Lakes Water Quality was signed by the respective Governments. As an integral part of this Agreement, the International Joint Commission (IJC) was asked to establish a Reference Group to study pollution in the Great Lakes system from urban development, agriculture, forestry and other land uses. Consequently, the Pollution from Land Use Activities Reference Group (PLUARG) was formed. The combined problems of erosion and sediment loss formed two key components of the terms of reference to be studied by this group. The PLUARG report (July 1978), in recognizing the importance and need for planned remedial measures, included the following major recommendations:

(a) Erosion and Sediment Control programs be improved and expanded to reduce the movement of fine-grained sediment from land surfaces to the Great Lakes.

(b) Management Plans for controlling urban stormwater runoff be developed. These plans should include:

  (i) proper design of urban stormwater systems in developing areas such that the natural stream flow characteristics are maintained; and

  (ii) provision for sediment control in developing areas.

(c) Management Plans, stressing site-specific approaches to reduce loadings of phosphorus, sediments and toxic substances derived from agricultural and urban areas be prepared. These plans should be undertaken by the appropriate jurisdictions within one year after the IJC's recommendations are transmitted to the Governments.

(d) Governments make better use of existing planning mechanisms in implementing non point source control programs by:

  (i) insuring that developments affecting land are planned to minimize the inputs of pollutants to the great lakes; and

  (ii) insuring that planners are aware of and consider PLUARG findings in the development and review of land use plans.

The Metropolitan Toronto and Region Conservation Authority, in being responsible for the development of a Watershed Plan, is certainly one of the agencies that can help implement the foregoing PLUARG recommendations.

In the past, the Authority has carried out protective work to correct erosion problems at a number of sites within those portions of Metropolitan Toronto and the Regions of Peel, York and Durham that lie within the Authority's jurisdiction. The Authority has also been involved in programs which have directly or indirectly aided in the control of sediment in the watersheds. These include the 'Stream Improvement Program' which provides sediment control upstream of existing or proposed reservoirs; and the revegetation work for eroding, marginally acceptable agricultural lands.

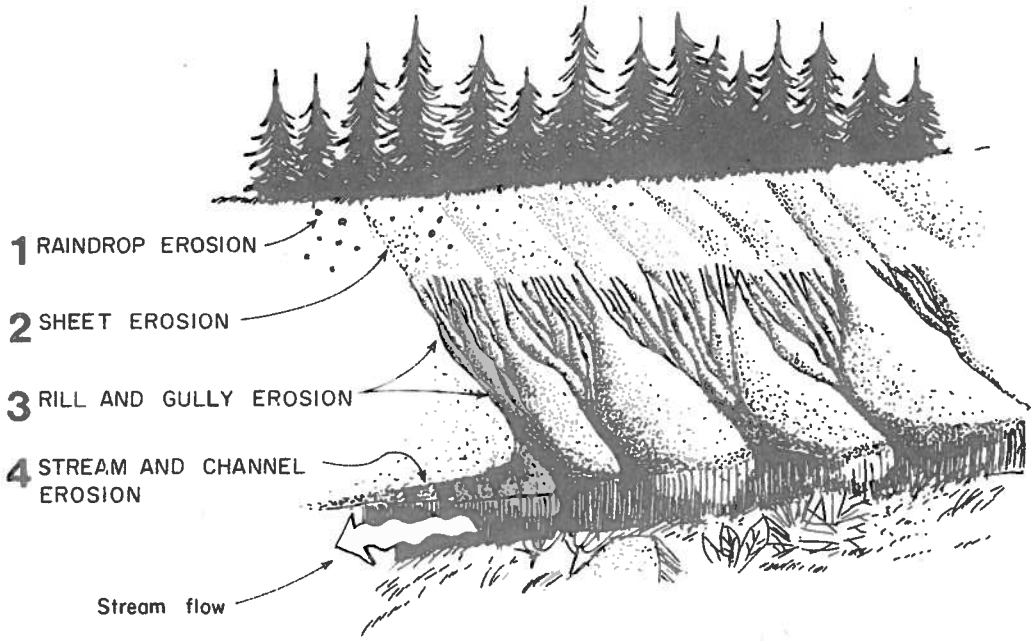
TYPES OF EROSION CAUSED BY FALLING AND FLOWING WATER

1 **RAINDROP EROSION:** Erosion resulting from the direct impact of falling drops of rain on soil particles. This impact dislodges soil particles and splashes them into the air. The dislodged soil particles can then be easily transported by the flow of surface runoff.

2 **SHEET EROSION:** The removal of a layer of exposed surface soil by the action of raindrop splash and runoff. The water moves in broad sheets over the land and is not confined in small depressions.

3 **RILL and GULLY EROSION:** As runoff flows it concentrates in rivulets, cutting several inches deep into the soil surface. These grooves are called rills. Gullies may develop in unrepaired rills or in other areas where a concentrated flow of water moves over the soil.

4 **STREAM and CHANNEL EROSION:** Increases in the volume and velocity of runoff may cause erosion of the stream or channel banks and bottom.



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WATERSHED PLAN

EROSION AND SEDIMENT CONTROL PROGRAM

TYPES OF EROSION

FIG. 1

Due to the magnitude and extent of the problem, the Authority proposes to continue placing emphasis on this subject as part of the Watershed Plan. Since the Authority's area of jurisdiction includes a diverse mixture of land use, it is felt that the Authority must adopt an 'area-wide' concept to deal with erosion and sediment control. In developing such a comprehensive system of control and/or treatment measures for a drainage area, it is important to avoid localized adverse effects on downstream property.

It should be noted that sediment control (streambank protection, reforestation, buffer planting, etc.) for non-urban areas is an integral component part of the Conservation Land Management Program. Due to the wide range of benefits resulting from the application of such a management program (fish and wildlife habitat enhancement, pollution reduction, aesthetics, etc.), non-urban sediment control is more fully addressed in the Conservation Land Management Program. As well, the control of sediment from urban sources such as construction activities is one of the major emphases of the Storm Water Management Program and is therefore also addressed in that program in the appropriate context.

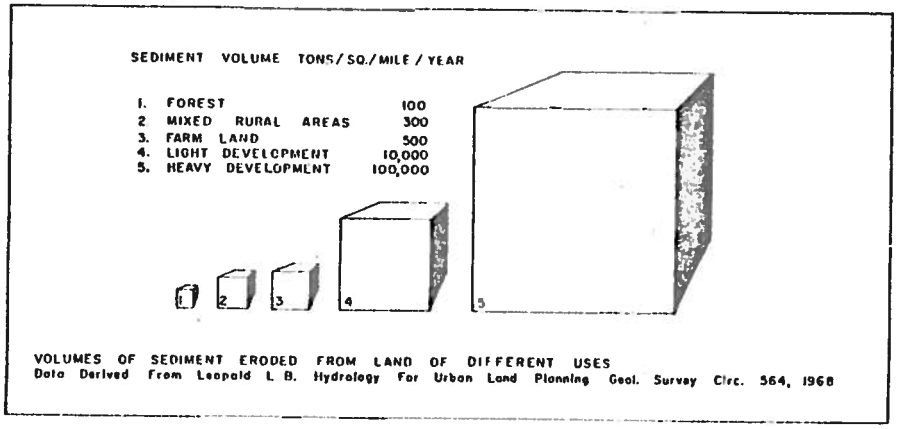
The two major directions then of the Erosion and Sediment Control Program are to minimize the aggravation or creation of erosion or sediment problems as a result of new development, and, to rectify existing problems through protective works.

2. PROBLEM AND IMPLICATIONS

2.1 General

Initially an increase in the rate of erosion and sediment loss occurs as forests are cleared and the land is plowed for agricultural use. A further increase in the rate generally occurs as the landscape is more severely modified to build roads, develop towns and cities and construct other facilities essential to economic and social development. In quantifying the problem, Figure 2 shows the order of increase in sediment generated per square mile for various land uses ranging from forest (100 tons/sq. mile/year = 35 metric tons/sq. km/yr.) to heavy development (100,000 tons/sq. mile/year = 35,000 metric tons/sq. km/yr.)

FIGURE 2



The sediments from an urbanizing area derive largely from erosion of substrate exposed during cut and fill operations required for the formation of streets, building sites and installation of underground utilities. Fully developed urbanized areas are relatively low sediment-producing areas, because a large percentage of land is protected against erosion by roofs, sidewalks, streets, curbs, gutters and storm sewers; parking lots and well cared for lawns and parks. During actual construction however, erosion rates are high and unless some control is exercised, more land clearing and grading may be done than is actually required. Wet weather conditions promote the conveyance of soil onto streets by trucks and other construction equipment where it is subsequently washed into the storm sewer system. Unless catch basins are cleaned regularly, the excess materials are carried directly to the receiving stream.

Perhaps the most visible effect of the urbanization of an area is the hydrologic modification. Increased areas of impervious surface tend to increase both the total volume of runoff and the flow velocities. The resultant effect is the

increased ability of the runoff to mobilize contaminants through solution, scour and suspension and to transport those contaminants to the receiving waters. The reduction of infiltration also reduces the portion of the contamination which is absorbed, filtered or otherwise attenuated by the soil.

Sediment is also deposited along the inside curve of stream bends, causing a gradual shift of stream alignments. This in turn results in cutbank erosion along the opposite bank, thereby causing the introduction of more sediment in the stream.

Under winter climatic conditions in Ontario the widespread use of both sand and salt considerably augments the supply of sediments to the streets and ultimately the watercourses draining the urban area. Although no representative data have been developed for Canadian conditions, it may be reasonably assumed that even from a well stabilized urban area somewhat more than one ton per acre per year of sediments and debris are washed into the storm sewer system.

Erosion rates vary markedly with intensity of rainfall and runoff. There is considerable accumulated evidence indicating that the maximum difference in sediment yield rates between developing and natural areas occurs during the more frequent storms. A United States study of the records of 72 watersheds ranging in size from 40.5 to 405 hectares showed that storms with a return period greater than two years caused from 3 to 46 percent of the total average annual suspended sediment yield; storms with a one to two year return period caused 3 to 22 percent of the total; and storms with a return period of less than one year, caused 34 to 92 percent of the total suspended sediment yield.

2.2 Causes of Erosion

The acceleration of erosion is introduced through man's activities and is essentially subject to man's control. With further urbanization within the Authority's area of jurisdiction river erosion will continue to be influenced by the ever changing hydrologic and hydraulic characteristics of the river system. The significance of this general process is magnified by the increasing pressures for use of land within erosion susceptible areas abutting the watercourses.

The following activities are particularly significant causes of erosion within the Authority's jurisdiction:

Non-Urban:
- cutting of trees and shrubs to create land that could be tilled for growing crops
- careless ploughing of land, reshaping or contours, exposure of sub soil and removal of organic matter from the surface
- installation of poorly designed surface and sub surface field drains.

Urban:
- cutting of trees and shrubs during preparation for residential, commercial or industrial development

- careless lot preparation and grading

- creation of impervious surfaces during urbanization: resulting in an increase in runoff and higher river velocities

- encroaching upon the natural flood plain with fill

- increasing instability of valley walls by allowing structural development (buildings and retaining structures) to encroach upon steep slopes

- changing natural drainage patterns by means of storm sewers and channels.

2.3 Effects of Erosion

Due to continued population growth and increasing urbanization of the Authority's area, damages associated with erosion are now quite evident. These damages include:

- danger to human habitations and loss of private property
- loss of structures within the valley systems
- loss of valuable open space in parklands and ravines
- loss of mature vegetation and fertile soil
- sedimentation

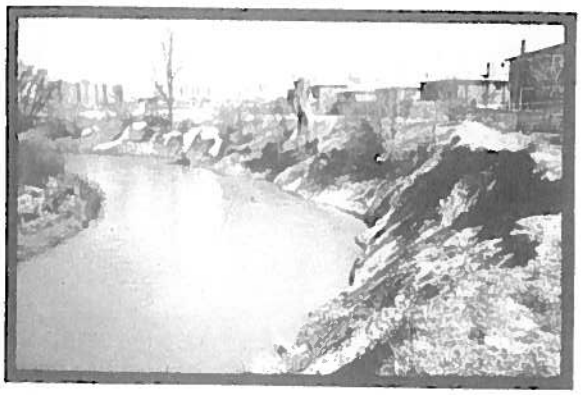
2.4 Erosion Data Base

The data base, hazard and instability indices, priority ratings and other pertinent information originally prepared in 1970, is used as a starting point in assessing the rate of progress and deterioration of erosion sites within Metropolitan Toronto. In 1978, the Authority also carried out erosion inventory and priority studies for the Regions of Peel, York and Durham in order to determine the extent, size and nature of the erosion problems in the respective areas.

These studies form the basis for the inventory of sites within the Authority's jurisdiction. Other sites within the inventory have been received from concerned individuals and the various municipalities. Table 1 indicates the erosion inventory for those watercourses draining in excess of 1300 hectares in Metropolitan Toronto and the Regions of Peel, York and Durham; whereas Figure 3 indicates those sites considered to be active and significant. With approximately 240 'significant sites' in the developed areas within the Authority's jurisdiction, erosion can be seen to be an important concern.

Since erosion is a dynamic process, physical conditions of a site are subject to continual changes. Based on year-round monitoring, the severity of the problem at a given time and its relative potential to deteriorate, the Authority has continued to update the priorities on an annual basis. Those sites reviewed are subjected to

CAUSES OF EROSION



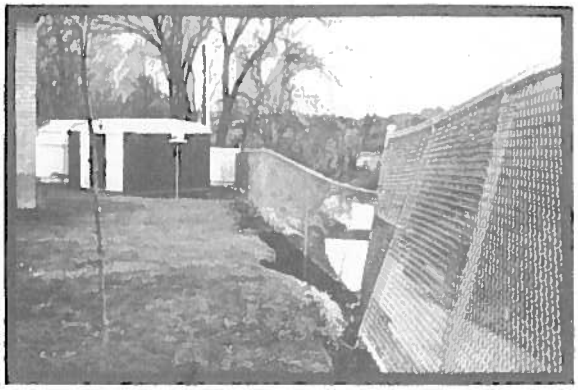
RIVER ACTION
(PHOTO 1)

IMPROPER
STORM
DRAINAGE
(PHOTO 2)

GROUND WATER
SEEPAGE
(PHOTO 3)

BANK SURCHARGE
(PHOTO 4)

EFFECTS OF EROSION



RIVER AND BANK EROSION NECESSITATED THE ACQUISITION OF THIS DWELLING

(PHOTO 5)

IMPROPER CONSTRUCTION PRACTICES RESULTED IN BANK FAILURE WHICH SEVERELY THREATENED THESE HOMES

(PHOTO 6)

IMPROPER BANK FILLING CAN RESULT IN THE LOSS OF BACKYARDS

(PHOTO 7)

BANK EROSION AS A RESULT OF TREE REMOVAL

(PHOTO 8)

MUNICIPALITY	WATERCOURSE		NO. OF SITES	TOTAL
Metropolitan Toronto	Etobicoke Creek		10	10
	Mimico Creek		35	35
	Humber River	- Main Branch	48	
		- West Branch	10	
		- Emery Creek	5	
		- Black Creek	21	84
	Don River	- Main Branch	25	
		- West Branch	34	
		- East Branch	44	
		- Massey Creek	15	
		- German Mills	4	122
	Highland Creek	- Centennial	2	
		- Main Branch	10	
		- West Branch	10	
		- East Branch	9	31
	Rouge River	- Main Branch	78	
		- Little Rouge	27	105
			TOTAL	387
Region of Peel	Etobicoke Creek		90	90
	Mimico Creek		11	11
	Humber River	- Main Branch	4	
		- West Branch	63	67
			TOTAL	168
Region of York	Humber River	- Main Branch	19	
		- West Branch	13	
		- East Branch	37	69
	Don River	- West Branch	15	
		- East Branch	13	
		- German Mills	9	37
	Rouge River	- Main Branch	45	
		- Little Rouge	52	97
	West Duffin Creek		7	7
			TOTAL	210
Region of Durham	Rouge River	- Main Branch	4	4
	Petticoat Creek		21	21
	Duffins Creek	- Main Branch	25	
		- West Branch	169	
		- East Branch	113	307
	Carruthers Creek		42	42
			TOTAL	374

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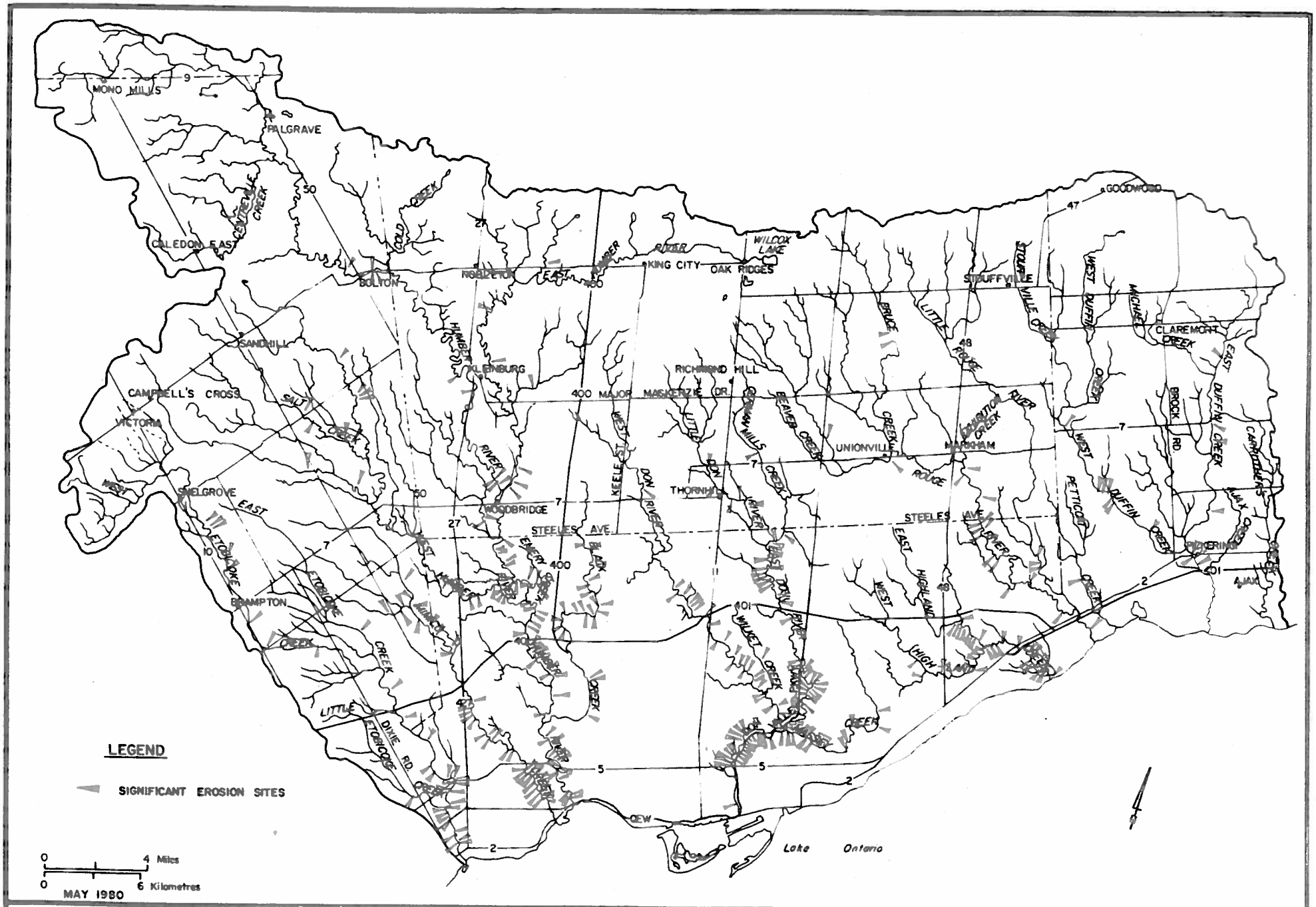
WATERSHED PLAN
EROSION AND SEDIMENT CONTROL PROGRAM

INVENTORY OF EROSION SITES

TABLE 1



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SIGNIFICANT EROSION SITES

FIG. 3

a weighting system in order to determine its relative ranking in the pool of priorities. This list of priorities is used in determining the sites at which remedial work will be carried out in the following year. A separate priority list is derived and revised annually for each of the regional municipalities: Metropolitan Toronto, Peel, York and Durham.

2.5 Sediment Sources

The sources of sediment that affect the watercourses within the Authority's jurisdiction are neither distinct nor independent. A great proportion of sediments, but not all, result from erosion on and transport from the land. The various sources include:

- urban construction activities
- farmland and cropping practices
- streambank erosion and landslides
- road debris
- gully, rill and sheet erosion.

The delivery of sediment from these sources has been increasing at an accelerated rate in response to the increase in man's activities. However, there has not been a corresponding acceleration in the rate of control.

Naturally, the amount of sediment delivered to a downstream point is a function of the quantity of available sediment to be transported and stream competence (capacity of stream to transport solids). The amount of sediment available for transport is generally a function of land use. The data in Table 2 gives an indication of sediment yield and channel stability for advancing forms of man's land use activities. These are only relative ratings and are dependent on many other factors such as rainfall, soil type and conservation practices.

Figure 4 graphically depicts the extent of urban and non urban land uses within each watershed and Table 3 expresses the percent breakdown for both existing and predicted urban and non urban uses. These values together with land use information (percent of land area under forest cover, active and pasture lands, urban development, etc.) provide some indication of existing and potential sediment sources.

Several tools are at hand to measure and estimate soil erodibility and sediment yields from land. The most widely known is the Universal Soil Loss Equation. It predicts soil loss as a function of precipitation, soil characteristics, topography, cropping practices and erosion control practice. The model can be used for sediment prediction when reliable delivery ratios are applied to the gross potential soil loss.

$$Y_{(S)E} = A\,(R.K.L.S.C.P.S._d)$$

Where

$Y_{(S)E}$ = sediment loading

A = source area

R = the rainfall factor, or the member of erosion index units in a normal years rain (the erosion index is a measure of the erosive force of specified rainfall)

K = soil erodibility factor
L = slope length factor
S = slope gradient factor
C = cover factor (includes for construction)
P = practice factor (for agricultural land)
S_d = sediment delivery ration (depends on transport distance)

The soil erodibility factor K is a gross indicator of the soil's ability to be eroded. A low K value is indicative of a soil with a low percent of fine particles; whereas a high K value is indicative of a soil, most likely silt and/or fine sand, which is more susceptible to erosion.

Figure 5 shows the "K" values for soils within the Authority's jurisdiction. Those soils with K values in the range of 0.20 - 0.30 are indicative of a greater than 40% silt and very fine sand content, with moderate permeability to water. Soils with K values in the range of 0.30 - 0.40 are indicative of greater than 60% silt and fine sand content, with slow to moderate permeability.

2.6 Effects of Sediment

Damages and effects of erosion and of the sediment generated from the sources discussed previously fall into one of three categories:

- loss of capacity in water impoundments, channels and sewers; and interference with navigable waterways and harbours;

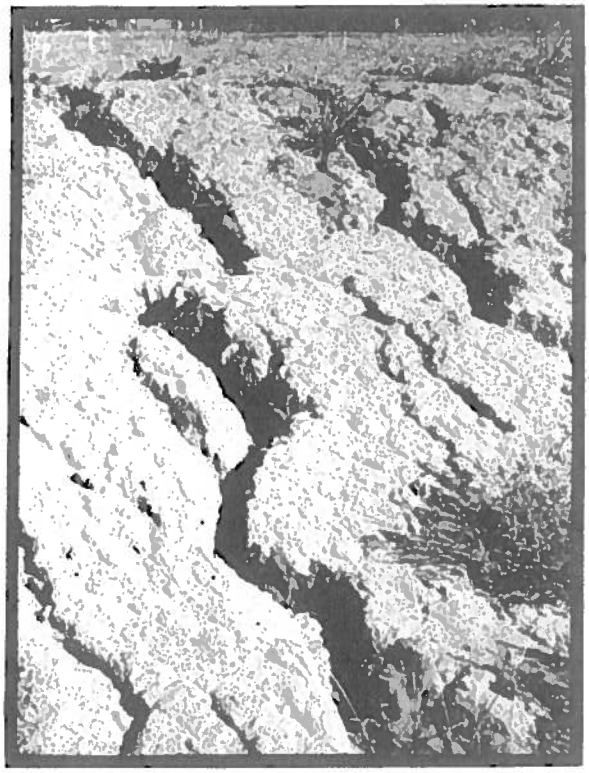
- damages to the land and associated facilities; and loss of productivity to farmland;

- the effect on the quality of water for the following desired uses: water supply, public health aspects, recreation, fish and wildlife, and aesthetic values.

SEDIMENT SOURCES

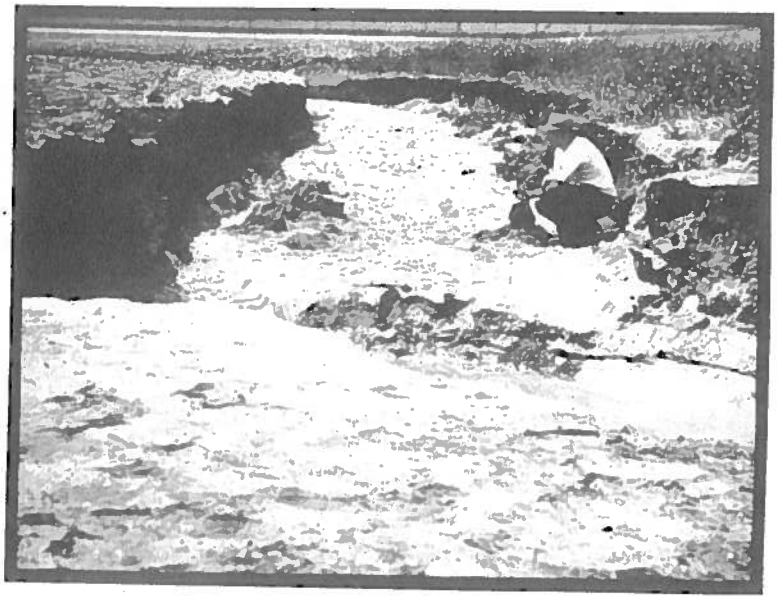
UNSTABLE BANKS
ADJACENT TO
WATERCOURSES

(PHOTO 9)



LACK OF VEGETATION
COVER DURING AND
AFTER CONSTRUCTION

(PHOTO 10)

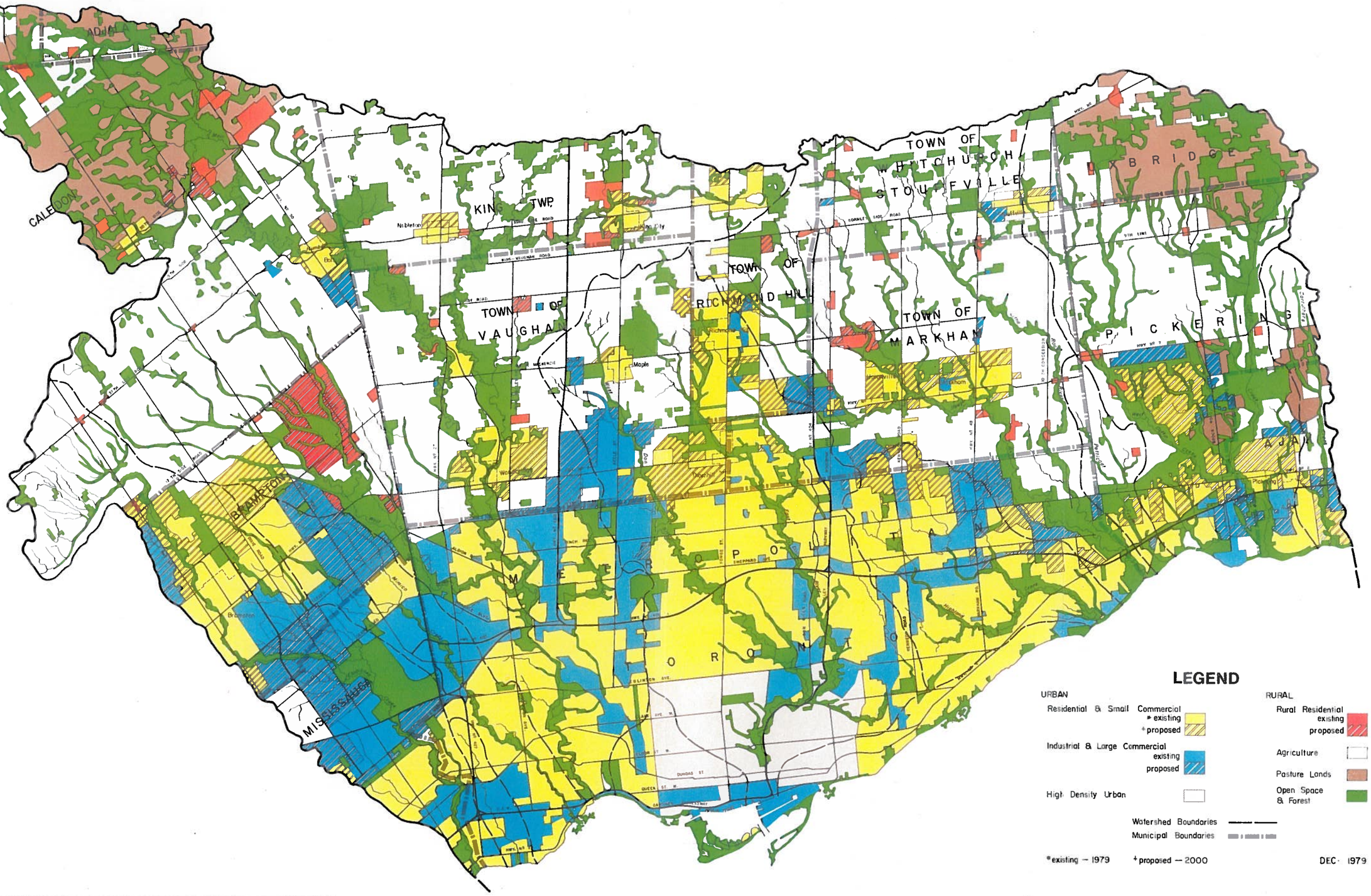


IMPROPER FARM
DRAINAGE

(PHOTO 11)

EFFECT OF LAND-USE SEQUENCE ON RELATIVE SEDIMENT YIELD AND CHANNEL STABILITY

LAND-USE	SEDIMENT YIELD	CHANNEL STABILITY
A. Natural forest or grassland	Low	Relatively stable with some bank erosion
B. Heavily grazed areas	Low to moderate	Somewhat less stable than A
C. Cropping	Moderate to heavy	Some aggradation and increased bank erosion
D. Retirement of land from cropping	Low to moderate	Increasing stability
E. Urban construction	Very heavy	Rapid aggradation & some bank erosion
F. Stabillzation	Moderate	Regradation and severe bank erosion
G. Stable urban	Low to moderate	Relatively stable



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M.T.R.C.A. WATERSHED BOUNDARY

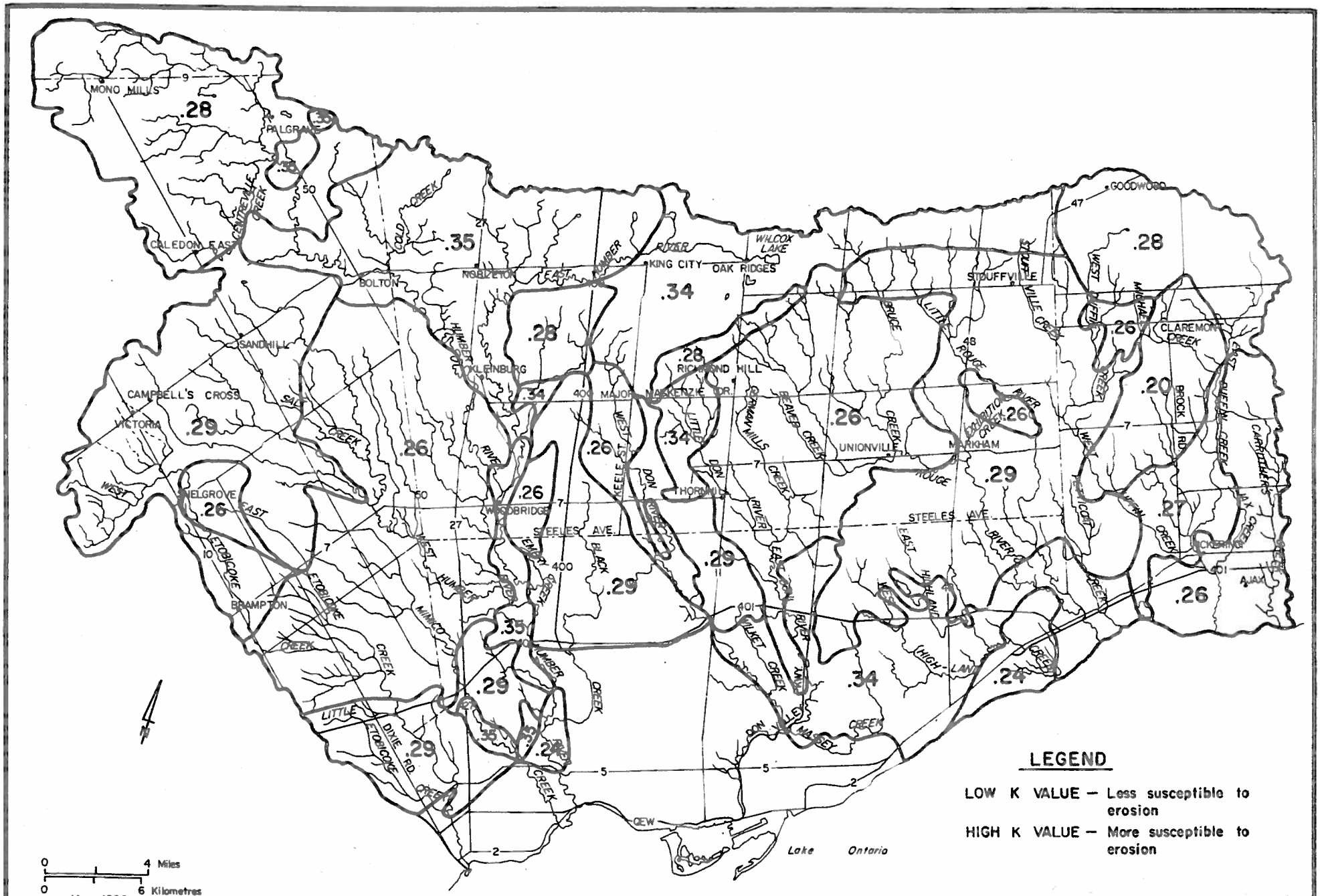
SCALE — KILOMETERS
0 1 2 3 4 5 6 7

WATERSHED PLAN
EROSION AND SEDIMENT CONTROL PROGRAM

LAND USE

FIG. 4

	PEEL		YORK		DURHAM		METRO	
	Existing	Predicted	Existing	Predicted	Existing	Predicted	Existing	Predicted
Etobicoke Creek	36/64	58/42					74/26	80/20
Mimico Creek	51/49	84/16					92/08	92/08
Humber River	01/99	5/95	4/96	9/91			85/15	85/15
Don River			22/78	36/64			89/11	90/10
Highland Creek			0/100	64/36			73/27	90/10
Rouge River			05/95	10/90	39/61	39/61	16/84	37/63
Petticoat Creek			0/100	0/100	13/87	19/81	0/100	14/86
Duffin Creek			05/95	09/91	04/96	14/86		
Carruthers Creek					07/93	20/80		



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K-FACTORS SOIL ERODIBILITY

FIG. 5

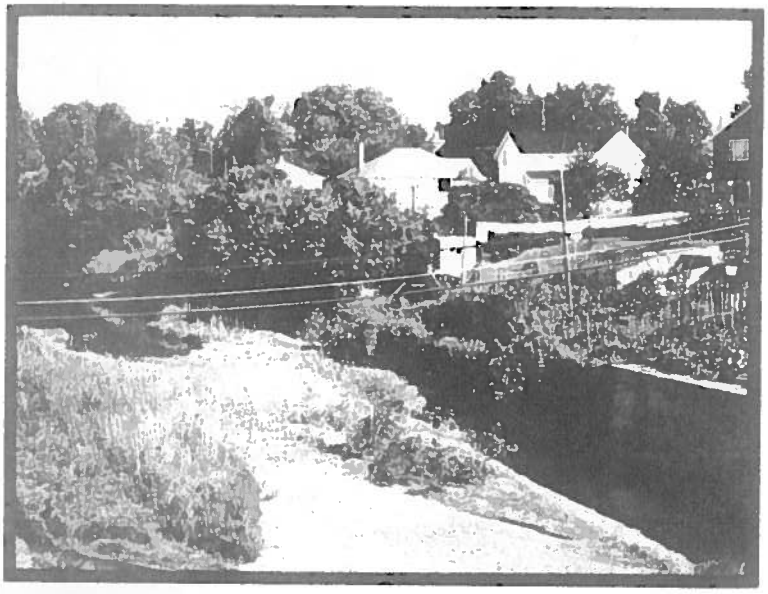
EFFECTS OF SEDIMENT LOSS

REDUCTION IN THE CAPACITY OF CULVERTS

(PHOTO 12)

STREAM CHANNEL SILTATION

(PHOTO 13)



RIVER MOUTH SILTATION

(PHOTO 14)

Sediment has many harmful effects on water and, therefore, warrants further discussion. It impairs water quality and damages recreational waters. Sediment also alters fish and other aquatic habitat by:

- changing the substrate of the stream
- increasing turbidity
- increasing toxic substances
- introducing nutrients such as phosphates and nitrates
- altering the physiology of the fish, e.g. respiration and excretion
- interfering with fish movement.

Turbidity (caused by suspended sediment) and siltation are detrimental to aquatic life. Turbidity, affects light penetration in water and thus reduces the growth of microscopic organisms on which insects and fish feed. It reduces the capacity of water organisms to absorb waste materials and hence delays the self-purification of water, thereby increasing the transport of organic wastes and other pollutants over long distances. The oxygen content of water is also reduced by the presence of suspended sediment which subsequently affects aquatic life such as fish and plants.

Siltation often traps organic matter on the beds of water and may result in anaerobic conditions. Silt destroys eggs in fish spawning gravels by reducing water seepage and hence oxygen supply, and occasions further losses through burial or suffocation of eggs and larvae.

Associated with the physical aspect of the sediments, are the other pollutants which are contained within or tightly attached to the sediment particles. Most of the phosphorus in the soil, whether it comes from organic or inorganic sources, is absorbed onto the soil particles. Organic or humus nitrogen lost from soil into water is associated with sediment. Because of the tight binding characteristics of some pesticide residues to soil particles, it is suggested that the general pollution of waters by pesticides occurs through the transport of soil particles to which the residues are attached. This phenomenon also holds true for a number of chemical pollutants as well. Thus control of many other pollutants in the chemical, nutrient and pesticide classification depends largely upon the control of sediment production and transport.

Sediment particles can carry nitrates, phosphates, heavy metals and other toxic materials such as polychlorinated bi phenyls (PCBs) in the water system. PLUARG has determined that these materials can become bound to the clay size fraction of suspended solids ($< 2\mu m$ particle size) and move easily with water. These particles settle out only very slowly. Their large surface area and slow settling rate can expose the clay-particle-associated pollutant to water for an extended period of time. This may allow the pollutant to be released into the water column and become available for biological uptake. For example, in terms of tributary phosphorus loads, PLUARG studies have shown that between 40 to 80 percent of the total phosphorus load is associated with sediment. Thus, sediment can act as both a pollutant and as a carrier of pollutants.

Problems created by the deposition of sediment are many and varied. Sediment deposited in stream channels reduces the flood-carrying capacity, resulting in higher, more frequent overflows and greater floodwater damage to adjacent properties. Deposition of sediment in irrigation and drainage channels, in storm sewers, in navigation channels and floodways, in reservoirs and harbours, and on streets and highways not only create a nuisance but also inflict a high public cost in maintenance removal or in reduced services.

2.7 Sediment Data Base

Within the Authority's jurisdiction, average annual sediment losses for the Humber and Don Rivers exceed 118,000 metric tons/yr and 55,000 metric tons/yr respectively which is a significant contribution in terms of volume.

Sediment production within the jurisdiction of the Authority is dependent upon land use within the urban and non urban environments. Within the urban sector, the great majority appears to be from construction sites and some from streambank erosion. Within the non urban sector any sediment production appears to be from agricultural practices and streambank erosion.

> *"The predominant sources of sediments to streams within agricultural areas are sheet and rill erosion from cropland (70 to 100%) and streambank erosion (0 to 30%)."* (PLUARG)

> *"Although rainfall-induced erosion occurs over the entire landscape at varying rates, the studies have confirmed that only a small percent of the agricultural landscape contributes eroded soil materials to stream channels. During the transport phase of the soil erosion process, deposition of eroded materials (all or in part) can take place in depressional areas, at fence rows, or in grassed bufferstrips before reaching the stream system."* (PLUARG)

> *"When viewed relative to other sources of sediment, streambank erosion does not appear to be a major contributor"* in the non urban areas. (PLUARG)

A study of the Don Basin has been undertaken as part of this program in order to relate the dredging data at the Keating Channel to changes in land use occurring throughout the period 1947-1973. The annual dredging volume from the records of The Toronto Harbour Commissioners are illustrated in Figure 6 and are indicative of a medium-term change in sediment yields induced through development activities. Although some materials are washed into Toronto Harbour during high flood flows and therefore not included in the records, it could be assumed that the bulk of the sediment is trapped in the Keating Channel (the Don River outlet channel).

Based upon information relating to the annual maintenance dredging of the Keating Channel, it is assumed that the substantial increase in dredged volumes experienced during the 1960's could be attributed to the post-war expansion of

Metropolitan Toronto within the Don River catchment. In addition to building and subdivision development, other major activities such as construction of the Don Valley Expressway, Highway 401 and the railway marshalling yards in the north-west of the basin were underway during this period.

Increasing urbanization and development can be seen to be directly correlated with higher sediment production. Noticeable on Figure 6 are several sharp peaks in sediment yield for the Don River. These peaks can be related to specific construction activities along the Don River. Such activities may produce excess sediment yields of up to 108,862 metric tons/yr above average. Thus, the most important impact of urbanization is during the period of construction, when sediment yields may increase considerably. The actual amount of increase is closely related to local construction practices. The high production of sediment within the Don River basin brought about by urban construction activity has been causing sedimentation along the lower reaches of the Don River and the Keating Channel. Until 1973, dredging of the Keating Channel was done by The Toronto Harbour Commissioners on an annual basis. After 1973, The Toronto Harbour Commissioners has had difficulty in disposing of the dredged material due to its high pollutant content, and has since stopped dredging the Keating Channel up to this point in time.

It is apparent that development activities occasioned a considerable increase in the area yield of sediments. Although it must be presumed that some of the material was derived from bank erosion and slides of some of the steeper valley sites, in all likelihood these in turn have been triggered to a large degree by development activities.

The downturn of yields in recent years as indicated in Figure 6 suggests increasing stabilization of the area. This also reflects the overall reduction of the area affected in recent years as well as an increase in redevelopment activities. Moreover, the characteristic pattern of subdivision development has changed during the period reviewed, with the extended period of open subdivision developments characteristic of the immediate post-war years giving way to a more rapid completion during the 1960's.

This examination of the Don watershed has demonstrated that urbanization has the potential for causing a severe change in the regime of a catchment and can result in very substantial costs attributable to soil erosion and sedimentation if not controlled.

It should be noted that while the Keating Channel (Don River) has been an area of major concern over the years, the mouths of the Humber River, and the Etobicoke and Mimico Creeks, have also all been previously dredged for navigation and/or flood control purposes.

Sediment yield variances do occur within each type of land use and are dependent on such variables as:

- hydrological characteristics
- land characteristics
- land use intensity

Little quantitative data is available regarding sediment production within the Authority's jurisdiction. Figure 7 shows the annual sediment yield for the Humber and Don Rivers at specific locations. The graphs for the Humber River were plotted using data accumulated by Water Survey of Canada sediment gauges at Weston Road and Elder Mills. These are the only existing sediment gauges in the Authority's area of jurisdiction. The graph for the Don River at Keating Channel was obtained from the Keating Channel Dredging records of The Toronto Harbour Commissioners. These three sources provide the only recorded sediment loads and help to give a feeling for the magnitude of the problem within the urban and non urban sectors. As can be seen in comparison, urban sediment generated in both the Don and Humber Watersheds produce higher sediment yields than the respective non urban sectors.

From the available data on the Humber and Don Rivers, sediment yields have been generated for the different types of land use within each watershed of the Authority's jurisdiction. This data, as shown in Figure 8 gives an outline of:

(a) Existing probable average sediment loads at the mouth of the watercourses.

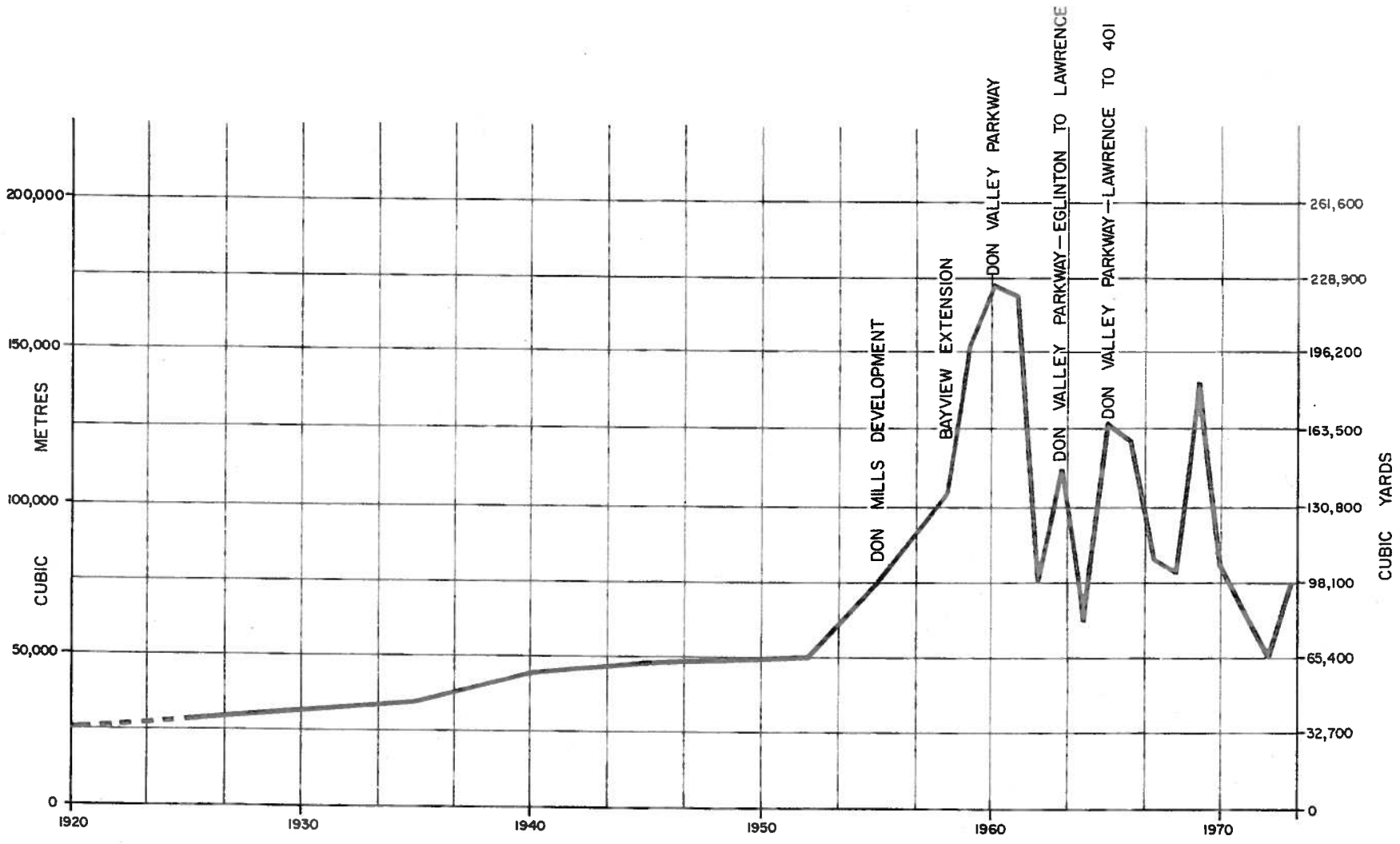
(b) Predicted future sediment yields after all known development has been completed.

NOTE: These are average figures and therefore any particular year can deviate significantly from an average year.

To project the data identified in Figure 8, land use information was gathered for all land with the Authority's jurisdiction. Average sediment yields for various types of land use were used to calculate the total sediment yields within the watershed. Adjustment coefficients taken from the Don and Humber Rivers were used to adjust watershed sediment yields to values that compared to actual known sediment loads on these two basins.

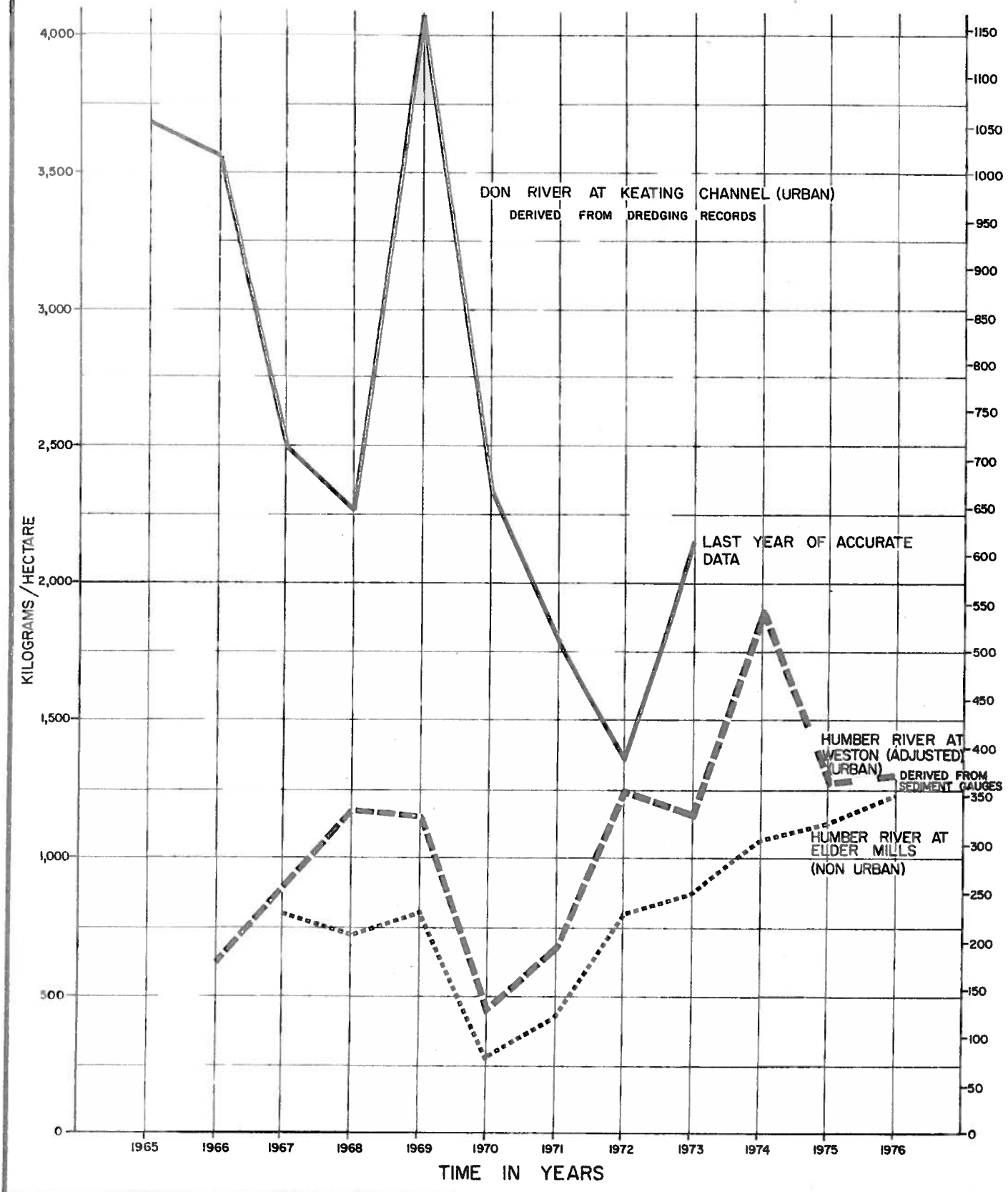
Unit area loads help compare non-point pollutant contributions between different land usages. From the data, unit area loads from forested land can be taken as base level. Unit area loads from intensive agriculture (i.e. cropland) and urban land uses are in the order of ten times as great as forested land. Unit area loads for construction sites are in the order of 1,000 times as great (PLUARG).

The above data is useful in assigning priorities for future sediment control and in determining areas that will be affected by sediment and generally what areas are generating sediment.



SOURCE: TORONTO HARBOUR COMMISSION

the metropolitan toronto and region conservation authority	WATERSHED PLAN EROSION AND SEDIMENT CONTROL PROGRAM	KEATING CHANNEL DREDGING	FIG. 6



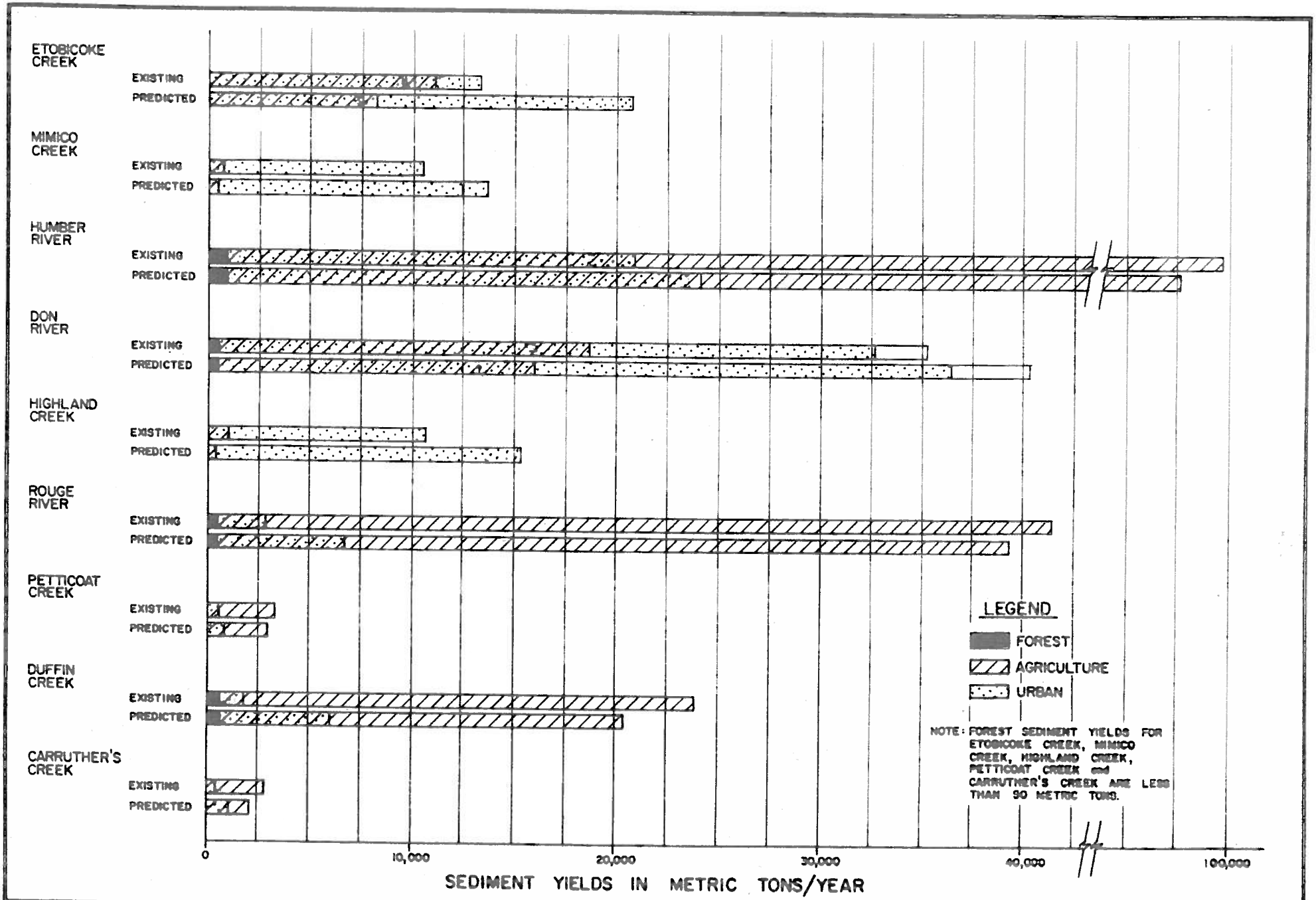
the metropolitan toronto and region conservation authority

WATERSHED PLAN

EROSION AND SEDIMENT CONTROL PROGRAM

ANNUAL SEDIMENT LOAD

I.



the metropolitan toronto and region conservation authority

WATERSHED PLAN

EROSION AND SEDIMENT CONTROL PROGRAM

ESTIMATE OF EXISTING AND PREDICTED SEDIMENT YIELDS

FIG. 8

4. POLICY

The rivers and streams within the Authority's jurisdiction and the water flowing in them, reflect the highly urbanized character of the region. The history of erosion and sediment loss clearly points to the need for the implementation of prevention measures in urbanizing areas in order to minimize the aggravation or creation of hazard problems, and, to minimize damage to structures and land. These in turn will help reduce public expenditures on protective works and help improve the quality of the lakes and streams.

Any protective program of erosion and sediment control must recognize that streams in an urban area cannot always follow their natural channels, but may have to be trained in certain areas. In carrying out erosion control works, it is therefore important to work with nature, so that the natural character of the valleys can be retained.

More frequently, the impact of sediment and the pollutants that adhere to it have highlighted the concerns of this problem. It is apparent that the quality of rivers and lakes is in part dependent on the quantity and quality of sediment which passes or is deposited in them. The control of sediments is a problem requiring a complex and multi-disciplinary solution. The Authority can play an active role in eliminating sources of sediment either directly, as with riverbank protection, or indirectly through advice to municipalities and landowners on the ways and means of controlling sediment generation. New directions in storm water management will also assist greatly in ameliorating the adverse effects of sediment in urban communities.

The Authority believes that a program of prevention and protection measures is a sound basis for the control of erosion and sediment. In this regard, it is the goal of the Authority:

> TO MINIMIZE THE HAZARDS OF EROSION TO LIFE AND PROPERTY, AND TO IMPROVE THE QUALITY OF THE STREAMS AND LAKES THROUGH SELECTIVE CONTROLS ON SEDIMENT SOURCES.

In order to achieve this goal, the following objectives have been identified:

(a) Under The Conservation Authorities Act the Authority has made and will continue to administer regulations applicable in the area under its jurisdiction dealing with the placing of fill in designated erosion hazard areas to prevent the occurrence of further erosion damage;

(b) to seek the cooperation of municipalities in preventing the creation of new erosion prone development through the incorporation of appropriate statements and designations concerning erosion hazard areas in Official Plans and secondary plans (or their equivalent), and, to ultimately control development in such hazard areas through the enactment of restricted area bylaws (zoning) and/or development control bylaws;

(c) to seek the cooperation of municipalities in making the preparation of an erosion-sediment control plan a condition of approval for draft plan of subdivision;

(d) to cooperate with municipalities and landowners during the design of urban drainage systems so as to incorporate into these systems mechanisms for controlling increases in flow and sediment;

(e) to implement a program of major and minor remedial works for the control of erosion and sediment loss;

(f) to recognize the importance of the natural valley character in the design of remedial works wherever feasible;

(g) to continue to update and augment the current state of the art regarding erosion and sediment control in the Authority's jurisdiction.

4. PROGRAM DETAILS

The Erosion and Sediment Control Program is composed of two major components:

- Prevention
- Protection

4.1 PREVENTION COMPONENT

In order to be fully effective, an erosion and sediment control program must endeavour to prevent future problems in addition to rectifying existing ones.

4.1.1. Rationale

As the middle and upper portions of the watersheds within the Authority's jurisdiction continue to urbanize, the downstream adverse effects of increased peak flows, erosion, and sediment loadings will be magnified if potential problems are not eliminated prior to or during development.

Increased urbanization also results in increased encroachment upon river valleys due to their aesthetic appeal. With structures being erected close to the edge of valleys, the problems of valley wall erosion and/or slope instability become increasingly noticeable. As well, poor construction practices can often aggravate if not create erosion or slope instability problems.

As identified previously, construction practices in urban or urbanizing areas is undoubtedly the major source of sediment loadings in the stream systems. The institution of control requirements during the planning and pre-development stages and stringent enforcement during the implementation stage is a necessity if the problems of increased sediment loadings, sediment pollution, maintenance dredging at deposition areas and disruptions to the aquatic environment are to be controlled.

If prevention measures aimed at minimizing potential erosion and sedimentation problems are not instituted, then protective works must continue to be undertaken at ever increasing costs. The cost of rectifying past actions and problems presently necessitates the establishment of work programs in the hundreds of thousands of dollars. With cooperation between the municipalities and the Authority, the preparation and enforcement of development control measures, and, the dissemination of information on wise land use practices, the present expenditures on remedial works should in fact decrease over time.

4.1.2 Program Direction

The implications of continued upstream urbanization have only been identified and addressed over the last several years. If an active prevention program is not implemented, the resulting problems will become increasingly evident as the urban area within the Authority's jurisdiction expands some 20% - 25% over the next twenty years.

The success of any prevention program requires the cooperation and working endorsement of the Authority, its member municipalities and other appropriate government agencies.

Where applicable, zoning and land use controls must recognize the existence of hazards and provide adequate 'set backs' for new development or redevelopment.

As the extent and phasing of urban development is tied into the availability of services such as water, power and sewage; the extent and phasing of development should also be tied into the capability of a watercourse to take increased storm water flows with a view to minimizing increased peak flows, erosion and sediment intake.

In order to be comprehensive and effective, master drainage plans should be prepared for large areas of proposed development so that the impact of anticipated storm water discharges can be determined. Individual subdivision developments would then be required to follow the master drainage plan and to implement whatever storm water management techniques that may be required to meet the desired quantities for storm water discharge. The concept of master drainage plans is more fully addressed in the Storm Water Management Program.

Development control must also recognize the possible impacts of urbanization at the active construction stage. Through subdivision or development control agreements, the Regulations adopted by the Authority under Section 27 of The Conservation Authorities Act, and under the powers of other public agencies, controls should be instituted to minimize the creation of erosion problems and the dramatic increase in sediment loadings so evident in developing areas.

The success of any prevention program is dependent, in part, on making the general public aware of existing hazards and problems and how such hazards and problems are created and their implications. Information programs should be prepared which include suggestions on wise land use practices which minimize the creation of erosion and sediment problems.

In order to adequately administer the prevention component of the Erosion and Sediment Control Program, an annual expenditure in the order of $75,000 is anticipated. This allocation would be for the review of official plans, policies, and plans of subdivision, and, the enforcement of the Regulations adopted by the Authority under Section 27 of The Conservation Authorities Act.

4.1.3 Operational Criteria

Erosion and sediment related problems can be minimized through the institution of the following criteria:

(a) For lands immediately adjacent to valleys, buildings or structures (including paved surfaces), whether situated above or below ground level, should not be permitted in the following erosion impact zones unless studies by a competent professional shows that the structures will be safe during their life, which for Authority purpose is 100 years,

and that the buildings or structures will not aggravate or create erosion problems:

- 10 metres back from the top of bank where a stable, defined valley exists;
- 10 metres back from a projected 2H:1V slope where an unstable, defined valley exists; and
- 10 metres back from the Regional Storm floodline where an ill defined valley exists.

NOTE: Unless shown to be otherwise, the average stable slope is assumed to be 2H:1V.

(b) Surface drainage from any building, structure or paved surface should not be permitted to be discharged over the valley wall. Such surface drainage should be directed away from the face of the valley wall or appropriately piped to the base of the valley wall.

(c) The municipalities be encouraged to have Master Drainage Plans (as described in the Storm Water Management Program), prepared for developing areas which will then be complied with as the individual subdivisions or developments are undertaken.

(d) In conjunction with the municipalities and other appropriate agencies, the Authority shall endeavour to have storm water management methods incorporated into new development. Such methods could include but not necessarily be limited to the following:

- temporary storage of rainfall on flat roofs, parking lots
- detention storage ponds
- in pipe storage
- diversion of rain water leaders on to grassed areas.

(e) The preparation of an erosion-sediment control plan should include mechanisms designed to maximize on site sediment control during active construction. Such mechanisms could include but not necessarily be limited to the following:

- temporary vegetation of stock-piled earth and exposed construction sites
- retention of vegetation buffer strips
- diversion ditches for runoff
- sediment traps and basins
- temporary drainage contouring
- straw bale filters, particularly in proximity to watercourses
- storm water management

(f) The Authority shall endeavour to increase public awareness of the problems of erosion control and sediment reduction by disseminating information and providing technical advice, where appropriate.

4.2 PROTECTION COMPONENT

Within the Authority's area of jurisdiction early development generally occurred along the waterfront and then moved northward, in many cases following the rivers because they were a source of food, power and transportation. This has resulted in much of the older development being adjacent to the rivers. As urbanization has increased, changes have also occurred in the hydrological characteristics of the rivers. Although this process is described in the Flood Control Program, it is important to recognize here that flows have increased and this in turn has increased erosion rates which have resulted in increased sediment volumes.

The protection component of this program addresses itself to the protection of life and property and the elimination of sediment sources.

The Authority has been involved in erosion control work for some time as a result of municipal concern over the loss of structures and property abutting the watercourses. Erosion control work began in Metropolitan Toronto in 1974 and was expanded into the Regions of Peel, York and Durham in 1979.

On the other hand, the need for sediment control has only recently been brought to the forefront largely through the efforts of PLUARG. While the major effort in sediment control lies in the appropriate control of new development and the regulation of land uses, readily identifiable sediment sources adjacent to the watercourses must also be rectified through protection works as part of a comprehensive approach to the minimization of sediment sources.

4.2.1 Rationale

There is continuing pressure on governments at all levels to assist in controlling river erosion and slope instability. Undoubtedly, erosion in the upstream sections contributes towards the aggravation of erosion in downstream areas through higher velocities and increased flows. The resulting increased sediment loadings also affect areas other than their sources, including the transient impact on water quality along the length of the watercourses and the receiving body, Lake Ontario.

Because of the social impact of erosion in developed areas, natural river processes in highly urbanized areas have to be controlled to some degree. In addition to the hydraulic changes in the river regime, there is some public responsibility for planning inadequacies. It must be acknowledged that if the hazard land development control measures being used today had been practised fifty years ago, some of the current problems might be non-existent.

The Authority has concluded that there is justification for government involvement in the protection of private and public property from erosion and in the elimination of sediment sources through corrective works.

The alternative to an erosion and sediment protection component is essentially do nothing. Doing nothing is an option which means continued loss of property and therefore tax revenue and considerable social disruption. The work proposed tackles the severe problems while working ahead to prevent smaller problems from becoming serious ones in the future; in the end it is economically efficient.

4.2.2 Program Direction

In order to ascertain the direction of the erosion control work of the Authority, inventories were carried out to determine the extent of the problem. The results were gratifying: no recent development (after mid-sixties) was in a vulnerable location, indicating the success of the development control measures being implemented. In areas developed prior to the mid-sixties, problems exist particularly in downstream locations where the effects of increased runoff are felt most severely. As one would expect, the inventories show Metropolitan Toronto as having the greatest number of significant erosion problems:

Metropolitan Toronto	:	153 sites
Peel	:	37 sites
York	:	36 sites
Durham	:	14 sites

Past Authority erosion control work experience has led to the separation of major and minor remedial work sites. Major work sites are those where a structure or a sizeable land area will be threatened in the near future and significant engineering works are required for its protection. Minor work sites are those where a small amount of protective work, whether it be rip-rap or vegetation, carried out now will prevent a serious problem from developing later. Within the Authority's jurisdiction, there is a definite trend towards fewer major remedial work sites due to the success of past work, while the number of minor remedial work sites remains constant, at least in the foreseeable future.

Provided that future development is controlled so that it does not become threatened, and provided that new development institutes storm water management techniques to control downstream flow increases; the level of funding required for the protection of erosion prone structures should be reduced in the future. It should be noted that the protection of structures in this instance refers to private development. The protection of public structures whether it be vehicle and foot bridges, park washrooms, or gas or hydro lines is assumed to be the responsibility of the agency that built them.

The protection of private structures must involve owner participation in land and/or money to a level determined by the Authority. Any land on which remedial works are located must be in Authority control whether it be by title or easement.

Another area of more recent concern, is the loss of significant valley land to erosion and the resulting increased sediment loading to the watercourse. Past Authority acquisition has brought much of the significant valley land into public ownership and it has become the core of the region's open space system in many instances. Loss of this land, due primarily to the increase in river flows, is of considerable concern. The Authority is of the opinion that in certain locations this loss of land should not be permitted and therefore conserving land through protection is important. This protection must be traded off against the policy of retaining the natural character of the watercourse as well as the intensity of the use of open space. The two main watersheds where this problem exists are the Don River and Highland Creek, where highly erodible soils and intensive urbanization are coupled to create problems in certain intensely used valley sections.

In attempting to minimize the problem of sediment detachment and transportation, the effort should concentrate on keeping the sediment at or as near to the source as possible.

As stated previously, the major source of sediment in the Authority's area of jurisdiction is that generated from construction activities in urban or urbanizing areas. Hence the most effective control in that instance would be directed towards the source through the use of regulatory measures. Such measures have previously been addressed in the Prevention Component subsection of this program.

The problem of sediment generated from streambank erosion in urban areas would be minimized by providing on stream protective works such as rip-rap or gabion armouring at the source, i.e. the affected site. The introduction of flow control structures, such as check dams, weirs and other drop structures, help reduce the erosive potential and hence the sediment loss from streambanks. Adequate storm water management to control downstream flows would also assist in minimizing the overall effect.

In carrying out the erosion and sediment protection component, continued monitoring and updating of the data base is important in order to keep abreast of changing site conditions. Because the rivers are dynamic, priorities can change from year to year and sometimes even after a single storm. The process of reviewing and updating priorities must be continued not only to make the system equitable but also to adjust annual funding requirements.

In evaluating and assigning priorities for erosion control works, three major categories are considered: effect on structures, valley wall factors, and, river action. The category entitled effect on structures is deemed the most important and accordingly weighted heavier than the physical and geological factors associated with the other two categories. Effect on structures include parameters such as the state of erosion, distance to structures, and the number, size and type of structure(s) affected. The valley wall category includes the height of valley wall, slope angle, vegetative cover, groundwater conditions and the soil type and composition as parameters; whereas the river action category considers the river alignment and the cutting action for parameters.

In evaluating and assigning priorities for the conserving of valley land and sediment reduction, works would be undertaken in descending order of priority based on existing information on the magnitude and extent of the problem. Together with the foregoing, it is important to establish an ongoing monitoring program in order to improve the present data base.

Based on the foregoing and the extent of the problems, the following is a suggested level of funding for the erosion and sediment protection component:

EROSION CONTROL

SUGGESTED ANNUAL APPROPRIATION

Municipality	Major Work	Minor Work	Total
Metropolitan Toronto	$300,000	$100,000	$400,000
Region of Peel	$ 20,000	$ 10,000	$ 30,000
Region of York	-	$ 20,000	$ 20,000
Region of Durham	-	$ 5,000	$ 5,000
TOTAL	$320,000	$135,000	$455,000

The suggested annual appropriation for sediment control is $120,000. These funds would be utilized in conserving valley land and eliminating sediment sources through protective works.

It must be emphasized that the above are not budget figures but appropriate levels of funding based on the problems that exist, and, as such, should be reviewed and updated regularly.

4.2.3. Operational Criteria

In carrying out the erosion and sediment protection component, certain operational criteria will apply. They are intended as a guide to when and how the Authority will involve itself; however, exceptions are made from time to time by the Authority where deemed appropriate. The criteria are:

(a) Watercourses or parts thereof on which the erosion protection works set out in this program are applicable are generally those which drain an area equal to or greater than 1300 hectares (Figure 9). Watercourses which do not meet this specific criteria but which in the opinion of the Authority have physical characteristics which require their inclusion for Erosion Control works have been included in Figure 9. These streams include the Newtonbrook Creek to Finch Avenue and the Centennial Creek to Kingston Road. Watercourses or parts thereof which generally drain an area less than 1300 hectares shall be the responsibility of the municipalities for the undertaking of erosion protection works.

(b) Except where defined otherwise, top of valley slope to top of valley slope shall be described as the area in which the Authority will undertake remedial works to control erosion and sediment loss.

(c) In assessing the severity of an erosion problem, a priority or ranking shall be given to each site. The priorities shall then serve as the basis for the development of an annual erosion works program. A priority shall be based on technical criteria including, but not necessarily limited to the following (also see Figure 10):

- distance from top of bank to structure
- extent of seepage
- ground water conditions
- steepness of slope and height
- soil composition
- vegetative cover, type and extent
- evidence of previous movement
- etc.

The procedures, parameters and weighting factors that contribute towards the establishment of a priority system shall be periodically reviewed to ensure the inclusion of new ideas and techniques.

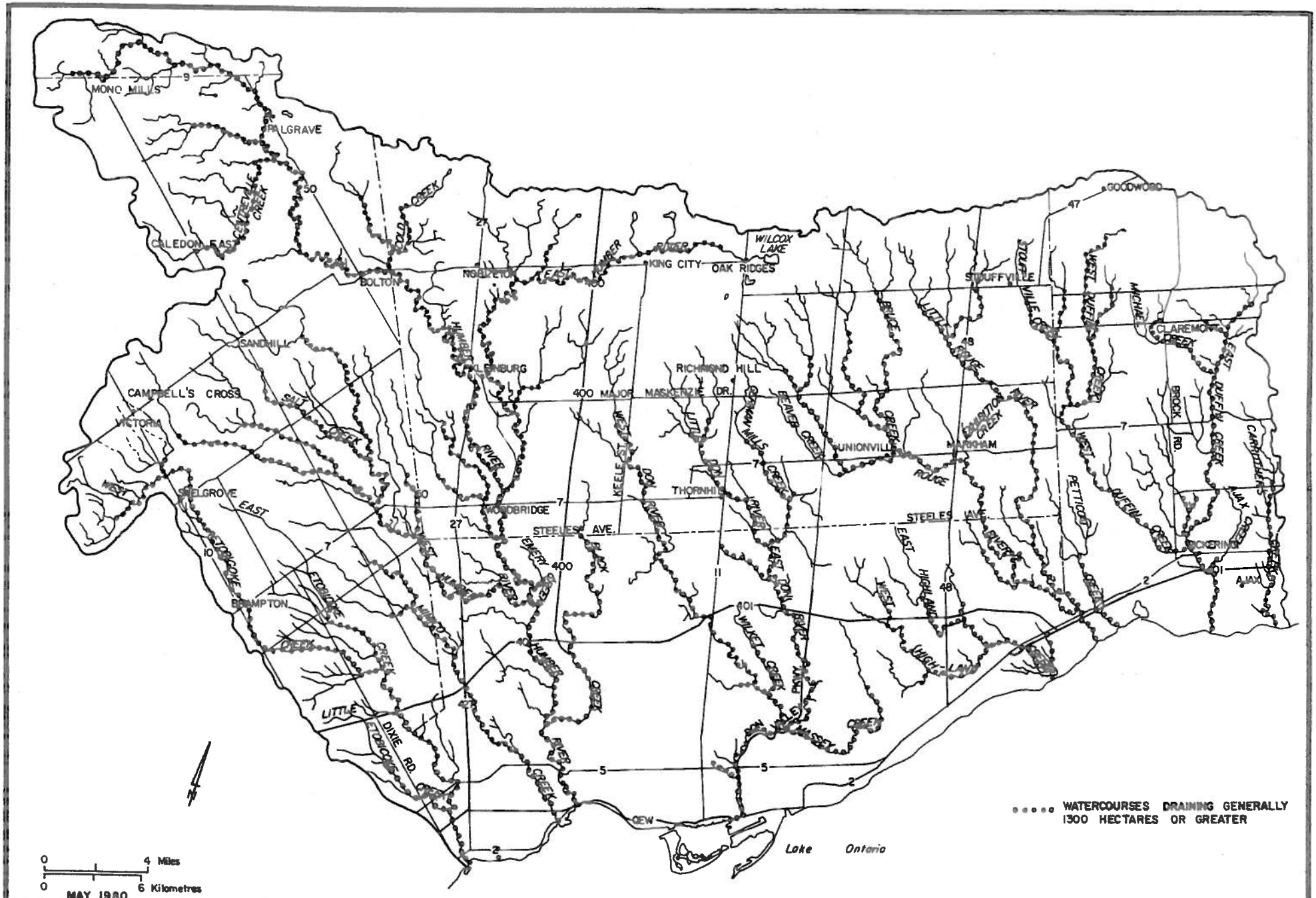
(d) For the purposes of erosion protection works, design blocks shall be established and works undertaken on a design block basis. Design blocks shall be of a size to be technically and economically feasible.

(e) Where erosion protection work is proposed on private land, the Authority shall require title to the land or an easement where applicable, and in addition may require a suitable financial contribution from the benefiting owner(s).

(f) Erosion protection works will be analysed on the basis of cost/benefit, with acquisition cost being used as a principal determining factor.

(g) Design criteria for erosion protection works are dependent upon the nature of each specific problem. Generally two types of problems exist, the first, and less common type, involves a bank or valley wall instability, in which slumping or major rotational failure is involved due to inherent soil conditions or overloading of the bank. The more common type of problem involves the river in coincidence with a valley wall. Wherever possible, erosion control work shall be designed to (also see Figure 11):

- accommodate the 100 year flood for the 'coincident case'
- accommodate the 10 year flow, in all other cases as a minimum, based on the ultimate development of the watershed
- permit channel overtopping with minimal damage to the remedial work
- decrease the velocity of the stream by flattening the hydraulic gradient and minimizing the flow energy - by incorporating meanders and/or controlled drop structures



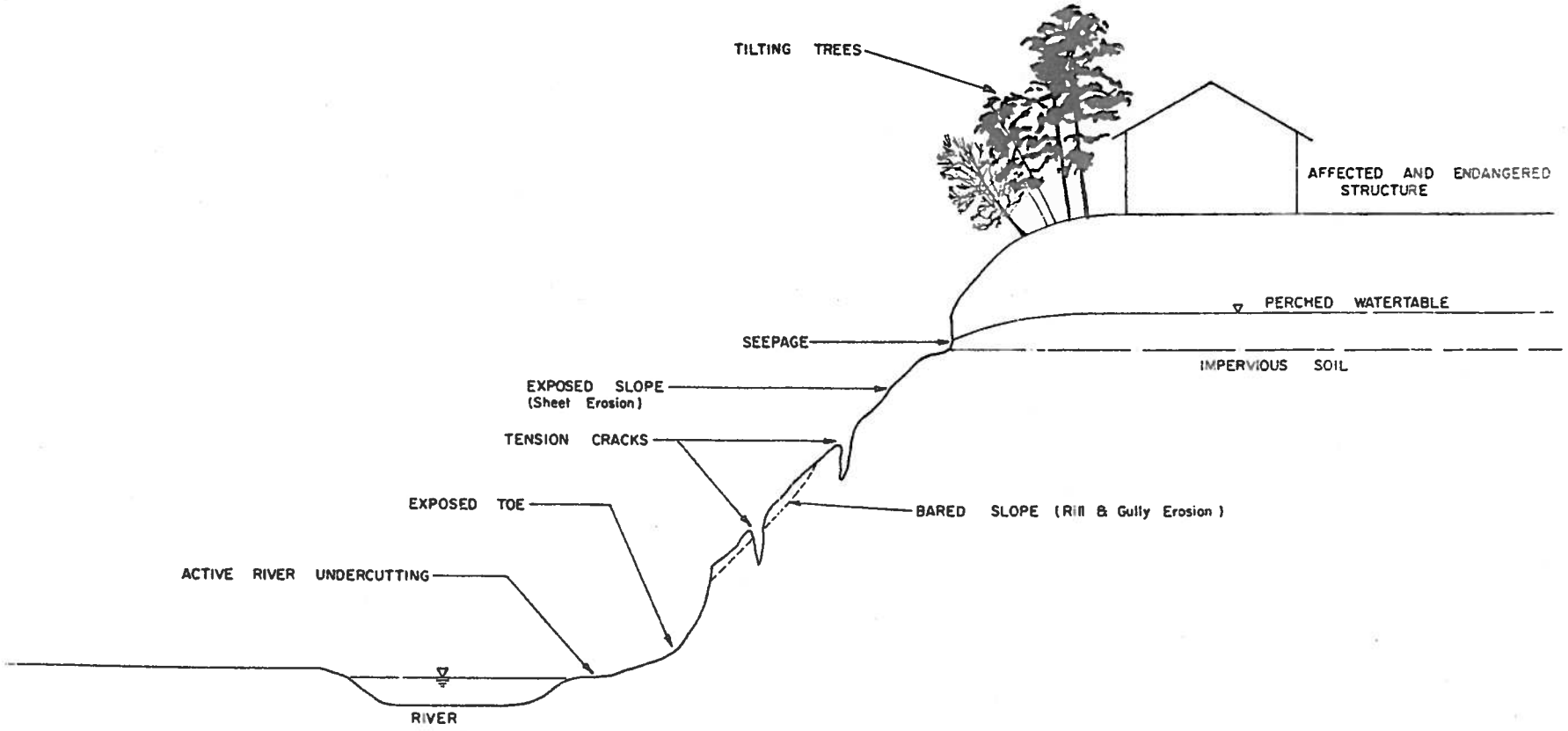
the metropolitan toronto and region conservation authority

WATERSHED PLAN

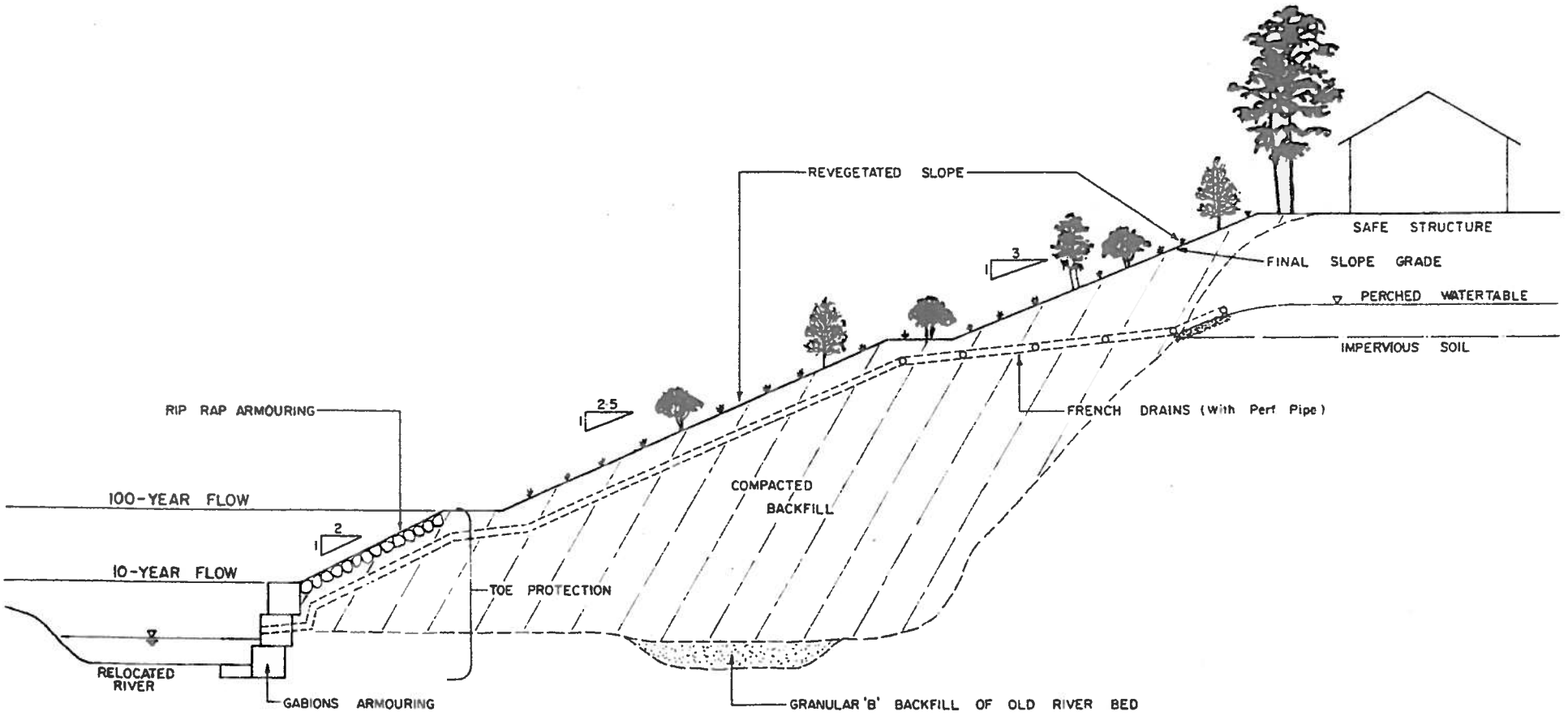
EROSION AND SEDIMENT CONTROL PROGRAM

WATERCOURSES DRAINING GENERALLY 1300 HECTARES OR GREATER

FIG. 9



the metropolitan toronto and region conservation authority	WATERSHED PLAN EROSION AND SEDIMENT CONTROL PROGRAM	TYPICAL EROSION PROBLEM	FIG. 10



the metropolitan toronto and region conservation authority

WATERSHED PLAN

EROSION AND SEDIMENT CONTROL PROGRAM

TYPICAL SOLUTION

FIG. 11

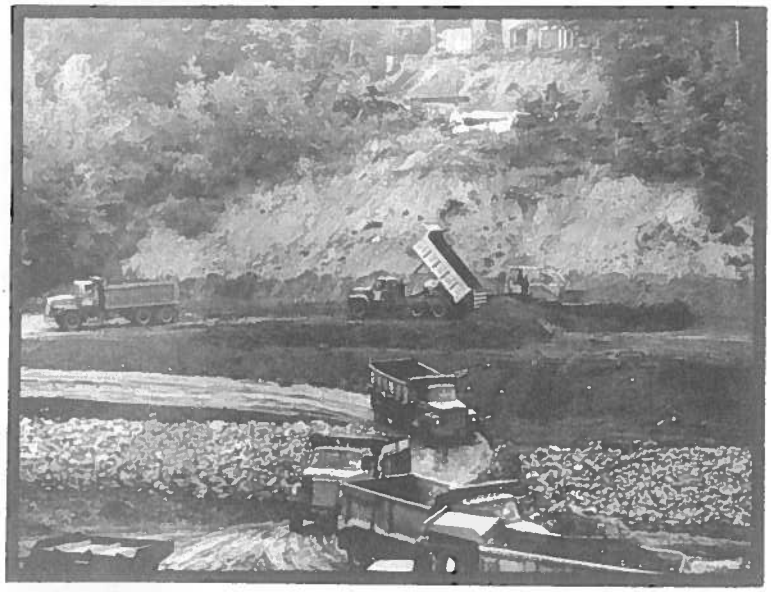
EXAMPLE EROSION SITE

BEFORE PROTECTION
WORKS UNDERTAKEN

(PHOTO 15)

DURING

(PHOTO 16)



AFTER

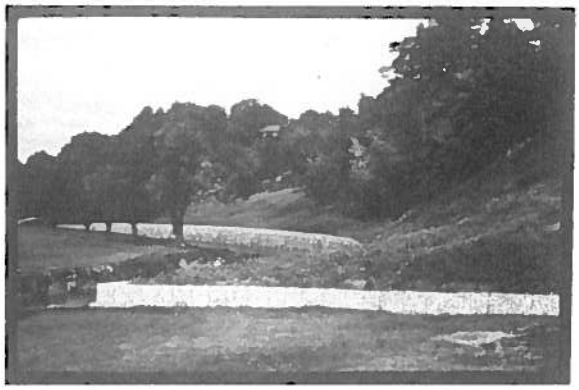
PRIOR TO VEGETATING
THE BANK

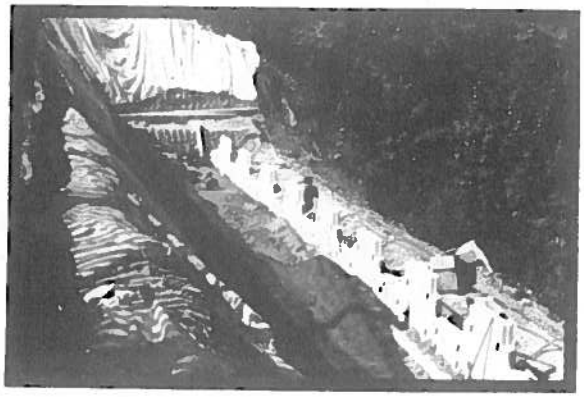
(PHOTO 17)

EXAMPLE PROTECTION MEASURES

RIP RAP
(PHOTO 18)

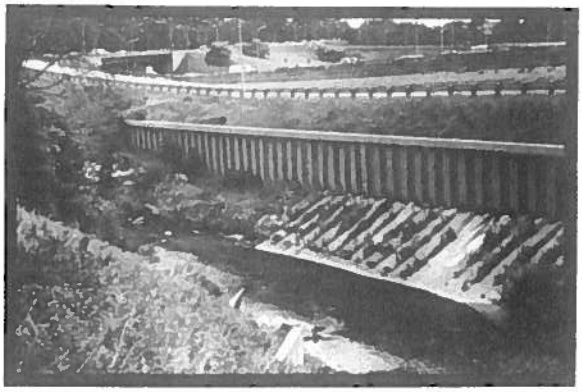
GABION BASKET
(PHOTO 19)





REINFORCED EARTH
RETAINING WALL
(PHOTO 20)

SHEET PILE
WALL
(PHOTO 21)



Location: Ogopunk Junction,
Duffin Creek,
Durham Region

Date: July 1, 1979

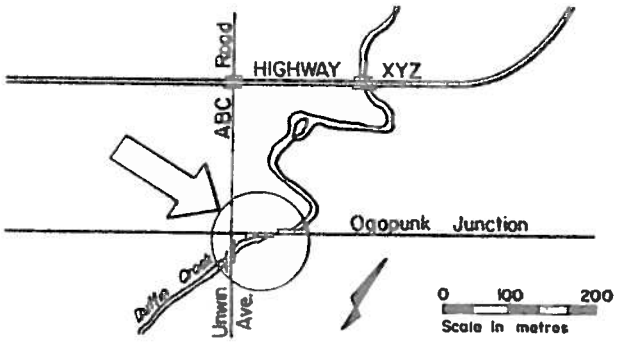
Ownership: - Mr. & Mrs. C. Pigwally
- Mr. A. Dogood

Figures: 1 Photos: 4

Type of Problem:

Toe erosion and groundwater seepage causing mass movement.

TABLE 4



EVALUATION SUMMARY

The upper valleywall located at the rear of Nos. 3-5 Ogopunk Junction was a high quality wooded area dominated by mature sugar maple, and to a lesser extent by beech and red oak. The four black walnuts lining the upper edge were Provincially "rare". The understory was moderately dense with rough avens, purple-flowering raspberry and herb robert predominating. Vegetation of this area was mature and provided cover and nesting sites for a variety of birds, including the red-eyed vireo and scarlet tanager. Few mammals were noted in this area.

The face of the slope on both sides of the scar was predominantly cedar, with no understory. The cedars aid in stabilizing the bank by taking up excess water and anchoring the soil. Soil compaction and/or vegetation stripping of this area would augment erosion.

Opposite the scar, south of the river, was a diverse shrubby habitat of red-osier dogwood, honeysuckle, and Manitoba maple. The overstory and understory of this area was bound together by riverbank grape and Virginia creeper. Vegetation of this area provided cover and food resources for birds and small mammals. This was evident by the high bird activity, numerous mammal trails and raccoon tracks in the area. A Provincially and Nationally "rare" wild plum was present along the waters edge. This species is a native only to southern Ontario and Manitoba. Due to the urbanization of these areas, this species has now become "rare" and worthy of preservation.

The water of this creek was of high quality providing for a number of cold water species including brook trout. The mass movement has posed a significant threat to the adjacent structures and adversely affected the aquatic regime. The sediment input, due to the mass movement, increased the turbidity which directly and indirectly kills fish, shellfish and fish food organisms. It is also possible that toxic substances have been leached out by the water.

Evaluation Summary (cont'd)

The study area was significant because of its overall diversity; as well as the high quality woodlands of the upper valleywall, the water storage capacity of the cedar woods, diverse habitat and species of the opposite shrubland; the "rare" wild plum and walnut species; and the cold water biology of the creek.

RECOMMENDATIONS

1. Major remedial work is required to stabilize the bank and prevent structural damage to the adjacent habitations and the further loss of private and public land.

2. Access be obtained off Unwin Avenue, eastward to the base of the slope, maintaining a five meter buffer zone from the edge of the creek.

3. The black walnut and wild plum be retained with a buffer zone to extend the distance of the canopy.

4. As much of the cedar woods as possible, be retained because of its soil and water retention capabilities.

5. The opposite shrubland be retained as favoured wildlife habitat and encourage revegetation if rechannelization is required.

6. The access route, work area, and parking facilities be marked and delineated to prevent unnecessary disturbance to the creek and wooded areas.

COMPILED BY:

APPROVED BY:

ENDORSED BY:

- increase roughness of the watercourse by a wide selection of design materials;
- consider park/open space plans of other public agencies in the design of remedial works.

(h) In assessing the severity of sediment loss problems, a priority or ranking shall be given to each site. The priorities shall then serve as the basis for the development of annual sediment reduction programs. A priority shall be based on technical criteria including, but not necessarily limited to the following:

- physical extent of the problem
- amount of material reaching the watercourse
- soil composition
- steepness of slope and height, if applicable
- etc.

The procedures, parameters and weighting factors that contribute towards the establishment of a priority system shall be periodically reviewed to ensure the inclusion of new ideas and techniques.

(i) In the design of all protection works, the Authority or any other proponent shall be cognizant of the natural surroundings and shall endeavour to provide ancillary benefits, where appropriate.

(j) In order to minimize the impact of remedial works on the valley ecosystem, an 'Environmental Inventory' (Table 4) shall be undertaken prior to the initiation of any works. Included in the inventory are:

- site description
- dominant overstory, understory and groundcover
- percent of cover types
- fauna species and habitat areas
- aquatic data (where applicable) includes benthic, sediment and chemical analysis
- significant features and/or species
- disturbances
- evaluation of site and proposed access
- recommendations considered as input to the planning, design and implementation of the proposed work.

5. COSTS AND FINANCIAL IMPLICATIONS

The preceding chapters of this program outline the direction that the Authority proposes to take in erosion and sediment control. Although this program is not intended to raise funds, that being the subject of a subsequent Project, it is important to determine an order of funding appropriate for this program when considered in the light of other Authority programs. The costs which are allocated in the following sections are approximate only and are based on 1980 dollar values.

5.1 PREVENTION

To adequately administer the prevention component of the Erosion and Sediment Control Program, the proposed allocation would be as follows:

- review of plans, policies, plans of subdivision, etc.

- enforcement of Authority adopted Regulations under Section 27 of The Conservation Authorities Act

TOTAL: $90,000

5.2. PROTECTION

Much of this program deals with the construction of protective works either to protect some form of development from being lost or to protect banks so they are not a source of sediment. The proposed allocation for these works is as follows:

Erosion Control:	Metro Toronto	$400,000
	Peel	$ 30,000
	York	$ 20,000
	Durham	$ 5,000
		$455,000
Sediment Control:	(urban/urbanizing areas)	$120,000

The erosion control figure represents a decrease from previous levels of funding principally as a result of the success of the work carried out to date. It is expected that this level of expenditure will remain relatively constant; reflecting a decrease in major remedial work sites, but an increase in minor remedial sites. The sediment control figure represents some new direction in order to respond to general concern resulting from loss of public open space and sediment loss problems.

The funds required for the Capital Works will be raised on the basis that the Province will grant 55% of the cost of the work and the balance, or 45%, will be raised by the Authority as follows:

erosion control - benefiting municipality; levy assigned to municipality where the works are located

sediment control - all municipalities benefiting; levy apportioned according to equalized assessment.

5.3 MAINTENANCE

It is important to recognize that the construction of remedial works carries a responsibility for maintenance. By 1981 the Authority will have constructed approximately $3,500,000 of erosion control works, their maintenance involves an annual expenditure of $15,000. As additional works are carried out, the maintenance allocation can be expected to increase at a rate of about 1% per year of the cost of remedial works installed. Using the proposed capital expenditures as a guide, this would result in an increase of about $5,750 per year for maintenance.

The funding for Maintenance will be on the normal basis: 45% Authority, 55% Provincial grant. The Authority share would be raised on the basis that all municipalities are benefiting and would be levied based on their equalized assessment.