ROCHESTER EMBAYMENT REMEDIAL ACTION PLAN
CHAPTER 2: ENVIRONMENTAL SETTING
6-8-93

INTRODUCTION

The Rochester Embayment of Lake Ontario is a shallow triangular indentation midway along the southern shore of Lake Ontario at the mouth of the Genesee River (See Figure 2-1). It has been designated as one of 43 Areas of Concern (AOC) in the Great Lakes Basin.

What sets the embayment apart as a distinct geographical feature is its physical form (geology), in conjunction with natural forces impacting upon it (climate and current). The inflow to the Rochester Embayment from tributary waterways has an effect on embayment and lake quality, and, at the same time, the lake modifies the water quality within the embayment.

This chapter describes the environmental setting of the embayment as a unique feature within the Lake Ontario ecosystem, as a part of the Great Lakes Basin, and as a composite of the waters that are influenced by human activity in each of three smaller drainage basins that contribute to the embayment. Since the waters from each of these three basins impact the water quality of the embayment, each basin is briefly described.

DEFINITION OF THE GEOGRAPHIC SCOPE OF THE ROCHESTER EMBAYMENT AREA OF CONCERN

The limits of the Rochester Embayment of Lake Ontario cannot be clearly seen. The accepted historic description of the embayment is an area of Lake Ontario formed by the indentation of the Monroe County shoreline between Bogus Point in Greece and Nine Mile Point in the Town of Webster, both in Monroe County. An appendix report for the Monroe County Comprehensive Sewage Study (Lozier, 1967) defines the northern boundary of the embayment as a straight line between the two points. It is recognized that describing the northern boundary is somewhat subjective since thermoclines and currents in the embayment and Lake Ontario change from day to day, thus changing the bounds of the embayment ecosystem that has different dynamics from the open Lake Ontario ecosystem.

Hydrologically, the southern boundary of the embayment can be described as those points from which water drains directly into the lake without first entering a stream. This fringe of land, that is exclusively within the embayment watershed, is quite narrow in places. For purposes of the RAP, the AOC also includes the approximately six miles of the Genesee River that are influenced by lake levels, from the river's mouth to the Lower Falls. This also includes the watershed that drains directly to this portion of the Genesee River from both sides of the river gorge.

LOCATION AND DRAINAGE AREA

From the lake side, the AOC comprises approximately 35 square miles of open water in Lake Ontario, the shoreline, and the watershed surrounding the six miles of the lower Genesee River. The mouth of the Genesee River is located at 43°16'N latitude and 77°36'W longitude, approximately seventy-five miles east of the mouth of the Niagara River, and six miles north of the City of Rochester.

The drainage area of the AOC is over 3000 square miles in area. It consists of the entire Genesee River Basin and parts of two other basins; the easternmost area of the Western Lake Ontario drainage basin (West Sub-basin) and the westernmost area of the Central Lake Ontario drainage basin (Central Sub-basin). (See Figure 2-1.)

The Genesee River Basin (shown in Figure 2-2) covers 2500 square miles and includes parts of ten counties. Its landscape steps down to the north in three major, fairly level plateau. Population and intensive development are concentrated at the north end, in and around the City of Rochester. Farmland and mixed forest dominate upstream, to the south. The Genesee River is the major waterbody in the basin. It collects water from 52 tributaries and six lakes as it flows 157 miles from headwaters in Pennsylvania. It flows through a steep rock gorge with three waterfalls in Letchworth State Park in Livingston County, and is controlled by a flood control dam at Mt. Morris. It then flows through a broad floodplain and into the City of Rochester, where it crosses the Erie Canal at grade before entering a steep rock gorge with three waterfalls and flowing into the embayment. The upper and lower falls in the City of Rochester each drop about 90 feet, and the middle falls drops about 30 feet.

The River is used for hydroelectric power generation (6 plants), receiving wastewater (from industrial, municipal and, other sources) and, at the Lake Ontario Port, limited commercial shipping. Recreational uses in the Basin are concentrated in three areas: boating near the mouth of the River; boating and trail use along the Erie Canal; and camping and sightseeing at Letchworth State Park. Public access is provided at other locations along the River and streams. The historic Erie Canal, which flows from west to east across the basin, both discharges water to and uses water from the Genesee River. A crucial role of canal water is augmenting the Genesee River flow during dry periods so that wastewater effluent in the lower Genesee River segment of the AOC can be adequately assimilated. The Genesee River Basin contains significant natural areas including Bergen-Byron Swamp, the Caledonia black duck wintering area and several streams with naturally reproducing populations of trout.

The Lake Ontario West Sub-basin (shown in Figure 2-3) includes 309 square miles and 25 miles of Lake Ontario shoreline in Monroe and Orleans County. It is part of the lake plain, sloping gradually toward the northeast. Population and intensive development are concentrated in the eastern area of the sub-basin, along the shoreline, and in five villages (Hilton, Spencerport, Brockport, Holley and Albion. The last four are located along the Erie Canal). By area, agriculture is the dominant land use. However the trend is toward expansion of residential, commercial and industrial development and reduction of farmland. The West Sub-basin contains a network of streams, many intermittent, flowing northeasterly into the embayment. The Erie Canal crosses the southern portion of the Sub-basin, and some of its water is used for irrigation and recreation. The streams are used for sport fishing and for wastewater discharge from a variety of sources. Recreational uses are concentrated on the shoreline (swimming and camping at Hamlin Beach State Park, and boating at Sandy Creek and Braddock Bay), and along the Erie Canal, with additional public access to some streams. The West Sub-basin contains one of the largest and most important coastal wetland ecosystems in the State at Braddock Bay. This 5000-acre area includes a 2500-acre State Wildlife Management Area that provides habitat and outdoor recreation opportunities as well as boat access to Lake Ontario. Significant habitats exist at Sandy Creek, Yanty Creek Marsh, and the Lake Ontario shoreline.

The Central Sub-basin (shown in Figure 2-4) includes 11 miles of shoreline in Monroe County and 224 square miles in Monroe and Wayne Counties. It has a rolling landscape with some steep shoreline areas. Population and intensive development are concentrated to the northwest, in and around the City of Rochester. The Sub-basin is predominantly and increasingly suburban in character, with diminishing areas of farmland in the northeast and southwest.

The dominant waterbody is Irondequoit Bay. It is significant due to its size (1700 acres), the extent of its watershed (over 70% of the Sub-basin area), and its scenic quality. The Bay water quality has benefitted due to remedial actions, including elimination of combined sewer overflows and the sealing of bottom sediments, which are intended to mitigate its eutrophication. It has very steep erodible slopes and significant shoreline ecosystems. It is an important recreational resource, and the only area in the sub-basin (except the Erie Canal) for launching or mooring motorboats.

In addition to Irondequoit Bay, the Sub-basin contains five smaller watersheds which drain to the embayment, and the Erie Canal which crosses through the middle of the Sub-basin. The streams in the

Sub-basin are used for sport fishing, some canoeing and receiving wastewater from a variety of sources. There are two major county parks along the lakeshore (Durand Eastman and Webster), swimming in two inland ponds, and public access to the Erie Canal and some streams in the sub-basin.

The sub-basin contains significant natural areas, (in addition to wetlands in Irondequoit Bay and the mouth of Irondequoit Creek), including: rare glacial landforms and ecosystems in Mendon Ponds Park; significant habitats in Shipbuilders Creek, Thousand Acre Swamp, Durand-Eastman Park, and the entire Lake Ontario Shoreline.

LAKE ONTARIO: THE BIG PICTURE

The RAP is primarily concerned with waters, sediments, and adjacent lands within the area of concern, and waters leaving the area of concern that may contribute to problems in Lake Ontario. The environmental setting focuses on the parts of the ecosystem that affect these areas.

Capacity and Physical Features of Lake Ontario

In surface area, Lake Ontario is the smallest of the Great Lakes, totalling 7340 square miles. It has a volume of approximately 393 cubic miles, which is more than three times that of Lake Erie. Lake Ontario has a maximum depth of 802 feet and a mean depth of 276 feet. Its deepest point occurs northeast of the mouth of the Genesee River. The Niagara River contributes about 85% of the water that flows into Lake Ontario.

Outflow from Lake Ontario is through the St. Lawrence River. If it were possible to displace all the water in the lake and replace it with the same amount of water currently feeding the Lake, the replacement time on the basis of the inflows, outflows and the volume of the lake would be about eight years (NYSDEC, 1977). So theoretically, if all of the inflow were clean, Lake Ontario could be cleansed in that time. However, the actual inflow is not clean. It contains contaminants that have been introduced upstream in other parts of the Great Lakes Basin, particularly the Niagara River. Many contaminants accumulate in lake sediments and can recycle back into the water.

Flow

The water that is stored in the lake circulates both vertically and horizontally, suspending particles in some areas and depositing them in others. Currents within the lake generally flow in a counter-clockwise direction. These currents are driven by the force of water entering the lake, changes in water temperature, wind, and the direction of the earth's rotation. Currents have the potential to resuspend contaminants in sediments.

The net surface flow of what can be considered Niagara River water is strongly developed toward the east along the southern shore. A lesser return flow moves west along the north shore. (See Figure 2-5)

Because of re-circulation and relatively low outflows compared to lake volume, a gradual dilution of pollutant concentration (depending on the quality of "new" water entering the system) takes place over a long period of time.

In its 1979 Annual Report to the IJC, the Science Advisory Board presented mapped data clearly showing that the Great Lakes become more stressed and polluted from west to east, as illustrated in Figure 2-6 showing concentrations of lead in Great Lakes sediments (Great Lakes Science Advisory Board, 1979). More information on pollutants can be found in Chapter 4.

Currents within the embayment itself depend on wind direction, and can respond to a change within hours. Based on prevailing wind patterns, it is estimated that water in the embayment flows toward the east 55 percent of the time and toward the west 35 percent of the time, and is in a process of reversal 10 percent of the time (U.S. Dept. of Interior, 1966).

Water Levels

The mean monthly water level in Lake Ontario varies seasonally with low levels in the winter and high levels in the summer. The range of this seasonal water level change is approximately two feet. The impacts of these fluctuations are intensified where streams and beaches are shallow.

The long term fluctuations of the water levels in all of the Great Lakes have been monitored since 1860. The Lake Ontario lake levels are monitored and somewhat controlled by international agreement through the International Joint Commission. Based on a 121 year data set, the lake has fluctuated from a high monthly mean of 248.06 feet to a low monthly mean of 241.45 feet. Levels in the last decade have been slightly higher than average (EDR, 1989). Since the last glacial period, a longer-term change has been taking place as a result of the earth's crust rebounding at differential rates in different locations within the basin. This tilting of the basin is expected to result in higher water levels on the southern and western shores of Lake Ontario relative to those on the north and east (Project Management Team, 1989).

Temperature and Wind

Seasonal variations in solar energy produce a seasonal heating and cooling cycle in Lake Ontario. Due to the lake's geographical location, westerly winds prevail during most of the year. During the winter and spring, the prevailing winds are from the west and northwest. During the summer, prevailing winds are from the west and southwest. The jet stream typically lies just north of the lake during the summer and just south of the lake during the winter. Because of the jet stream's influence on the movement of weather patterns, many of the main storm tracks in North America pass directly over Lake Ontario. Air temperature and wind have a major influence on lake levels by affecting the amount of runoff relative to precipitation, and evaporation from the lake's surface.

Temperature Stratification and Overturn

The heat content of the lake changes seasonally and causes vertical movements of water. These changes influence the long term distribution of contaminants once they have entered the lake system by resuspending contaminants that are stored in the bottom sediments.

Heat begins to be stored in the lake around mid-to-late March. The warming begins around the lake perimeter in the shallow waters. This ring of warm water is separated from the colder offshore water mass by a transition zone, known as a thermal bar, where lake water is at its maximum density temperature (4 degrees Celsius). Four degree C water and sinks from the lake surface to the lake bottom and is replaced by colder, less dense water upwelling from the bottom that may contain pollutants from the sediments. As lake warming continues through the spring, the thermal bar migrates lakeward and eventually disappears when the entire lake surface is at a temperature above 4 degrees C -- usually in mid-June. By the end of June, the lake is vertically stratified by temperature into an upper warmer layer (the epilimnion) and a lower colder layer (the hypolimnion), separated by a temperature transition zone called the metalimnion or thermocline, where the temperature gradient is steepest. The upper layer warms as summer heating progresses and thickens as a result of wind mixing. Characteristically, the mid-lake upper layer temperatures will reach 20 degrees Celsius and the thermocline (area of rapid temperature change) depth will reach 20 meters (67 feet) or more. During the period of stratification, the thermocline position changes in response to changing wind conditions at the lake surface, frequently resulting in the generation of internal waves. These vertical shifts in the position of the thermocline play a major role in the observed water temperature fluctuations in the near shore regions of Lake Ontario. Also, during the stratification period, wind effects are largely confined to the upper layer thereby limiting disturbance of bottom sediment.

The cooling phase of the lake begins by mid-September and continues throughout the winter period. The shallow regions of the lake cool first, resulting in a ring of cooler water around the lake perimeter, but without the formation of a thermal bar. Generally, around late October, an early winter wind event is sufficient to cause the vertical layers to mix. At this time, the lake becomes essentially one temperature throughout.

Throughout the winter, the lake continues to lose heat, but its great depth and large thermal inertia cause the main part of the lake to remain ice-free, although shore ice is a common feature. During the winter the lake may develop a weak stratification, with water at temperatures less than 4 degrees C overlying the dense bottom water which remains at 4 degrees C. This rarely persists in the near shore regions where wind keeps the water column well-mixed vertically (Matsumoto, Rumer and Argus, 1989.)

Seasonal stratification also affects what happens to runoff as it enters the lake. Temperature differentials and sediment loads affect the density of stream water relative to the lake, and may be a determining factor in how and where waters and pollutants become mixed within the embayment. For example, warm water from the Genesee River in the summer may flow many miles across the surface of colder Lake Ontario water before lake and river waters mix completely. In summary, in Lake Ontario there are two periods of stratification (Summer and Winter) and two periods of mixing (Spring and Fall).

Wave Action

Another major factor affecting the confluence of lake water and runoff is wave action, determined by the wind's strength, direction and duration, and the area over which it blows. While the moon has a generally negligible impact on the water levels of Lake Ontario, the water levels are fluctuating constantly due to a number of factors, primarily precipitation rates within the Great Lakes Basin. Shorter term fluctuations of a few hours or a day, at local points on the lake, are caused by local weather features, i.e., wind set up and barometric pressure differences. These fluctuations can range from a few inches to over two feet.

The Lake Ontario shoreline of Monroe County is exposed to storm waves generated by winds originating from the west-northwest to north-northeast. The exact exposure of any specific site varies somewhat due to the shape of the local shoreline and the offshore depth.

The movement of waves across any offshore shallow areas (shoaling) will greatly transform a wave's height and steepness and change its impact on the shoreline. The presence of a one- to two-mile-wide sand shelf offshore of the Monroe County shoreline serves both to limit many storm waves by shoaling and to provide a source of beach material.

Wave action is responsible for sediment transport characteristics of the shoreline areas. The present erosion west of the embayment at the western edge of Hamlin Beach State Park is replenishing sand beaches to the east. These processes are largely driven by the wave energy at the site and the site topography and geology, but they can also be greatly influenced by human development activities. The impact of humans on the process of sediment transport can be seen at the harbor structures for Rochester. These breakwater structures serve as a sediment transport barrier, which is causing the growth of sand beach fillets on both sides of the entrance. This buildup indicates that there is significant transport within the shore zone in both directions, depending on the prevailing wave direction and an adequate source of sand. It is likely that in the embayment area, the offshore sand bottom serves as a major source of beach sand during calmer periods, when waves are less steep, and receives back some of this same sand during the storm periods, when steep high waves are eroding the beaches (EDR, 1989).

The Rochester harbor (at the Genesee River) is largely protected from the wave action offshore by breakwalls, but significant water surge occurs in the Genesee River due to the funnelling of wave energy from the lake. The U.S. Army Corps of Engineers began a study on the water surge in 1990. The study, expected to be completed in 1992, will identify options to deal with this problem.

Lake Ontario is a complex and dynamic system. In addition to the physical activity described above, plant and animal life affects the chemistry of the water.

The Food Web and Bioaccumulation

An aquatic ecosystem is based on a complex food web made up of producers, consumers and decomposers. The producers are plants -- algae, phytoplankton and rooted vegetation (macrophytes) -- that use the sun's energy to produce carbohydrates from carbon dioxide and water. Those carbohydrates then become the food which sustains the rest of the ecosystem. Aquatic plants require over 20 chemical nutrients in order to survive; these nutrients are dissolved in the water, available from the air, and contained in sediments where rooted vegetation can extract them. During photosynthesis (the production of carbohydrates), aquatic plants give off oxygen that dissolves in the water and sustains life for other organisms.

Aquatic plants provide not only food and oxygen, but also shelter for many animals. Wetlands, which are filled with aquatic plants, are breeding grounds for fish, birds, amphibians and some mammals. Plants provide sites for egg-laying, concealment or hunting.

Because the producers depend on light, they are affected by turbidity that decreases the depth to which light penetrates. Because their growth depends on dissolved nutrients, they are sensitive to changes in nutrient concentrations. These primary producers increase greatly in number when a scarce nutrient becomes abundant. The macrophytes, because they grow along the shore, are affected by changes in shorelines and sediments (caused by development, for example) that alter or destroy their habitats.

Consumers do not produce their own food, but obtain it by eating other organisms. Microscopic zooplankton are the primary consumers, feeding on algae and phytoplankton. They in turn provide food for secondary consumers, or carnivores, such as alewives, gizzard shad and the young of other fish species. The community of carnivores is very diverse, ranging from benthic invertebrates (insects, crayfish, clams and organisms that live in or on the bottom sediments) to fish, waterfowl, raptors (hunting birds) and fish-eating mammals. Those at the top of the food web eat other carnivores, and are thus several levels removed from the original nutrient sources in the inorganic environment. These "top carnivores" in the Great Lakes basin normally include trout, salmon, mink, otter, gulls, terns, ducks, loons, bald eagles, ospreys and humans. Not all of these species are present in the Rochester Embayment.

At each step in the food web, some energy is lost; thus the numbers of top carnivores are small compared to the large numbers of plankton, minnows and others lower on the food web. These relatively small populations of top carnivores are also particularly affected by pollution, due to the process of bioaccumulation. Toxic substances that are not metabolized or excreted build up in each organism's body, becoming concentrated even further when that individual and others like it are eaten by a predator. Figure 2-7 shows how PCBs are concentrated hundreds of times through four levels of predation in Lake Ontario. Gulls and Lake Trout eat Smelt and Sculpin which eat Pontoporeia and Mysis which eat Plankton.

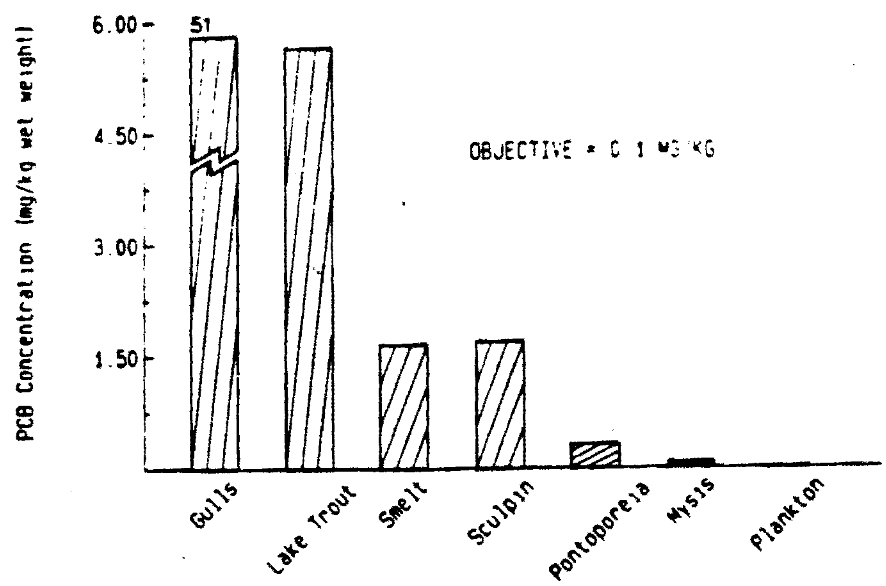

FIGURE 2-7. BIOMAGNIFICATION OF PCB THROUGH THE LAKE ONTARIO FOOD CHAIN

Source: Canada Dept. of Fisheries and Oceans. From Rathke and McRae (1989).

The populations of aquatic consumers in the embayment are sensitive to the physical and chemical qualities of the water such as temperature and oxygen levels, and to the presence or absence of other organisms that serve as food, as predators, or as competitors within the ecosystem.

The third category of organisms is the decomposers. These essential organisms recycle organic wastes and dead plants and animals by breaking them down into their chemical constituents, which are then released for use once again as nutrients by aquatic plants. Bacteria, fungi and yeasts commonly perform these functions. They not only break down dead matter, but transform nutrients from one form to another (e.g. ammonia to nitrite, nitrite to nitrate, etc.). They themselves may also be eaten by other organisms, forming another base for the food web. It is the decomposers that carry out waste treatment both in natural systems and in most wastewater treatment plants.

In areas heavily loaded with conventional pollutants, the populations of decomposers increase and they recycle more nutrients, providing added fertilizer for plants such as algae. Even with increasing populations, however, decomposers may not be able to process all the wastes entering the ecosystem.

Decomposers that require oxygen to break down organic matter can deplete the dissolved oxygen in the water when a great deal of waste is present. The lack of oxygen makes the water inhospitable to fish and many other organisms. Excess wastes then build up in the sediments, creating an oxygen debt so that depletion of oxygen continues whenever the sediments are disturbed. The problem is exacerbated because oxygen depletion causes the breakdown of a naturally-occurring chemical process that retains many pollutants in bottom sediments, and allows release of the wastes and toxins that are stored there.

In a healthy environment, the food web is normally complex and diverse -- composed of many different species. Inhabitants of the ecosystem include species that are tolerant of pollution or low oxygen conditions and those that are not. Polluted environments that can still support life often contain many individuals but few species, since only those especially tolerant of pollution survive there. This lack of diversity makes it more difficult for the ecosystem to maintain stability and respond to stresses.

In addition to pollution and habitat destruction, another important factor in determining the biological composition of the embayment has been the introduction of species from outside the area. When exotic organisms (those not native to an ecosystem) are introduced into the system, they can cause the disappearance of native species through predation or competition for the same resources, or they can undergo population explosions due to a lack of natural enemies. At times they can tolerate degraded conditions better than the native species, and assume an important place in the system. Lake Ontario has experienced the introduction of the alewife, white perch, carp, Pacific salmon, sea lamprey (a parasitic fish), and more recently the zebra mussel, which encrusts boats and water intakes and consumes large quantities of plankton. Many exotic species have been brought into the lake in the ballast water of ships.

Eutrophication

Eutrophication is a process that has caused use impairments in the Embayment, Irondequoit Bay, and several of the smaller lakes and ponds within the sub-basins. The trophic classification of a lake refers to its productivity, or the amount of food available in it. A lake can be oligotrophic, mesotrophic or eutrophic (Odum, 1971). Lake Ontario is primarily mesotrophic. (U.S. EPA and Environment Canada, 1988).

An oligotrophic (few foods) lake is normally clear, with little vegetation around its margin and little visible algae. In nature, such lakes are normally deep and/or geologically young. In contrast, a eutrophic lake has an abundant supply of available nutrients and produces a large crop of algae and aquatic plants. A mesotrophic lake is between the two in character. Over geologic time, many lakes naturally will become shallower and more eutrophic, eventually becoming marshes, then dry land.

There is more life in a eutrophic lake than in the other types, but the species composition and functioning are different. For example, cold-water fish such as trout and salmon are frequently able to live in the cold depths of an oligotrophic lake, but not in a eutrophic lake. In a eutrophic lake, algae and other organisms are produced in such abundance that when they die, their decomposition uses up the lake's oxygen supply faster than it can be replenished. The rain of dead matter to the depths of the lake creates anoxic conditions there, preventing these game fish from surviving.

Even through many natural lakes are eutrophic, it is considered undesirable when human actions result in the eutrophication of a naturally oligotrophic or mesotrophic lake. The algal blooms, vegetation-clogged shorelines, odors from decomposing organic matter, and loss of desirable fish species all detract from the enjoyment of the lake. The primary cause of eutrophication is the accelerated flow of nutrients from the watershed into the lake. Phosphorus is naturally the most limited nutrient in most cases, so it is the addition of phosphorus that permits the algal blooms and associated detrimental conditions to occur.

CLIMATE

The climate in the vicinity of the AOC and its drainage basin is humid continental. The prevailing wind movement is the same as for Lake Ontario -- predominantly from the west and northwest in winter and southwest and west in summer. Wind acquires moisture as it moves over the lakes, contributing to precipitation in the form of rain and snow (which is termed lake effect). Figures for the weather over the embayment and its drainage basins are based on data collected at the Greater Rochester International Airport southwest of Rochester, about ten miles inland from the lake.

Seasonal temperatures fluctuate between extremes of -25 degrees to 104 degrees F with an average annual temperature of 46-48 degrees. Lake Ontario plays a major role in the Rochester weather. Because the lake water warms and cools at a slower rate than the land, in the summer the lake has a cooling effect that inhibits the temperature from rising much above the low- to mid-90s F. In the winter the modifying temperature effect prevents temperatures from falling below minus 15 degrees F most of the time.

The lake also plays a major role in winter snowfall distribution. Inland from the lake and toward the airport, the seasonal snowfall is usually less than in the area north of the airport and toward the lakeshore where wide variations occur. Snowfalls of one to two feet or more in 24 hours are not uncommon near the lake in winter due to lake effect alone. The area is also prone to other heavy snowstorms and blizzards because of its proximity to the paths of low pressure systems coming up the east coast, out of the Ohio Valley, or to a lesser extent, from the Alberta area. Total annual snowfall ranges from 80 to 90 inches, and continuous snow cover is possible though not recently common, from December through March.

Precipitation is rather evenly distributed throughout the year (NOAA, 1989). Excessive rains occur infrequently, but may be caused by slowly moving thunderstorms, slowly moving or stalled major low pressure systems, or by hurricanes and tropical storms that move inland from the Atlantic Coast. Hail occurs occasionally. Heavy fog is rare on land but is common on the lake. Winds average 11 mph, and wind magnitude throughout the region tends to vary in inverse proportion to distance from the lake.

The growing season in the drainage basin averages 150 to 180 days near the lake, depending on microclimatic influences, and as little as 110 days in the southern uplands. The year's first frost usually occurs in late September and the last frost typically occurs in mid-May (NOAA, 1989).

Concerns for air quality have given rise to recent monitoring of long range air movement patterns. While atmospheric movement is somewhat constrained by local topography and meteorological events, there is no direct analogy between a watershed and an airshed. However, it can be said that a given area is within a certain Atmospheric Region of Influence (AROI). In contrast to its hydrological counterpart where all points within a river drainage basin are in the same watershed, the AROI is receptor site specific, meaning that every site has its own unique AROI. This data is not presently available for the Rochester area. However, Figure 2-8 shows the one to five day AROI for the entire Great Lakes Basin. The general pattern for individual points in the basin are similar and tend to correspond to the known dominant wind patterns. The probability of a particular windborne substance being deposited at a site depends, among other things, on travel distance and the substance's lifetime in the atmosphere. (International Air Quality Advisory Board, 1988-89)

TOPOGRAPHY/GEOLOGY

Topography

The land that drains to the Rochester Embayment has been raised in elevation through a long, intermittent, erratic and slow process of uplift since it formed the bottom of several inland seas. The region was later covered with glacial deposits and subsequently exposed to the erosional influences that have produced the physiographic features of today. Ridge Road (State Route 104, shown on Figures 2-9 and 2-10) follows the prominent shoreline of the former glacial Lake Iroquois (Monroe Co. EMC, 1976). Topography of the area is characterized by a fairly level lake plain to the north of Ridge Road with a gradual transition to rolling hilly features to the south. Elevations in the two Lake Ontario subbasins range from 245 feet at the lake shore to around 1100 ft. in the southeastern portion of the Lake Ontario Central sub-basin. The greatest elevation in the Genesee basin is 2500 ft. in Pennsylvania. There are very few areas within the Lake Ontario West sub-basin that have steep slopes. The specific areas of steep slope in the Lake Ontario Central sub-basin are concentrated around the Lake Ontario shoreline, Irondequoit Creek, Irondequoit Bay, and drumlin fields in the southeastern portion of the sub-basin. The Lake Ontario shoreline in the Central sub-basin generally consists of steep slopes with a gradient of over 10% adjacent to or a short distance from the water's edge. The Irondequoit Bay shoreline is composed of very steep slopes ranging from 15% to 60% grade. Steep slopes in the Genesee Basin are generally concentrated along the walls of the river valleys, particularly in the headwater areas and in the gorges through Letchworth State Park. (See the Genesee Basin Plan for a map of slopes in the basin).

The western portion of the embayment itself has a relatively gradual slope -- about half of what is typical along the rest of southern lakeshore including the eastern portion of the embayment (see Figure 2-10). As the easterly lake current rounds the tips of Devil's Nose and Bogus Point (Bogus Point shown on

Figure 2-9), a drop in velocity occurs as currents are deflected around the headlands. This slowing of the lake current prevents sedimentary particles carried into the embayment by the Genesee River from being scoured away. Instead, it appears that they build up over time (e.g. continual sand blockage of Braddock Bay). Sediment blocking bays is normal longshore transport related to all rivers and beaches providing sediment. This sediment is generally being reworked by long-shore drift (west to east) (see Figure 2-5).

The rising lake levels of Lake Ontario, since the last glaciation, have resulted in the flooding of lower reaches of streams as they approach the lake. The subsequent development of sand bars across the mouths of these streams has caused the development of shoreline ponds (e.g. Round Pond in Greece shown in Figure 2-10) which add to the diversity of the embayment area. (EDR, 1989)

Dredging of the Genesee River has occurred regularly over several decades. Dredge spoil is dumped in a designated one-half mile square area of the embayment, located about 1.5 miles northeast of the river jetties (see Figure 2-10). The volume of spoils deposited over this time totals more than a cubic mile, but there is no significant accumulation of sediments on the Lake bottom in the designated dumping area. What can be seen on the depth charts is an elongation of the shallows extending northeast of the river's mouth toward the deepest portion of the lake floor. It would appear that the long term impact of dredging on the bathymetry of the embayment does not vary substantially from the effects caused by the force of the river itself before the jetties were built.

Geology

Within the AOC drainage area, the bedrock is basically one of six types: shale, limestone, siltstone, evaporites (salt, gypsum, etc) , sandstone, or dolostone. The bedrock is thousands of feet thick and was formed by the deposition of clay, silt, sand and calcareous material at the bottom of seas that covered the area throughout much of geologic time. Several ancestral Genesee Rivers predated the latest glacial events. Prior to the arrival of the last glaciers, the river had an outlet to the lake through Irondequoit Bay (Kappel and Young, 1989). Glaciation eroded the hills and deepened and widened the valleys. When glaciers retreated they left behind massive deposits of clay, silt, sand, gravel and rock debris known as glacial drift. Glacial deposits are generally thin (less than 50 ft. deep) on upland sites, and thick (100-300 ft.) within the valleys of the Genesee River and its major tributaries. The principal exceptions to such thickness in the valleys are the postglacial Genesee River gorges where bedrock is at or close to the surface. The glacial and postglacial sediments in the old Irondogenesee Valley in the Lake Ontario Central sub-basin are 300-400 feet thick in many places near Irondequoit Bay. A detailed description of the glacial history of the basin is presented in Muller et. al., 1988.

Soils are diverse and variable with significant areas susceptible to erosion and/or considered poor for disposal of septic effluent (Landre, 1990).

Groundwater aquifers in the embayment drainage area in general are variable, with some good quality but some moderately hard water. Usual depths of wells range from 30 to 80 feet. Estimates of available groundwater reserves far exceed what is drawn for regular use. Ninety percent or more of drinking water within the drainage basin comes from surface sources, and well over half of that is drawn from Lake Ontario (Weston, 1987). All of the three basin plans prepared at the same time as the RAP have extensive information on groundwater included in their appendices. Please see these appendices for further information on groundwater. Additional information on water use and drinking water sources may also be found in the basin plans.

Major Waterways and Water Uses

The Genesee River discharge varies seasonally with maximum flows generally occurring in early spring (March-April) as a result of rain and snow melt runoff. Average annual river discharge as measured at Driving Park Avenue (near Lower Falls) over a 76 year record period was 2794 cubic feet per second. This represents a minor portion of the total water load to Lake Ontario (approximately 1% vs. over 4% from the

Oswego River and nearly 85% from the Niagara River). Sediment loadings in the Genesee River discharge are high and turbidity events are common. Stream bank erosion throughout the drainage system is thought to be the primary source of sediments.

After the river, the next largest channel in the drainage basin is the Erie Canal, which flows west to east beginning at Lake Erie. The canal receives water from local waterways, including the Genesee River, and discharges water into local waterways, including the Genesee River and Irondequoit Creek. Its use in recent years has been primarily recreational. The canal receives stormwater and treated wastewater and has an impact on the embayment via its discharges to the Genesee River and other waterways that flow to the embayment.

Several other major streams make their way to the embayment from both urban and agricultural watersheds. Irondequoit Bay is fed primarily by Irondequoit Creek, which has a 163 square mile watershed. Irondequoit Bay is heavily used for recreation, and is a harbor of refuge. Six creeks with a watershed area of 64,039 acres (approximately 100 square miles) feed Braddock Bay at the western end of the embayment.

Uses of the embayment by humans are described below briefly:

Water Use/Consumption:

The Monroe County Water Authority (MCWA) is the primary user of Lake Ontario water for drinking. The Monroe County Water Authority primarily serves people within Monroe County outside the City of Rochester. The MCWA has a maximum allowable withdrawal of 140 million gallons per day (mgd). Actual usage averages less than half of that to serve over 700,000 people. The water intakes for the MCWA's Shoremont Water Treatment facility lie approximately one mile west of the Genesee River mouth in the Rochester Embayment. The Village of Brockport, which serves some other communities in the Lake Ontario West sub-basin as well, also draws its water from Lake Ontario. The intake for the Brockport waterworks is located about one and a half miles west of the mouth of Sandy Creek (see Figure 2-3). The City of Rochester draws an average of 37 mgd from Hemlock and Canadice Lakes (see Figure 2-2). A conduit system conveys the water to the city and also supplies an amount less than 1/2 mgd to water districts in Livingston County. A reciprocal water sales purchase agreement between the city and the MCWA allows MCWA to draw an average of 13 mgd from the conduit system to serve their customers south of the city. The city in turn receives water from MCWA to offset the amount taken from the conduit and to supplement the city's water supply.

Eastman Kodak, the largest industrial user in the basin, draws water from the lake via an independent system. The Kodak intakes lie approximately one and a half miles west of the river mouth within the Rochester Embayment.

Wastewater Discharges:

Most of the wastewater from industry and homes throughout the drainage basin is discharged into the Genesee River, Lake Ontario, streams or the Erie Canal. Some is also discharged to the ground. Depending on the volume and velocity of discharge, extent of vegetation, evaporation, sunlight, etc., the biotic, chemical, and thermal wastes received by the streams and river will be altered, concentrated in sediments or other sinks, or carried downstream. Direct discharges of wastes to surface and groundwaters are regulated by the State Pollutant Discharge Elimination System (SPDES) overseen by the New York State Department of Environmental Conservation. As of June 1989, throughout the drainage basin, there were twenty-eight permits issued for discharges in excess of 0.5 mgd. In all, these total nearly 500 million gallons per day of permitted volume (NYSDEC, unpubl.a).

Several outfalls for municipal and industrial discharges are located in the lake and in the Lower Genesee River. The single largest discharger using the lake directly is Monroe County with its Frank E. VanLare sewage treatment plant designed to handle 135 mgd and the Northwest Quadrant Plant with a design flow of 22 mgd. The Town and Village of Webster systems handle an additional 10 mgd. All of these discharge pipes are located close to or beyond the limits of the Rochester Embayment.

The largest industrial treated wastewater discharges is Kodak which discharges to the lower Genesee River. Permitted municipal wastewater and industrial facilities which discharge to the river and lesser tributaries, are listed by design flow and receiving waters in the individual basin reports. Chapter 5 of this report estimates pollutant loadings from various sources.

Stormwater drainage in urbanized areas is a significant source of non-point pollution. Because a high percentage of the land surfaces are impervious (roofs, paving, compacted soils), the ratio of runoff to precipitation is high. Nutrients, sediment, particles and chemicals on impervious surfaces are more susceptible to being washed into the streams than would be the case in meadow or forest landsurfacesr. The quality of this discharge is only starting to be measured and regulated. In the Irondequoit Basin, which flows to the embayment, stormwater runoff was found to wash significant amounts of pollutants to Irondequoit Bay. Results are summarized in the final reports of the Nationwide Urban Runoff Program in 1983 and 1986 (O'Brien and Gere, 1983; Kappel, et al., 1986).

In addition, combined sanitary/storm sewers exist in the City of Rochester. The original system frequently discharged untreated combined sewage to the Genesee River and Irondequoit Bay. This problem has been alleviated by the construction of underground conveyance tunnels, built as part of the Combined Sewer Overflow Abatement Program (CSOAP) described further in Chapters Four and Five.

Transportation/Commercial Shipping/Commercial Fishing:

The lower Genesee River is dredged to maintain a 21-foot deep shipping channel two and a half miles upstream from the mouth in the harbor area. Although once used extensively for commercial shipping, as of 1992 the river has only one commercial user, Essroc Materials, Inc. (a cement company). The Lower Falls drops nearly 100 feet to the lower river, precluding the use of the river as a transportation route upstream.

Commercial fishing is no longer an industry for the embayment as it was in the earlier part of the century. In the last two decades, recreational fishing, primarily for trout and salmon stocked in the lake by federql and state fishing management agencies, has become an important social and economic activity in Lake Ontario and the Rochester Embayment.

POPULATION and LAND USES

Population Density

The 1990 Census puts the population within the drainage area at slightly over 1.2 million people. Monroe County accounts for 84% of the total population and about 15% of the total land area. (Based on CGR, Unpubl.).

A greatly simplified illustration of dominant land use patterns can be seen in Figure 2-11. Forest and agriculture account for approximately 90% of the land use within the combined drainage basins, but these uses are farthest from the Area of Concem. Population densities increase dramatically as one moves north toward the embayment. The fastest rates of population growth since 1920 have taken place in the towns immediately to the west and southeast of the City of Rochester in Monroe County.

Residential growth in the Monroe County villages has been more modest, but Monroe County far outpaces all the other basin counties in its rate of development and that trend is expected to continue.

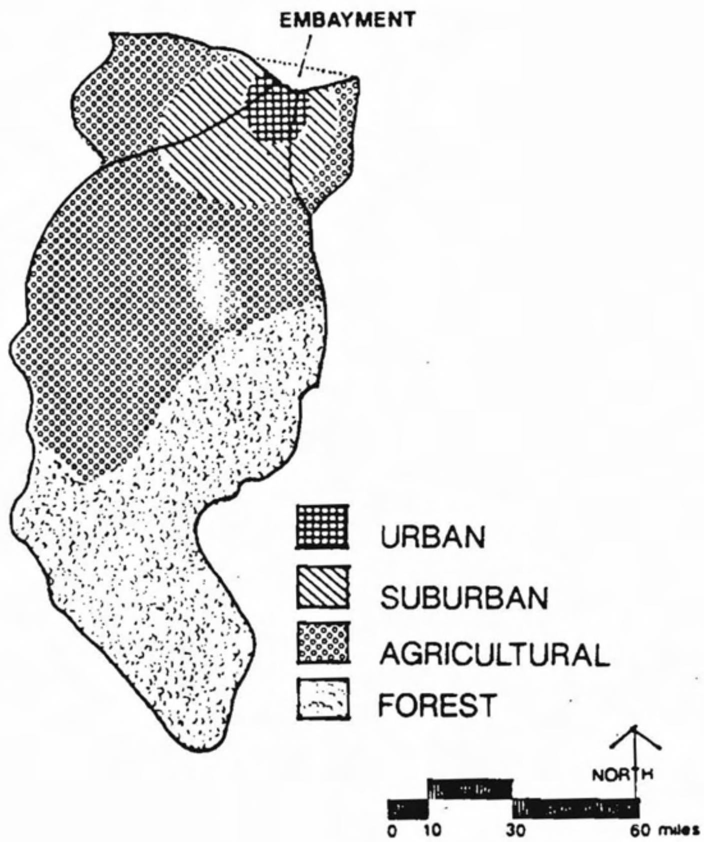

FIGURE 2-11. DOMINANT LAND USE PATTERNS IN THE ROCHESTER EMBAYMENT BASIN. Source: Landre (1990). (Note: generalized--in reality some ag. use in area designated as forest and vice versa)

There is a direct connection between the distribution of people within the land area of the basins and the amount of stormwater runoff that carries pollutants to the embayment. Unfortunately, features of the natural environment that are most likely to have a long term buffering effect on the impacts of human activity are least likely to remain undisturbed in an urban setting. The filtering effect of soils is negated when covered with impervious asphalt and concrete, which collect atmospheric pollutants that later wash off into waterways. In such urbanized areas, runoff speeds through straight stream channels devoid of vegetation that facilitate flow and do not impede the transport of sediment and other pollutants in the water.

Forest and Agriculture

Agricultural land use has experienced some decline in recent decades. What may be more significant for water quality is that the remaining agriculture has changed dramatically. There is a tendency toward consolidation and large-scale farming techniques. Compared to even ten years ago, there are fewer farms overall, with an increase in the average size per farm. In the southern part of the basin, farmland is predominantly used for dairy production. In the northern part of the basin, crop production is more significant. The moderating effect on air temperature caused by Lake Ontario enhances the climatic conditions for growing fruit near the lake.

Although there are no formal predictions for changes in agricultural production, the dairy industry has been dependent on government subsidy for some time, and surpluses have built up. The recent economic downturn could force notable changes upon that industry in the coming decade, similar to the national programs that reduced tilled acreage of grains in the 1960s. With less land being tilled, there has been a slight increase in the amount of wooded cover as old fields have reverted to secondary growth, especially in outlying suburban areas.

Commercial and Industrial Land Use

Manufacturing, retail and service industries are concentrated in the City of Rochester and Monroe County along major transportation routes. Rochester is a world leader in several industries including photography, xerography, telegraphy, telephone automation, optics and imaging (Great American Brokerage, Inc., 1989). The distribution and amount of industry within the basin is well established and is not expected to change dramatically in the foreseeable future. There are, however, efforts by many economic development agencies to attract new industries to the basin. There is some mining of gravel and sand, but it is not extensive.

Transportation

The drainage basin is well served by major state and interstate highway routes. The Lake Ontario Parkway and connecting roads are part of New York's Seaway Trail that promotes tourism along scenic waterfront areas. Not surprisingly, most transportation corridors are concentrated in and around the City of Rochester. The largest airport in the basin is adjacent to the Genesee River near the southwest portion of the city. One notable trend in transportation is renewed interest in promoting the use of the Erie Canal as an intrastate transportation/recreation route. See the basin reports for discussion of other transportation corridors.

Recreation

The drainage basin is rich in water resources that attract related recreational use. Recreation is proving to be a growth industry. Demand for waterfront recreation facilities and services currently exceeds supply and is growing. The Rochester Harbor in the lower Genesee River, Irondequoit Bay, and Braddock Bay are the primary access points to Lake Ontario. Boat launches and marinas are available in these areas as well as in several of the streams along the shore. There is public swimming at Ontario Beach Park (immediately west of the Genesee River) and Hamlin Beach State Park (west of the embayment). There has been substantial growth in sport fishing in recent years, despite consumption advisories for a number of fish species.

Lake Ontario and its shoreline areas are most suitable for power and sail boating, swimming, fishing, scenic access, and camping. There is some tourism related to fishing, other attractions in the Rochester area, and travel along New York's Seaway Trail. Current demand for facilities to support these activities generally exceeds the supply depending on the economy, and demand is expected to grow. There is potential for these demands to threaten aquatic habitat.

Aesthetics

The waterways are the major scenic resources in the drainage basins. Views to the water ways from public roads are typically screened or blocked by the interposition of landform, vegetation or shoreline development. Panoramic views from public roads such as those of Irondequoit Bay, Braddock Bay, and the lower Falls, are rare and of outstanding quality. Many notable scenic locations in the embayment area have been preserved as parkland and public access provided -- e.g. the Rochester gorge and waterfalls, Seneca and Maplewood Parks on either side of the gorge, Ontario Beach, and Durand Eastman Park.

Planning/ Regulating Jurisdictions

Governing bodies whose jurisdiction can potentially impact water quality within the embayment range from private owners of parcels that drain directly into the embayment or streams, to the International Joint Commission itself, which has called for this Remedial Action Plan and is coordinating policy review and implementation for the entire Great Lakes Basin. Intermediate governments and the areas which they oversee are discussed in detail in the basin reports. Briefly they include:

Local Government:

Villages, Towns, and Cities: These municipalities prepare land use master plans (including local waterfront revitalization plans) and develop and implement land use regulations based on State enabling legislation (this includes approving plans for stormwater drainage). The City of Rochester provides water to its population directly, as do many Villages. Some villages and many towns purchase water from other suppliers and deliver it to their population. The City of Rochester and many villages provide garbage and trash pick-up and disposal. Some Villages and Towns provide wastewater collection and/or treatment.

County: Some counties have their ownHealth Departments. Depending on the county, their roles include approval and inspection of water supply extensions, on-site wastewater treatment facilities, drinking water supply monitoring,beach, stream, and some ground water quality monitoring and response to stream pollution complaints, State Pollution Discharge Elimination System commercial sewage plan review, inspection, and enforcement, an inactive hazardous waste site program, and response to petroleum and hazardous material spills. The Monroe County Division of Pure Waters is responsible for municipal wastewater collection, wastewater treatment, operation and maintenance of the sewer system in many areas, and operation and administration of an industrial pretreatment program. The Counties provide overall solid waste management concentrating primarily on recycling and disposal. Counties operate and maintain roadside drainage on County roads, and in Monroe County, work with others to track road salt usage and discourage the excessive use of road salt. County Environmental Management Councils provide education in the area of water quality. County Planning Departments are involved in land use planning that impact water quality. County agencies also work together to conduct research and demonstration projects that lead to improved water quality.

Monroe County Water Authority (MCWA): This Authority provides drinking water to much of the population of Monroe County that lives outside the City of Rochester.

County Soil and Water Conservation Districts: Staff of the districts, together with staff from the federal USDA Soil Conservation Service provide planning and technical assistance to landowners in preventing soil erosion and water degradation in both urban and agricultural areas. District staff also encourage tree planting and helps landowners design ponds.

New York State:

Department of Environmental Conservation (NYSDEC): The State regulates actions that may have an impact on water quality. This includes issuing permits for discharges of wastewater to streams, groundwater, and lakes; issuing municipal water supply permits; issuing permits for emissions to the air (which can enter the water via stormwater runoff); managing and protecting fish and wildlife; issuing permits for development on or near certain wetlands; regulating of hazardous and solid waste disposal facilities and transportation; and undertaking some monitoring and research activities. The NYSDEC also is the lead Stage agency coordinating with the State Departments of Law and Health in implementing the Inactive Hazardous Waste Site Remediation Program.

Department of Transportation (DOT): This state agency builds and maintains many roads and bridges which include water issues such as stormwater drainage and winter deicing methods.

Department of State: This state agency is responsible for overseeing State coastal management programming such as the local development of Local Waterfront Revitalization Plans.

Department of Health: This state agency is responsible for insuring safe drinking water and safe food (including locally caught fish). In many cases, such as in Monroe County, the State regulations are actually enforced through the County Health Department. They annually issue fish consumption advisories in areas where they determine there may be concerns about the safety of consumption.

Regional Agencies:

Genesee/Finger Lakes Regional Planning Council: This group promotes economic development, including tourism and recreation as elements that attract and keep industry. This agency is also involved in assisting counties in its region in conducting research that will result in improved water quality. Counties covered by this agency are Genesee, Livingston, Monroe, Ontario, Orleans, Seneca, Wayne, Wyoming, and Yates.

Finger Lakes Water Resources Board: This multi-county group works together as a consortium to apply for State aid to localities to improve water quality. Funds obtained by the Counties that are members of this group are used for many different kinds of water quality and aquatic weed control projects. This group is also trying to coordinate water quality activities among the counties (Cayuga, Cortland, Genesee, Madison, Onondaga, Ontario, Oswego, Seneca, Wayne, Wyoming, and Yates).

Federal Agencies:

U.S. Environmental Protection Agency (EPA): This agency, with regional offices in New York City, has a Great Lakes section which oversees work ongoing in the Great Lakes Region. In addition, EPA is responsible for setting water quality criteria and ultimately enforcing Clean Air and Clean Water standards. There is also a Great Lakes Regional Program Office located in Chicago, Illinois. The EPA works closely with the NYSDEC in allocating funding for many water quality programs.

U.S. Army Corps of Engineers: The Corps, with a regional office located in Buffalo, is responsible for issuing permits for filling of wetlands under Section 404 of the federal Clean Water Act. They also perform maintenance dredging of federal navigation channels including the Genesee River and Irondequoit Bay and regulate dredging by others. The Corps also does feasibility studies on many projects that affect the water including flooding and surge, monitors Lake Levels in Lake Ontario and works with the International Joint Commission to regulate lake levels.

National Oceanic and Atmospheric Administration (NOAA):. This federal agency is a source of information on the effects of human activities on environmental quality. One NOAA responsibility, together with the U.S. Envioronmental Protection Agency, is to guide and approve State Coastal Nonpoint pollution control programs.

U.S. Department of Agriculture Soil Conservation Service (SCS) and Agricultural Stabilization and Conservation Service (ASCS): These two agencies work together to prepare conservation plans for agricultural lands and to cost share the implementation of best management practices to protect soil and water quality.

International:

International Joint Commission(IJC): The IJC regulates Great lakes water levels and carries out the activities outlined in the Great lakes Water Quality Agreement by convening meetings and preparing reports. Under the auspices of the IJC, a declaration of intent between four parties (NYSDEC, USEPA, Environment Canada, and the Ontario Ministry of the Environment) has resulted in a toxic management plan for lake Ontario.

The planning jurisdictions with the most immediate effect on water quality in the embayment are local planning boards at the municipal level, because their actions affect the most proximate and intense land uses. The New York Department of State, Army Corps of Engineers and NYSDEC have some jurisdiction over coastal lands adjacent to the embayment.

NATURAL FEATURES

The natural features of the AOC relate most strongly to the dominant characteristics of the shoreline: extensive low lying wetlands west of the river and steep bluffs to the east. There are three distinct shoreline types: low-lying sand beaches; narrow, non-sand beaches; and wetlands.

The sand beaches are found along the western shore of the embayment and further west. They include:

1. Hamlin Beach State Park (west of the embayment) where sands are stabilized by jetties and replenished by erosion of the Devil's Nose headland, farther to the west.

2. Bogus Point, a largely low-lying littoral spit (small point of land or a narrow shoal projecting into a body of water from the shore) where the offshore bathymetry provides protection and permits an apparently stable beach.

3. Ontario Beach, on the west side of the river jetties, which has a public beach developed for swimming.

4. Durand Eastman beach, part of 10,000 feet of park lake frontage. Natural topography is rolling with several natural drainage ways extending across it carrying small stream flows to the lake. The shoreline has a narrow sand beach.

Non-sand beaches line the shore at the toe of steep slopes on the east:

1. Webster Park with a total lake frontage of about 2000 feet in length, has a high bluff section of shoreline with a ravine cut at its eastern edge by a small stream. The toe of the bluff is stabilized by rubble. The bluff deposits are mapped by the Surficial Geologic Map of New York as lacustrine deposits of silt and clay. There is no beach at the shoreline. The offshore area is relatively steep and rocky with no established offshore bar or beach.

2. Nine Mile Point has a single beach at the toe of an eroding high bluff. The foreshore is steep and there is no sign of any sand deposits either on the beach or immediately offshore of the toe and of the bluff. Bluff materials appear to be primarily lacustrine silts and clays which are sand and gravel deficient.

The major wetland areas include:

1. The Braddock Bay Area in the Lake Ontario West Basin (see Figure 2-3) is an extensive area of ponds and marshes that is actively managed for fish and wildlife production. Five thousand acres of wetlands, sections of which are designated wildlife refuges, provide critical spawning and nesting habitat for a wide variety of fish and birds, including several species listed as endangered or threatened. It is particularly noted as a viewing area for migrating birds. This is one of the largest and most significant coastal wetlands on Lake Ontario. In some areas, there is conflict between recreational boating use and use of the wetland for wildlife habitat. It should also be noted that the entire shoreline area from the Genesee River west to Hamlin Beach State Park is dotted with wetlands.

2. In the Lake Ontario Central Basin (Figure 2-4), Irondequoit Bay was originally formed as the entrance bay of the Genesee River into the ancestral Lake Iroquois. The river has redirected its flow to the present day channel through Rochester and the sand bar at the mouth of the bay has grown and moved bayward with subsequent rises in the level of the lake. The bay is eutrophic: rich in organic matter and nutrients. Near the center its depth exceeds 50 feet, but the northern and southern ends of the bay are quite shallow. Although its waters open to the lake, the opening is narrow and allows little mixing to occur. Along the shoreline and at the south end of the bay, (the mouth of Irondequoit Creek), are extensive wetlands, which serve as important fish spawning and waterfowl nesting areas. Irondequoit Creek and its tributaries provide unique spawning habitat in a suburban setting.

3. The Lower Genesee River has extensive areas of wetlands in and south of the Turning Basin (shown on Figure 2-10. It is a significant salmon movement area, and a productive warm water fishery. However, the species of fish are limited to those which tolerate high turbidity. The wooded gorge is an important wildlife habitat within this intensively developed urban area.

Fishery Resources:

Salmon stocking by the DEC has created an important recreational fishery in Lake Ontario and its major tributaries. In 1990, a total of 270,000 chinook salmon, 20,000 steelhead (lake-run rainbow trout) and 25,000 coho salmon were stocked in the Genesee River. An additional 32,000 brown trout were stocked directly to Lake Ontario in the vicinity of the Kodak Water Treatment Plant (NYSDEC, unpubl.b). However, the New York State Department of Health (DOH) has issued a health advisory on eating salmonids from Lake Ontario because their flesh contains potentially harmful levels of some chemical contaminants. The DOH recommends that all lake trout and chinook salmon, as well as larger sized coho salmon, steelhead and brown trout not be eaten. Smaller sized coho salmon, steelhead and brown trout should be eaten no more than once per month (NYSDOH, 1993). For further information on the fish advisory, see Chapter 4, section 1d.

The Zebra mussel, an exotic species, introduced into the Great Lakes by international shipping, is proliferating in the absence of predators. It is having an impact on the AOC. These impacts include impacts on the sport fishery (competition for food), improvement in water clarity, and actions necessary by humans to prevent water intakes from becoming clogged with zebra mussels.

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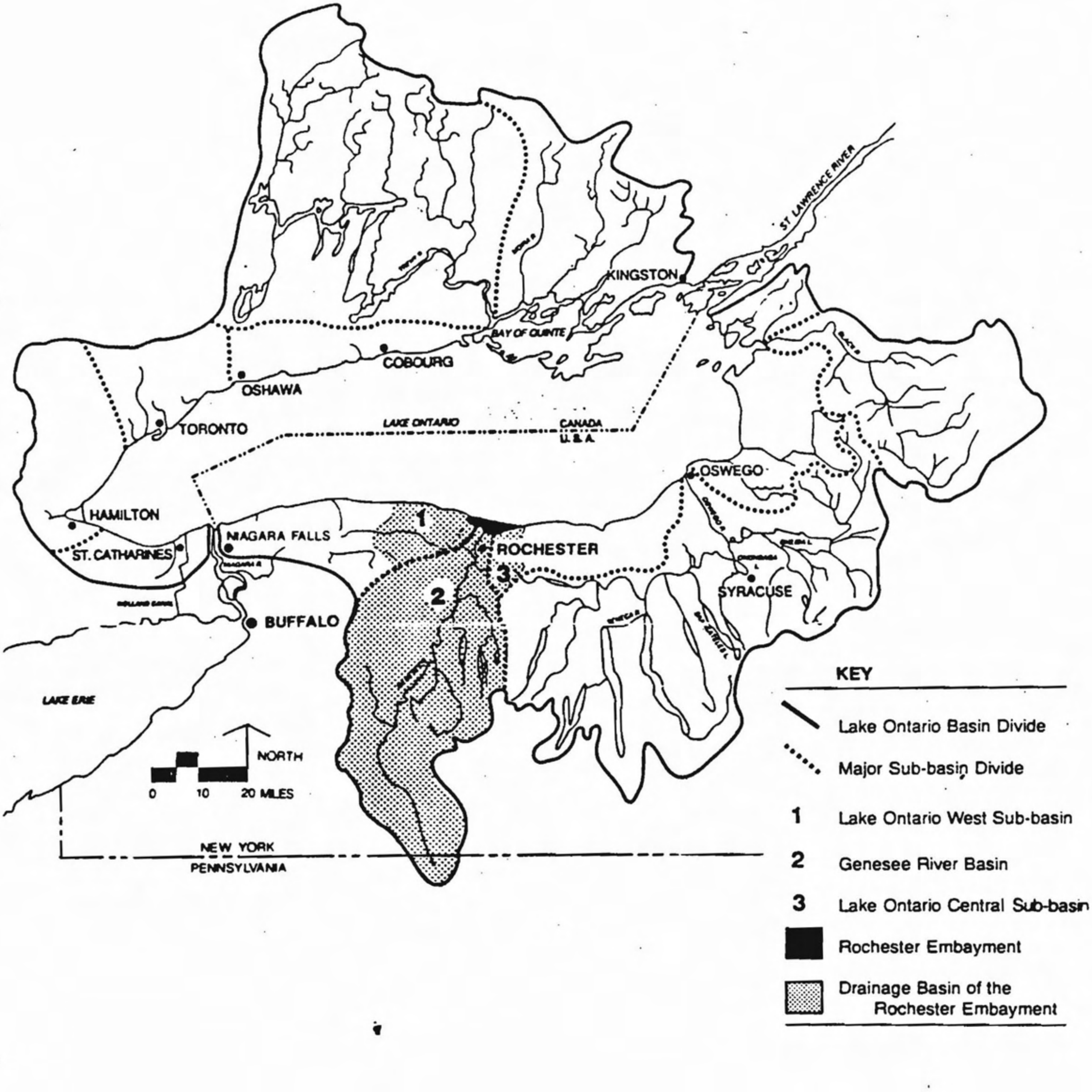


FIGURE 2-1. LOCATION MAP: ROCHESTER EMBAYMENT AREA OF CONCERN AND ITS DRAINAGE BASIN.

Source: Lake Ontario Toxics Management Committeee (1989) (modified)

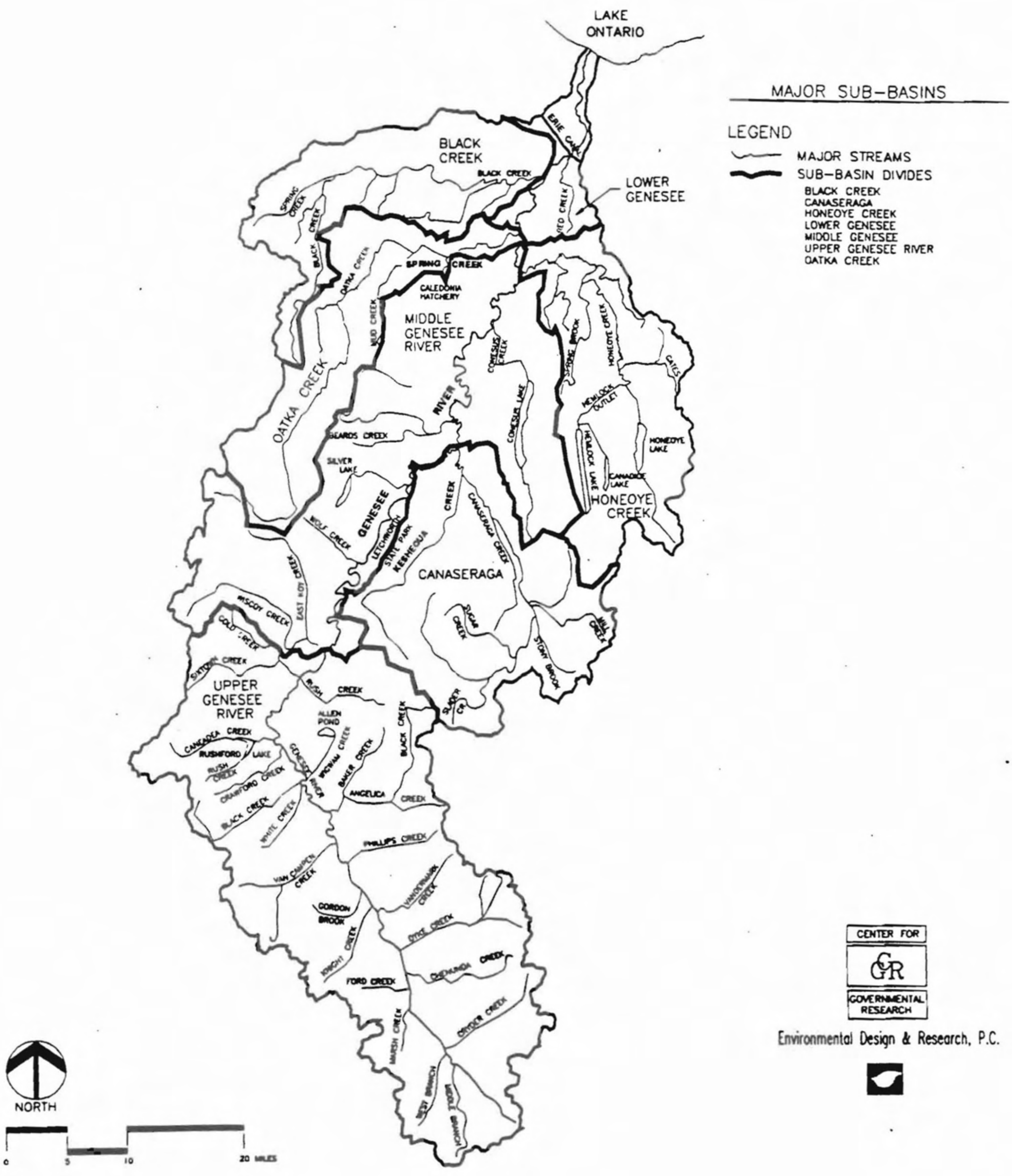


FIGURE 2-2. GENESEE RIVER BASIN

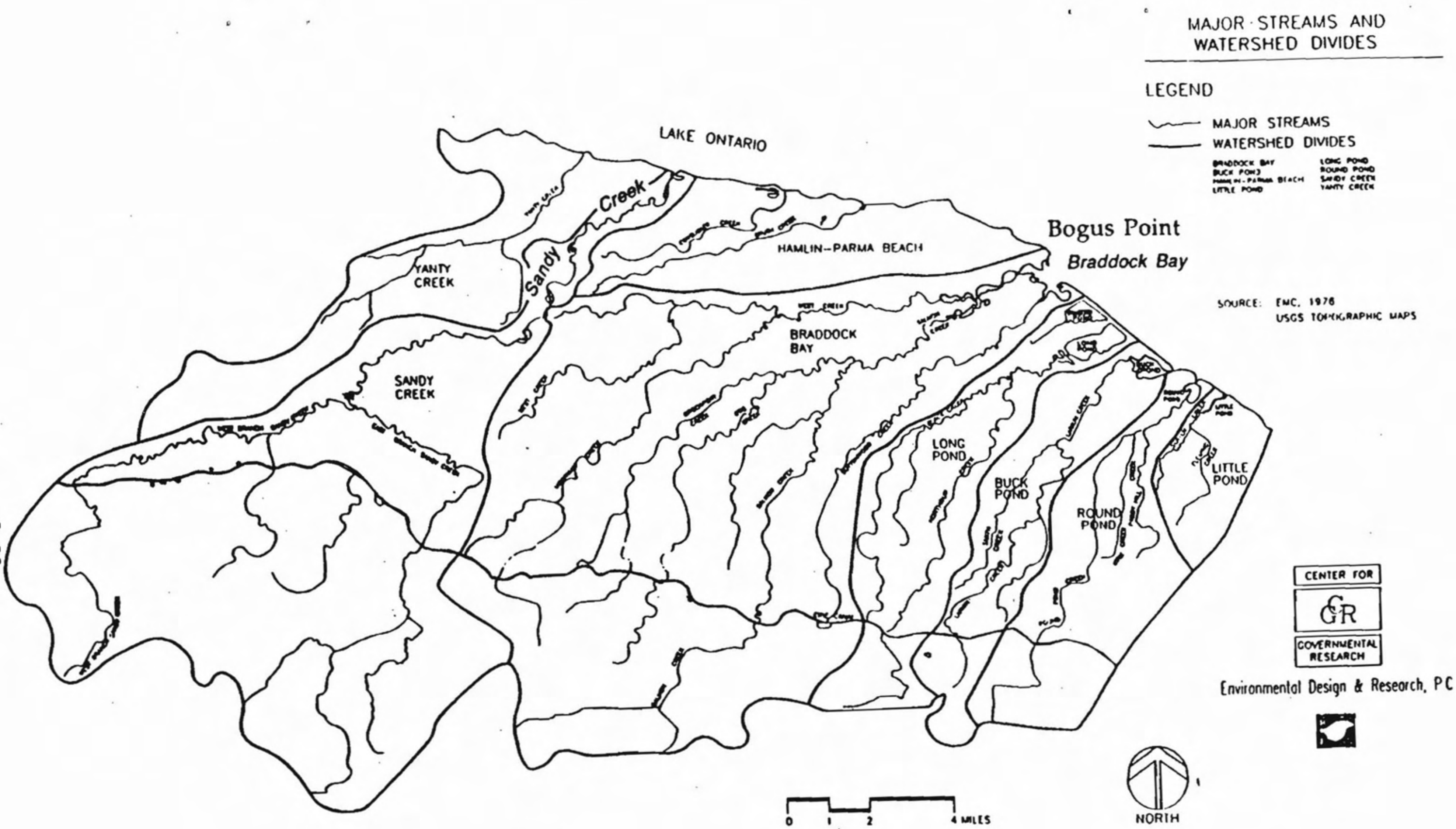


FIGURE 2-3. LAKE ONTARIO WEST SUB-BASIN

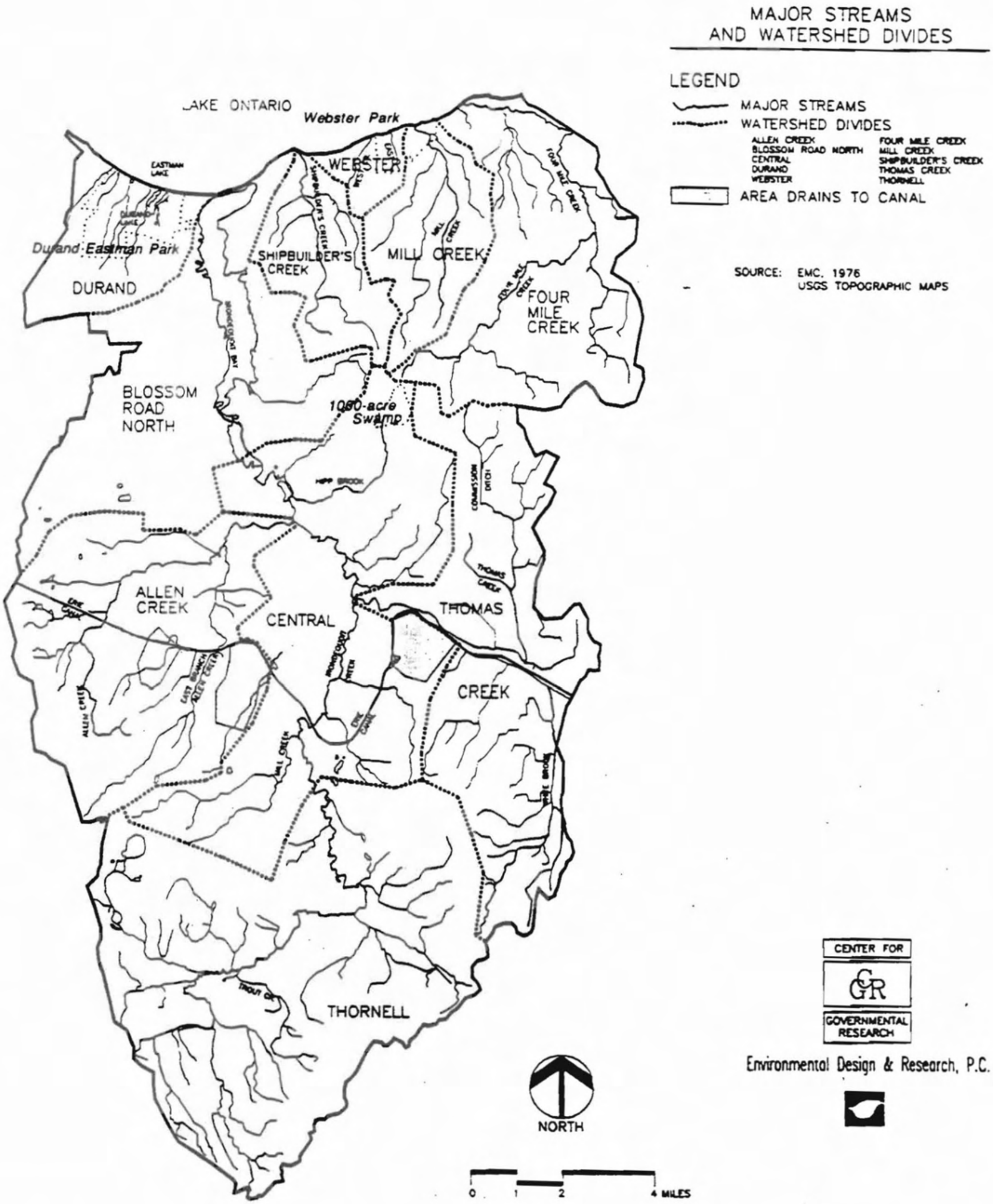


FIGURE 2-4. LAKE ONTARIO CENTRAL SUB-BASIN

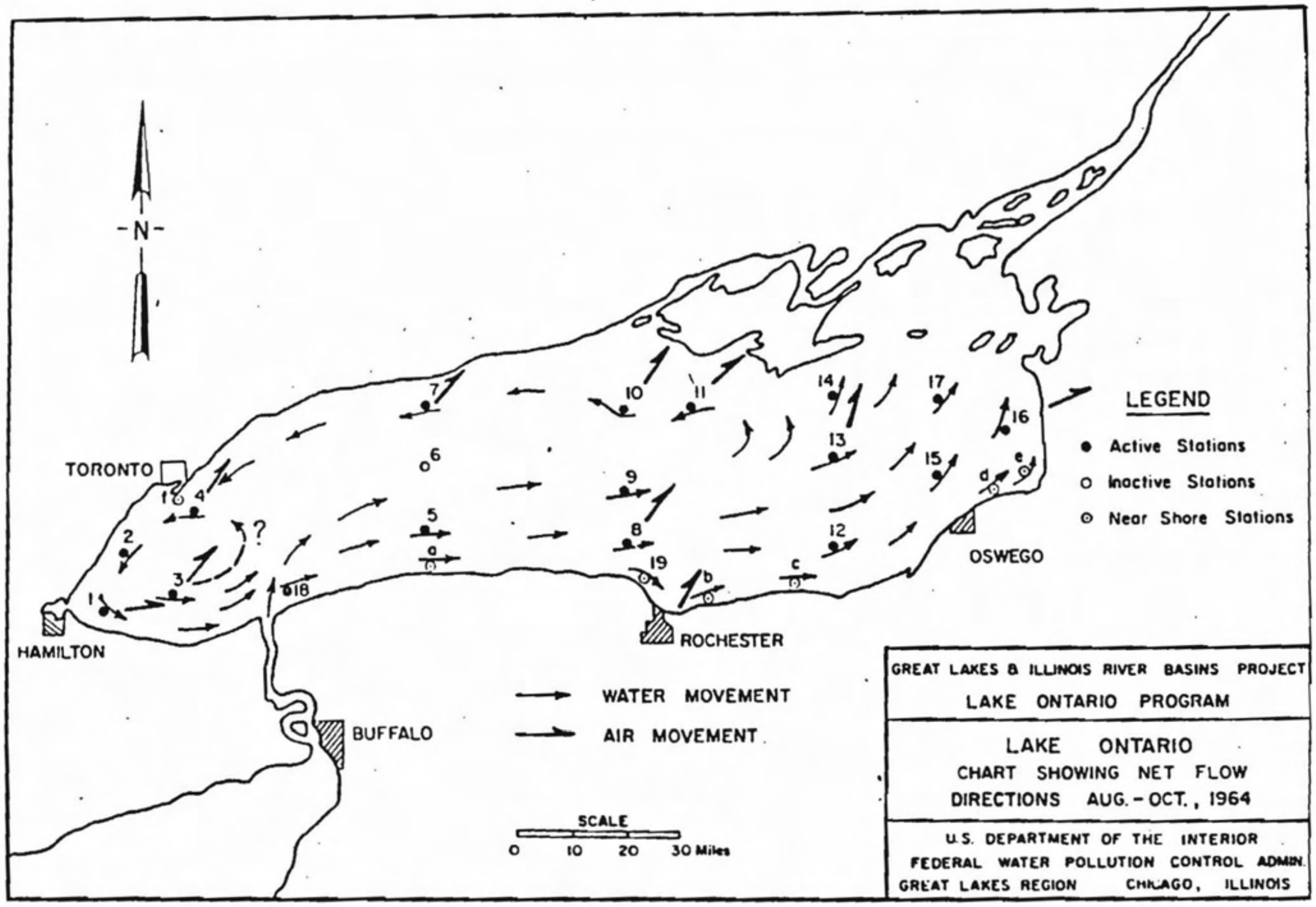


FIGURE 2-5. NET FLOW DIRECTIONS IN LAKE ONTARIO, AUGUST - OCTOBER

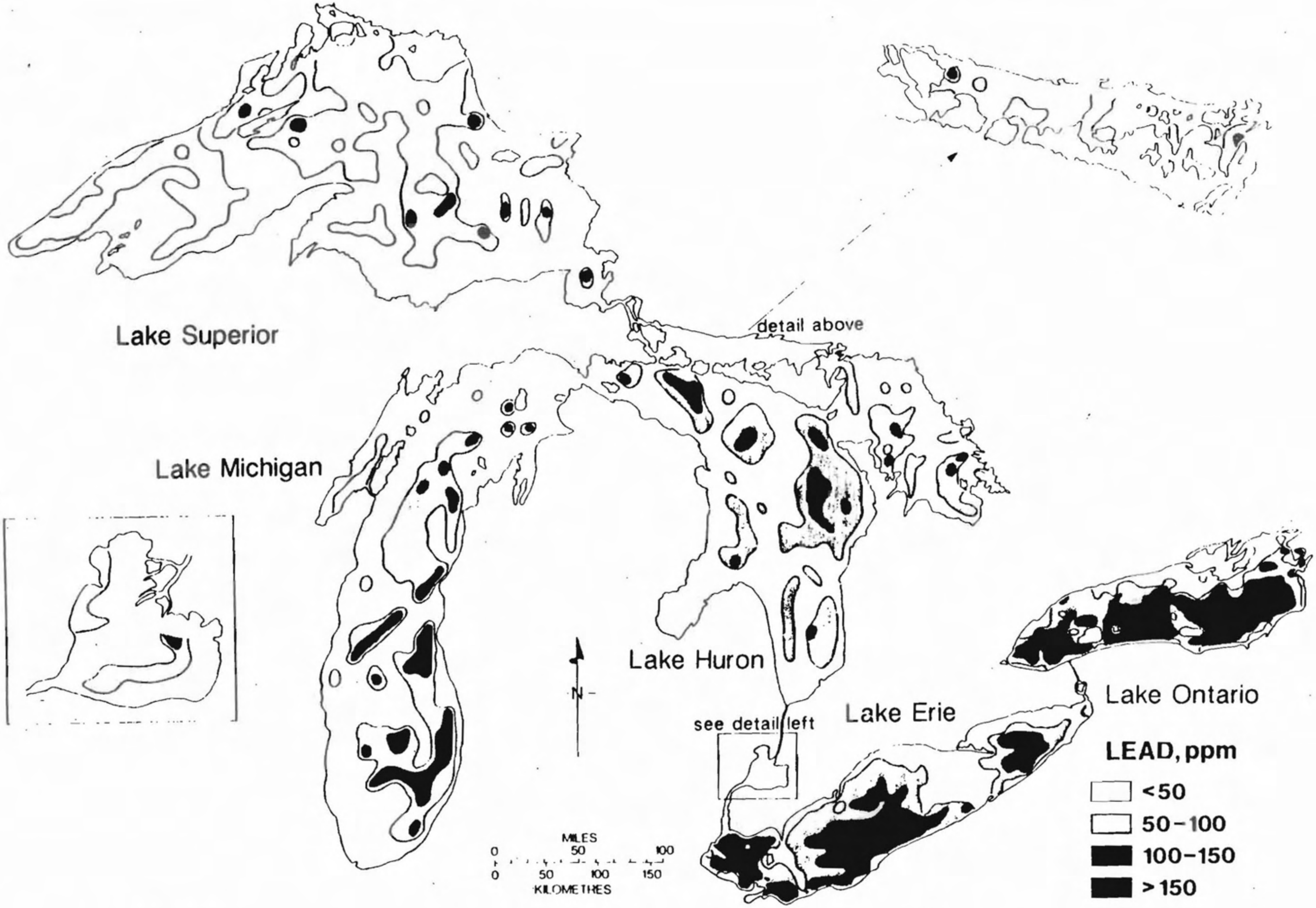
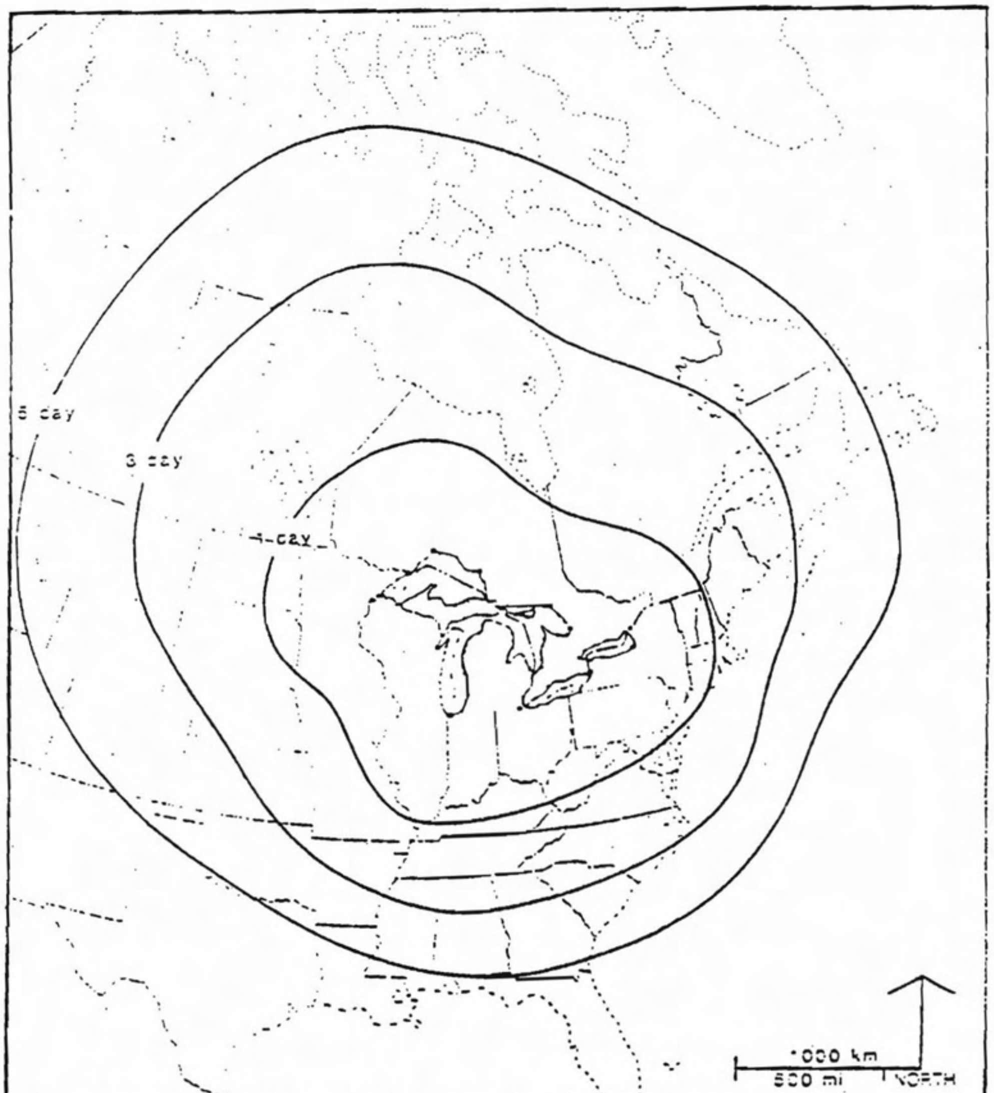


FIGURE 2-6.
LEAD CONCENTRATIONS IN SURFACE SEDIMENTS OF THE GREAT LAKES.

From: Great Lakes Science Advisory Board (1979).



Atmospheric Region of Influence for the Great Lakes Basin

Lines of the median location of an air parcel which would reach the Great Lakes Basin within the number of days shown. For example, the 3-day line indicates that it would take approximately three days for an air parcel to travel from a location on that line to the closest point on the Great Lakes.

FIGURE 2-8.
ATMOSPHERIC REGION OF INFLUENCE FOR THE GREAT LAKES BASIN

From: International Air Quality Advisory Board (March, 1988).

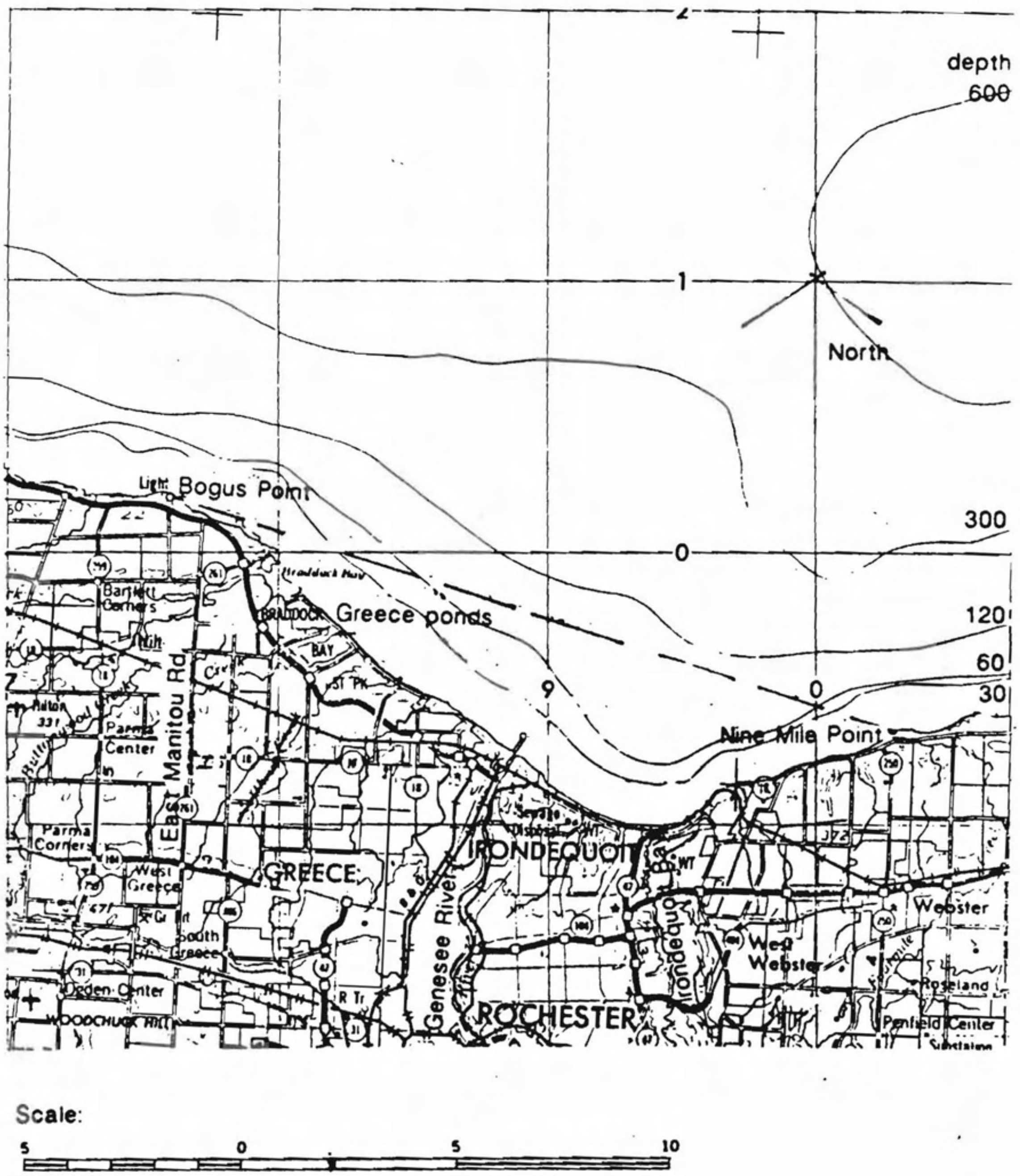


Figure 2-9: DETAIL OF LAKESIDE PORTION OF ROCHESTER EMBAYMENT AREA OF CONCERN: Bogus Point to Nine Mile Point

SCALE

1 Mile

FIGURE 2-10. ROCHESTER HARBOR

From: National Oceanic and Atmospheric Administration, National Ocean Service (1990).